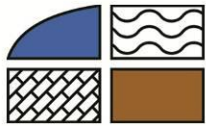




APPENDIX 8-3

PEATLAND HYDROLOGY STUDY



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**PEATLAND HYDROLOGY STUDY
AT 4 NO. BNM BOGS**

PEATLAND HYDROLOGY STUDY REPORT

FINAL REPORT

Prepared for:

BNM

Prepared by:

HYDRO-ENVIRONMENTAL SERVICES

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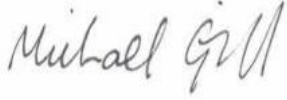
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1. INTRODUCTION

1.1 BACKGROUND

Hydro-Environmental Services (HES) were commissioned by BnM to complete a hydrological study at 4 no. peat bogs. HES installed piezometers transects at the bogs to allow collection of seasonal water level data. Investigations and monitoring were completed at Garryduff, Blackwater, and Mongan bogs (Blackwater Group), and Derrycolumb bog (Mountdillon Group). BnM collected water level data at these 4 no. sites between September/October 2018 and February 2020. The purpose of the study was to determine likely zones of influence of drainage on BnM bog unit sites, and also to determine the likely zones of influence of BnM pumping stations. A site location map, showing the relative location of the study sites is included below as **Figure A**.

The hydrological study at these bogs had the following objectives:

- Setup and installation of hydrological monitoring transects that include monitoring points in shallow peat, deep peat and underlying mineral subsoil;
- Collect and analyse seasonal water level data; and,
- Inform how far the likely Zone of Influence of BnM bog drainage and pumping station dewatering has on surrounding peatland and aquifers.

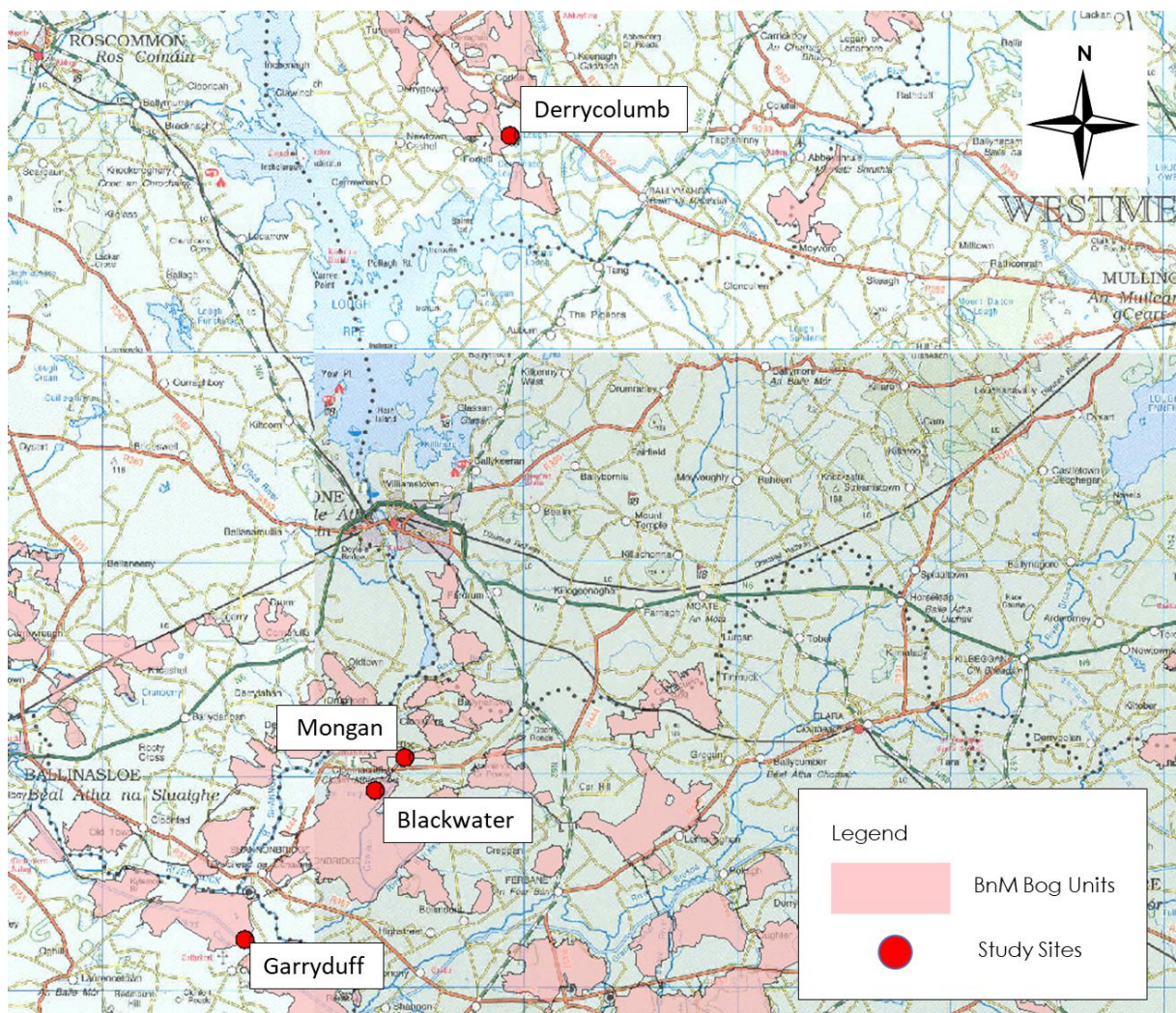


Figure A: Study Sites Location Map

2. SITE INVESTIGATION WORKS

2.1 BLACKWATER

Table A provides a summary of the site investigation and piezometer install works at the Blackwater Study site.

Table A: Summary of piezometer install works at Blackwater Study site

Information Type	Data
Install Dates	July 2018
No. of Transects	3 (T1, T2, and T3)
No. of Shallow Phreatic Tubes	43
No. of Deep Peat Piezometers	26
No. of Mineral Soil Piezometers	0
Interval of Peat Depths Recorded (m)	0.1-3.41 (n=42, $\sigma=1.28$) ¹
Dates of Water Level Monitoring (by BnM)	July 2018 to February 2020 (n=19)

Full details of the site investigation and piezometer install works are attached in **Appendix I**. A map of the Blackwater piezometer install locations is shown below as **Figure B**.

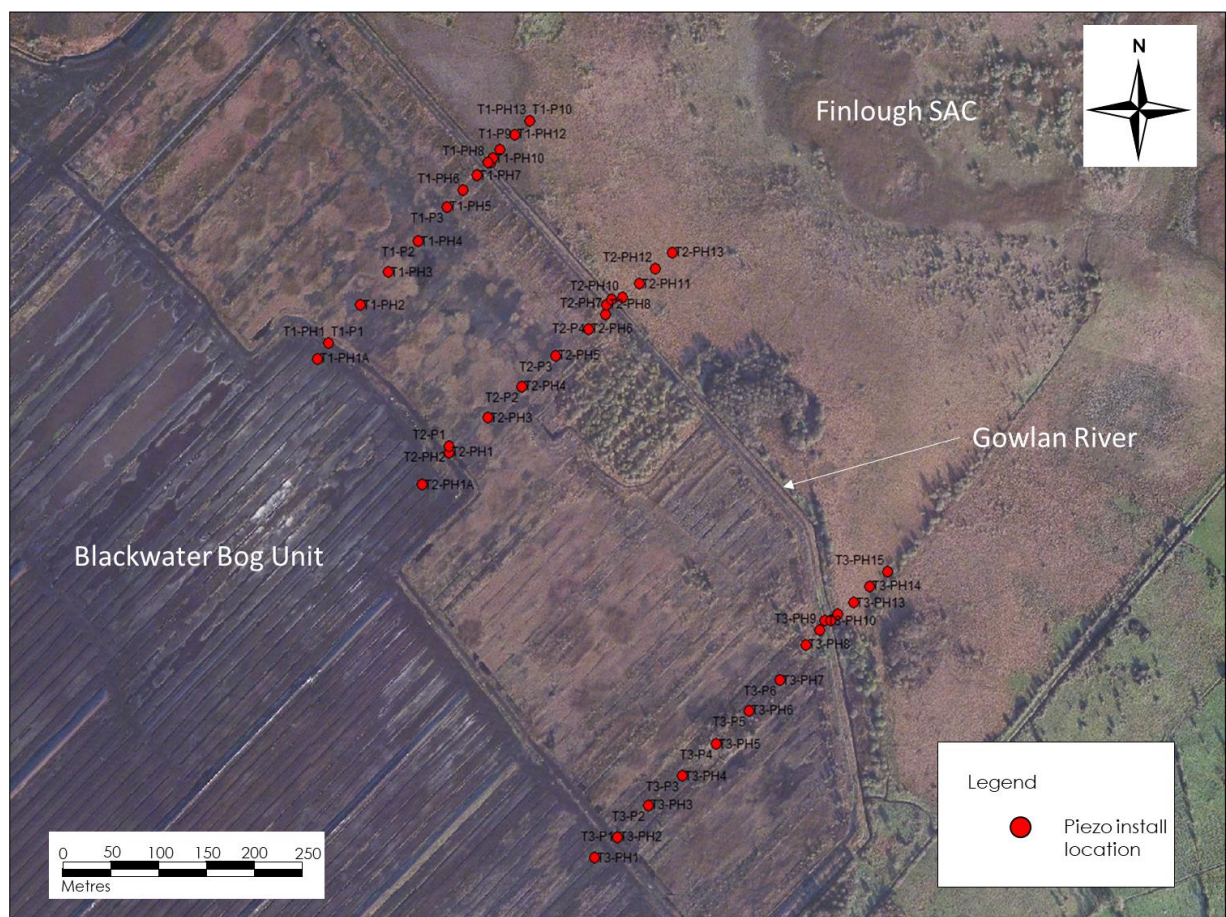


Figure B: Blackwater - piezometer install location map

¹ n = no. of data points. σ = mean of data.

2.2 DERRYCOLUMB

Table B provides a summary of the site investigation and piezometer install works at the Derrycolumb Study site.

Table B: Summary of piezometer install works at Derrycolumb Study site

Information Type	Data
Install Dates	August 2018
No. of Transects	3 (T1, T1A, and T3)
No. of Shallow Phreatic Tubes	18
No. of Deep Peat Piezometers	17
No. of Mineral Soil Piezometers	0
Interval of Peat Depths Recorded (m)	3.2->7.0 (n=18, $\sigma=4.63$)
Dates of Water Level Monitoring (by BnM)	Sept 2018 to November 2019 (n=14)

Full details of the site investigation and piezometer install works are attached in **Appendix I**. A map of the Derrycolumb piezometer install locations is shown below as **Figure C**.

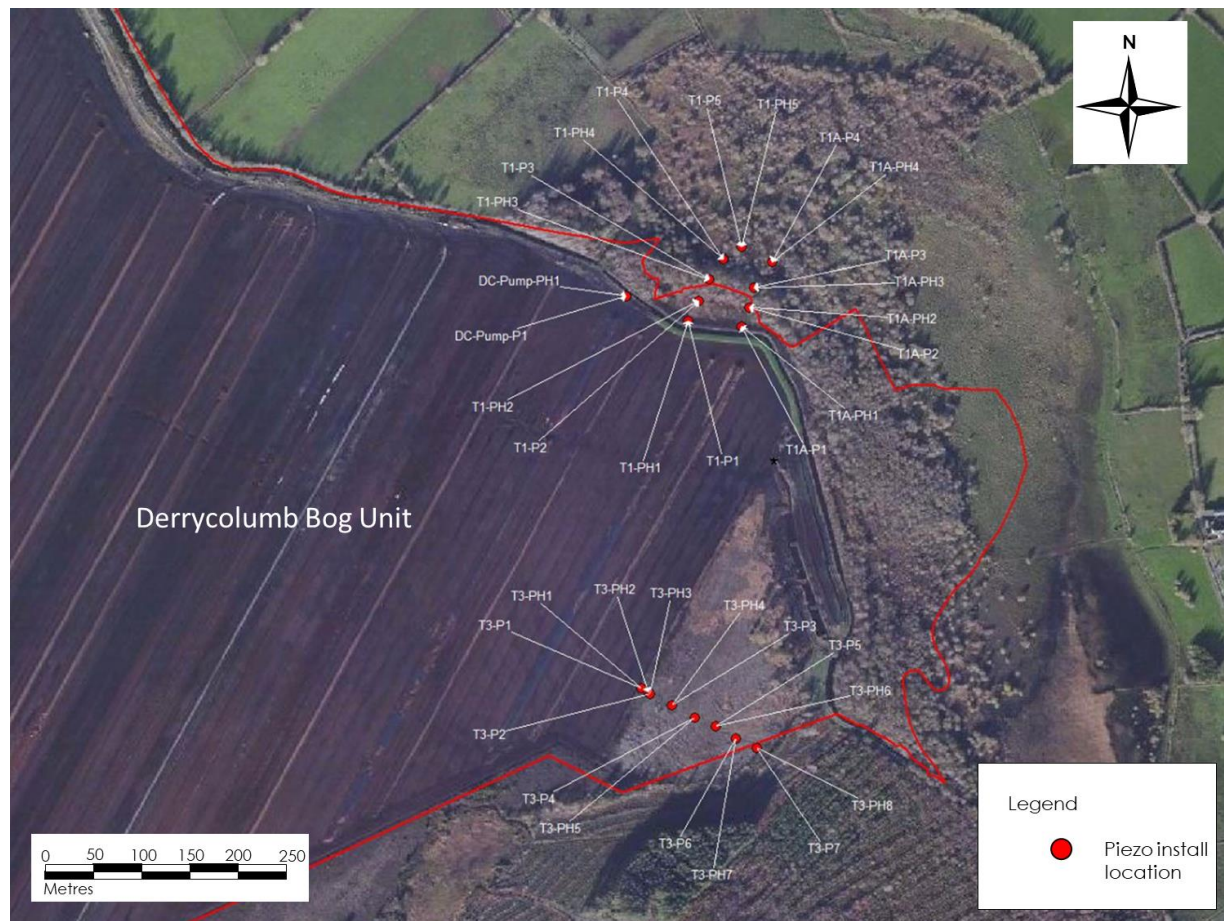


Figure C: Derrycolumb - piezometer install location map

2.3 MONGAN

Table C provides a summary of the site investigation and piezometer install works at the Mongan Study site.

Table C: Summary of piezometer install works at Mongan Study site

Information Type	Data
Install Dates	August 2018
No. of Transects	3 (T1, T2, and T3)
No. of Shallow Phreatic Tubes	26
No. of Deep Peat Piezometers	22
No. of Mineral Soil Piezometers	0
Interval of Peat Depths Recorded (m)	3.3-6.5 (n=26, $\sigma=4.99$)
Dates of Water Level Monitoring (by BnM)	Sept 2018 to February 2020 (n=19)

Full details of the site investigation and piezometer install works are attached in **Appendix I**. A map of the Mongan piezometer install locations is shown below as **Figure D**.

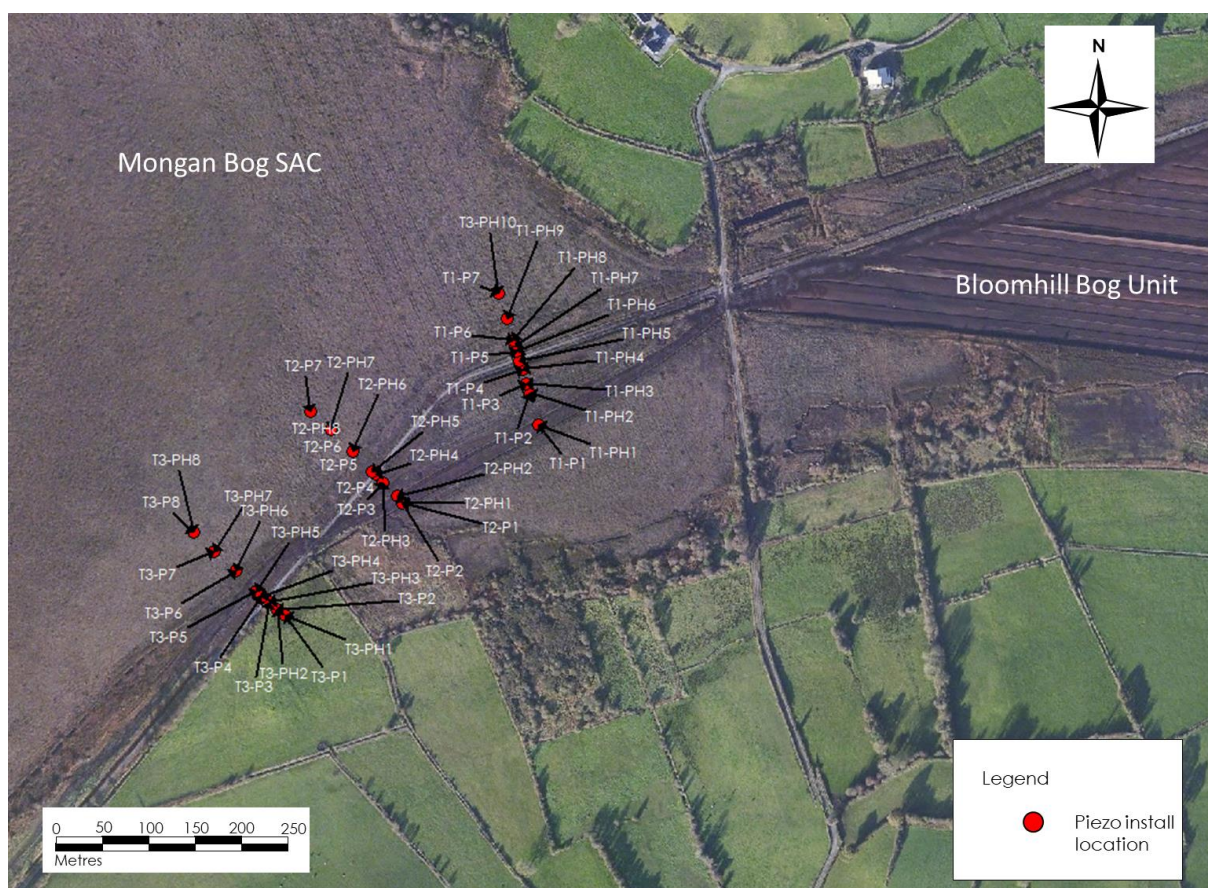


Figure D: Mongan - piezometer install location map

At Mongan bog, HES also completed a detailed survey of peat depths between Mongan bog and the adjacent Bloomhill bog unit. 34 no. peat depths were recorded. The minimum peat depth recorded was 1.55m, and the maximum peat depth recorded was 5.7m. The average peat depth recorded in the augering study area was 4.17m. Data from the Mongan augering study is attached in **Appendix II**.

2.4 GARRYDUFF

Table D provides a summary of the site investigation and piezometer install works at the Garryduff Study site.

Table D: Summary of piezometer install works at Garryduff Study site

Information Type	Data
Install Dates	August 2018
No. of Transects	1 (T1)
No. of Shallow Phreatic Tubes	4
No. of Deep Peat Piezometers	0
No. of Mineral Soil Piezometers	4
Interval of Peat Depths Recorded (m)	1.8-3.10 (n=4, $\sigma=2.12$)
Dates of Water Level Monitoring (by BnM)	Aug 2018 to December 2019 (n=18)

Full details of the site investigation and piezometer install works are attached in **Appendix III**. A map of the Garryduff piezometer install locations is shown below as **Figure E**. An existing shallow and deep set of monitoring wells existed to the south of the pump station as shown on **Figure E**.



Figure E: Garryduff - piezometer install location map

3. HYDROLOGICAL ANALYSIS

3.1 BLACKWATER

Data and water level plots for the Blackwater study site are attached in **Appendix IV**.

The following is observed from analysis of the seasonal water level data:

- Water levels in cutover parts of Blackwater bog show less seasonal fluctuations than those to the north of the Gowlan River (within the designated Finlough SAC area);
- Beyond ~50m to the south of the Gowlan River, water levels in all phreatic tubes are consistently within 10cm or less of the residual peat surface level with only small temporal fluctuations. The field drains in this area are blocked and essentially those measures have stabilised the hydrology to the benefit of the local vegetation;
- Further to the south, where operational field drains occur along open production fields, water levels in the peat profile are deep, and well below ground level (up to 0.75m below ground level). This shows the influence of field drains, as within 20/30m where drains are locked water levels are consistently higher as outlined above; and,
- The influence of the Gowlan River on water levels is apparent, especially to the north of the river where seasonal fluctuations in water levels can be as deep as 1m below ground level.

3.2 DERRYCOLUMB

Data and water level plots for the Derrycolumb study site are attached in **Appendix V**.

The following is observed from analysis of the seasonal water level data:

- Water levels in piezometers [along T1 and T1A] close to the deep bog boundary drain [northeastern corner of the bog] and pumping station P05-031 show higher seasonal fluctuations than those to the north of the bog, remote from the deep bog boundary drain;
- Beyond ~50 to ~80m to the north of the deep bog boundary drain, along Transect 1 and Transect 1A, water levels in all phreatic tubes are consistently within 10cm or less of the natural peat surface level with only small temporal fluctuations. Beyond these distances the bog hydrology does not appear to be significantly altered by the drainage and pumping completed at Derrycolumb bog unit; and,
- Further to the south at T3, the facebank drain shows an influence on peat water levels to ~40m to the southeast of the facebank. Beyond ~40m water levels in all phreatic tubes are consistently within 10cm or less of the natural peat surface level with only small temporal fluctuations, and deeper piezometers also show normal temporal variations.

3.3 MONGAN

Data and water level plots for the Mongan study site are attached in **Appendix VI**.

The following is observed from analysis of the seasonal water level data:

- Water levels in piezometers along Transects T1, T2, and T3, close to rail line and associated drains show higher seasonal fluctuations than data from higher on the intact raised bog to the north;
- On the high bog there is a surface drain parallel to the facebank [on T1 and T2, not T3], and while this is blocked, it appears to have some continued influence on temporal (phreatic) water levels;

- Deep peat piezometers have water levels up to 1m below ground level, and this indicates a strong downward gradient, and this is likely driven by deep perimeter drainage along the rail line, and the edge of the bog to the south;
- On the high bog within ~30 to ~40m of the rail line water levels in some phreatic tubes are occasionally (~50% of the time) within 10cm or less of the natural peat surface level, but with variable temporal fluctuations; and,
- From visual inspection there appears to be significant surface subsidence towards the rail line along the southern edge of Mongan bog.

3.4 GARRYDUFF

Data and water level plots for the Garryduff study site are attached in **Appendix VII**. Continuous water level monitoring was also completed in GW1 and GW2, and these data are plotted and also included in **Appendix VII**. On/off operational data (time series of when duty and standby pumps were on/off) for the pumping station was also provided by BnM.

The following is observed from analysis of the seasonal water level data:

- The pumping station is operated almost continuously, and it has a high low float switch, and a duty and standby pump set;
- Most of the water pumped is surface water, which feeds towards the sump via a network of field drains off the adjacent Garryduff bog unit;
- The pump sump is ~4.5m deep;
- Water level observations in the deep wells (GW1, GW2, GW3, and GW4) do not appear to respond (rise and fall) significantly to on/off pumping in the pump sump;
- Seasonal variations in deeper (mineral soil) water levels vary by ~1m. This is not significant;
- Shallow peat water levels do not appear to respond to pumping or changes of water level in the pump sump;
- Shallow peat water levels are influenced by deep drains at the edge of the bog; and,
- Water levels at GW4 and GPH4 do not appear to be influenced at all by drawdown at the pumping station. These wells are ~60m from the pumping station.

In order to extrapolate our observations from Garryduff to all pumping sites, we have completed a sensitivity analysis on R_0 (radius of influence) calculations using the Sichardt equation (Section 6.2.1 of CIRIA, 2000)². Using variations in permeability of the mineral soil profile, and varying the thickness of mineral soils, indicates that even in the most extreme of circumstances (i.e. using the most conservative values) the radius of influence of shallow pumping stations is <300m. this is without even trying to separate out groundwater flows from surface water flows (i.e. the analysis assumes all water is coming from groundwater, which is clearly not the case).

² Groundwater Control – Design and Practice, CIRIA C515, 2000.

4. SUMMARY CONCLUSIONS

We have used the water level data to attempt to determine conservative Zone of Influences for peat works field drains, deep perimeter drains, facebank drains, and pumping stations.

The following was observed:

- Without blocking or management, field drains can influence peat water levels at a distance of up to 30m;
- Deep perimeter bog drains can have an influence on peat water levels at a distance of between ~50-80m. Applying a zone of influence distance of 100m would be a conservative buffer;
- The influence of facebank drains depends on the height of the facebank. But data from Derrycolumb indicates that water levels on the high bog adjacent to a 1.5m high facebank (with drain along production side) are not significantly influenced by the facebank and associated drainage beyond ~40m distance. Applying a zone of influence distance of 60m would be a conservative buffer; and,
- Data from Garryduff bog indicates that the pumping station there (P21-019) does not significantly influence water levels in monitoring wells at a distance of ~60m from the pump sump. Additional hydrogeological modelling and analysis indicates that even when using the most conservative aquifer parameters the zone of influence of BnMs pumping stations (which are generally <5m deep) on local groundwater levels is likely to be <300m.

* * * * *

APPENDIX I: SITE INVESTIGATION DATA

Bog	Date	Transect	Piezo type	Location ID	Easting	Northing	Top of Pipe (mOD)	Ground Level (mOD)	peat depth (m)	peat interval(mbgl)	marl interval (mbgl)	lacustrine clay interval (mbgl)	standpipe screen (mbgl)	piezoemter screen (mbgl)	upstand (m)	Top of Pipe (mOD)	Ground Level (mOD)
Blackwater	Jul-18	T1	phreatic	T1-PH1A	202510.2	229238	37.544	36.459	0.4	0-0.4	0.4->1.2	-	0-1.0	1.10		37.544	36.459
Blackwater	Jul-18	T1	phreatic	T1-PH1	202528.1	229258.9	37.528	36.471	1.44	0-1.44	1.44->2.0	-	0-1.0	-	1.00	37.528	36.471
Blackwater	Jul-18	T1	Piezo	T1-P1	202528.4	229258.7	37.518	36.54				-		1.1-1.4	0.98	37.518	36.54
Blackwater	Jul-18	T1	phreatic	T1-PH2	202567.5	229297.7	37.963	36.64	0.57	0-0.57	0.57->2.0	-	0-1.0	-	1.35	37.963	36.64
Blackwater	Jul-18	T1	phreatic	T1-PH3	202601.4	229334.1	37.702	36.654	0.4	0-0.4	0.4->1.0	-	0-1.0	-	1.06	37.702	36.654
Blackwater	Jul-18	T1	phreatic	T1-PH4	202635.4	229370.7	37.705	36.691	2.4	0-2.4	2.4->3.0	-	0-1.0	-	1.03	37.705	36.691
Blackwater	Jul-18	T1	Piezo	T1-P2	202635.4	229370.5	37.817	36.692				-		2.0-2.3	1.13	37.817	36.692
Blackwater	Jul-18	T1	phreatic	T1-PH5	202670	229406.5	38.113	37.203	1.16	0-1.16	1.16-1.56	1.56-2.36 (brown silt)	0-1.0		0.91	38.113	37.203
Blackwater	Jul-18	T1	Piezo	T1-P3	202670.4	229406.3	38.169	37.17				-		0.8-1.10	1.00	38.169	37.17
Blackwater	Jul-18	T1	phreatic	T1-PH6	202687.7	229424.4	38.303	37.557	1.35	0-1.35	1.35->3.0	-	0-1.0		1.00	38.303	37.557
Blackwater	Jul-18	T1	Piezo	T1-P4	202687.8	229424.1	38.526	37.537				-		1.0-1.3	0.78	38.526	37.537
Blackwater	Jul-18	T1	phreatic	T1-PH7	202704.8	229441.9	39.049	38.137	2.4	0-2.4	2.4->3.0	-	0-1.0		0.90	39.049	38.137
Blackwater	Jul-18	T1	phreatic	T1-PH8	202714.1	229451.9	38.794	38.032	2.3	0-2.3	2.3-4.2	4.2->5.0	0-2.0		0.77	38.794	38.032
Blackwater	Jul-18	T1	Piezo	T1-P5	202714.3	229451.6	38.7	38.042				-		2.0-2.3	0.70	38.7	38.042
Blackwater	Jul-18	T1	phreatic	T1-PH9	202719.8	229457.1	38.845	37.729	2.4	0-2.4	2.4->3.0	-	0-1.0		1.10	38.845	37.729
Blackwater	Jul-18	T1	Piezo	T1-P6	202719.5	229457.2	38.675	37.714				-		2.15-2.45	0.96	38.675	37.714
Blackwater	Jul-18	T1	phreatic	T1-PH10	202723.8	229461.8	39.27.1	38.365	2.56	0-2.56	2.56->3.0	-	0-1.0		0.92	39.271	38.365
Blackwater	Jul-18	T1	Piezo	T1-P7	202724.1	229461.6	39.178	38.353				-		2.25-2.55	0.86	39.178	38.353
Blackwater	Jul-18	T1	phreatic	T1-PH11	202729.9	229468	39.572	38.893	2.8	0-2.8	2.8->3.0	-	0-1.0		0.75	39.572	38.893
Blackwater	Jul-18	T1	Piezo	T1-P8	202729.6	229468.4	39.57	38.894				-		2.40-2.70	0.70	39.57	38.894
Blackwater	Jul-18	T1	phreatic	T1-PH12	202747.6	229486.2	39.948	38.948	3.41	0-3.41	3.0->4.0	-	0-1.0		1.00	39.948	38.948
Blackwater	Jul-18	T1	Piezo	T1-P9	202747.5	229485.9	39.213	38.898				-		2.8-3.1	0.35	39.213	38.898
Blackwater	Jul-18	T1	phreatic	T1-PH13	202764.4	229503.4	39.534	38.546	2.05	0-2.05	2.05->3.0	-	0-1.0		1.43	39.534	38.546
Blackwater	Jul-18	T1	Piezo	T1-P10	202764.4	229503.5	39.952	38.569				-		1.7-2.0	1.00	39.952	38.569
Blackwater	Jul-18	T2	phreatic	T2-PH1A	202633.8	229111.5	38.242	36.71	1.95	0-1.95	1.95->2.5	-	0-1.0		1.55	38.242	36.71
Blackwater	Jul-18	T2	phreatic	T2-PH1	202671.9	229140.9	37.523	36.421		in pond		-	0-1.0		1.06	37.523	36.421
Blackwater	Jul-18	T2	phreatic	T2-PH2	202679.7	229147.4	37.878	36.888	0.75	0-0.75	0.75->2.0	-	0-1.0		1.01	37.878	36.888
Blackwater	Jul-18	T2	Piezo	T2-P1	202679.9	229147.2	37.832	36.849				-		0.45-0.75	1.00	37.832	36.849
Blackwater	Jul-18	T2	phreatic	T2-PH3	202717.9	229179.7	37.533	36.724	0.4	0-0.4	0.4->2.0	-	0-1.0		0.82	37.533	36.724
Blackwater	Jul-18	T2	phreatic	T2-PH4	202755.6	229212.2	37.773	36.77	1.67	0-1.67	1.67->2.5	-	0-1.0		1.02	37.773	36.77
Blackwater	Jul-18	T2	Piezo	T2-P2	202755.8	229212.1	37.758	36.776				-		1.25-1.55	1.00	37.758	36.776
Blackwater	Jul-18	T2	phreatic	T2-PH5	202794.3	229244.6	38.096	37.061	1.1	0-1.1	1.1->2.0	-	0-1.0		1.05	38.096	37.061
Blackwater	Jul-18	T2	Piezo	T2-P3	202794	229244.8	38.05	37.08				-		0.7-1.0	1.00	38.05	37.08
Blackwater	Jul-18	T2	phreatic	T2-PH6	202832.9	229278.1	38.216	37.287	1.44	0-1.44	1.44->2.0	-	0-1.0		0.93	38.216	37.287
Blackwater	Jul-18	T2	Piezo	T2-P4	202832.7	229278.3	38.279	37.25				-		1.1-1.4	1.02	38.279	37.25
Blackwater	Jul-18	T2	phreatic	T2-PH7	202851.7	229293.2	38.78	37.759	2.05	0-2.05	2.05->3.0	-	0-1.0		1.05	38.78	37.759
Blackwater	Jul-18	T2	Piezo	T2-P5	202851.6	229293.5	38.79	37.785				-		1.7-2.0	1.02	38.79	37.785
Blackwater	Jul-18	T2	phreatic	T2-PH8	202857.3	229302.1	38.337	37.484	1.8	0-1.8	1.8->2.2	-	0-1.5		0.865	38.337	37.484
Blackwater	Jul-18	T2	Piezo	T2-P6	202857	229302.1	38.041	37.48				-		1.5-1.8	0.55	38.041	37.48
Blackwater	Jul-18	T2	phreatic	T2-PH9	202861.8	229307.6	38.056	36.912	0.8	0-0.8	0.8->2.0	-	0-0.8		1.14	38.056	36.912
Blackwater	Jul-18	T2	Piezo	T2-P7	202861.6	229307.7	38.194	36.922				-		0.5-0.8	1.275	38.194	36.922
Blackwater	Jul-18	T2	phreatic	T2-PH10	202873.5	229312.1	38.076	37.532	0.7	0-0.7	0.7->1.6	-	0-0.8			38.076	37.532
Blackwater	Jul-18	T2	Piezo	T2-P8	202873.5	229312	38.194	37.533				-		0.4-0.7	0.7	38.194	37.533
Blackwater	Jul-18	T2	phreatic	T2-PH11	202892.3	229327.8	39.514	37.991	0.5	0-0.5	-	0.5->1.0	0-1.0		1.58	39.514	37.991
Blackwater	Jul-18	T2	phreatic	T2-PH12	202912	229344.5	39.473	38.055	0.25	0-0.25	-	0.25->1.0	0-1.0		1.62	39.473	38.055
Blackwater	Jul-18	T2	phreatic	T2-PH13	202931.8	229361.1	39.359	37.993	0.15	0-0.15	-	0.15->1.0	0-1.0		1.52	39.359	37.993
Blackwater	Aug-18	T3	phreatic	T3-PH1	202840.9	228696	37.848	36.81	0.85	0-0.85	0.85->1.0	-	0-1.0		1.04	37.848	36.81
Blackwater	Aug-18	T3	phreatic	T3-PH2	202870.9	228723.5	38.077	37.216	1.2	0-1.2	1.2-1.6	1.6->2.0	0-1.0		0.875	38.077	37.216
Blackwater	Aug-18	T3	Piezo	T3-P1	202870.7	228723.7	38.297	37.221				-		0.9-1.2	1.085	38.297	37.221
Blackwater	Aug-18	T3	phreatic	T3-PH3	202906.9	228757.5	38.605	37.535	2.25	0-2.25	2.25->3.0	-	0-1.0		1.07	38.605	37.535
Blackwater	Aug-18	T3	Piezo	T3-P2	202906.7	228757.7	37.844	37.353				-		1.8-2.1	0.32	37.844	37.353
Blackwater	Aug-18	T3	phreatic	T3-PH4	202944.5	228790.6	37.643	37.114	1.73	0-1.73	1.73->2.6	-	0-1.0		1.05	37.643	37.114
Blackwater	Aug-18	T3	Piezo	T3-P3	202944.7	228790.3	38.18	37.094				-		1.4-1.7	0.55	38.18	37.094
Blackwater	Aug-18	T3	phreatic	T3-PH5	202980.9	228827.2	38.651	37.244	1.8	0-1.8	1.8->2.6	-	0-1.0		1.37	38.651	37.244
Blackwater	Aug-18	T3	Piezo	T3-P4	202980.6	228827.5	37.764	37.275				-		1.4-1.7	0.48	37.764	37.275
Blackwater	Aug-18	T3	phreatic	T3-PH6	203016.9	228864.3	38.473	37.383	1.5	0-1.5	1.5->2.6	-	0-1.0		1.1	38.473	37.383
Blackwater	Aug-18	T3	Piezo	T3-P5	203016.7	228864.7	38.238	37.379				-		1.1-1.4	0.87	38.238	37.379
Blackwater	Aug-18	T3	phreatic	T3-PH7	203054.6	228897.5	38.338	37.334	1.3	0-1.3	1.3->2.0	-	0-1.0		1.02	38.338	37.334
Blackwater	Aug-18	T3	Piezo	T3-P6	203054.3	228897.7	37.822	37.327				-		0.9-1.2	0.5	37.822	37.327
Blackwater	Aug-18	T3	phreatic	T3-PH8	203089.9	228934.5	38.471	37.47	1.2	0-1.2	1.2->2.0	-	0-1.0		1.02	38.471	37.47

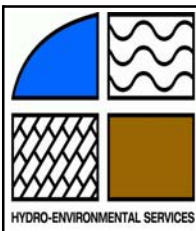
Bog	Date	transect	Piezo type	Location ID	Easting	Northing	peat depth (m)	peat interval(mbgl)	marl interval (mbgl)	lacustrine clay interval (mbgl)	standpipe screen (mbgl)	piezoemter screen (mbgl)	upstand (m)
Derrycolumb	Aug-18	T1	phreatic	T1-PH1	209308	260082	6.54	0-6.54	6.54->7.0	-	0.26-1.26		0.74
Derrycolumb	Aug-18	T1	Piezo	T1-P1	209308	260082						5.7-6.0	0.33
Derrycolumb	Aug-18	T1	phreatic	T1-PH2	209319	260103	5.7	0-5.7	5.7->6.0	-	0-1.0		0.92
Derrycolumb	Aug-18	T1	Piezo	T1-P2	209319	260103						5.3-5.6	0.81
Derrycolumb	Sep-18	T1	phreatic	T1-PH3	209329	260125	3.2	0-3.2	3.2->4.0		0-1.0		0.98
Derrycolumb	Sep-18	T1	Piezo	T1-P3	209329	260125						2.8-3.1	0.3
Derrycolumb	Sep-18	T1	phreatic	T1-PH4	209344	260140	5.1	0-5.1		5.1-6.1	0-1.0		0.89
Derrycolumb	Sep-18	T1	Piezo	T1-P4	209344	260140						4.7-5.0	1.05
Derrycolumb	Sep-18	T1	phreatic	T1-PH5	209363	260159	4	>4.0			0-1.0		0.98
Derrycolumb	Sep-18	T1	Piezo	T1-P5	209363	260159						2.6-2.9	0.54
Derrycolumb	Aug-18	T1A	phreatic	T1A-PH1	209363	260076	7	>7	-	-	0.34-1.34		0.66
Derrycolumb	Aug-18	T1A	Piezo	T1A-P1	209363	260076						5.1-5.4	0.39
Derrycolumb	Aug-18	T1A	phreatic	T1A-PH2	209371	260096	5.5	0-5.5	5.5-5.8		0-1.0		0.84
Derrycolumb	Aug-18	T1A	Piezo	T1A-P2	209371	260096						4.0-4.3	0.72
Derrycolumb	Sep-18	T1A	phreatic	T1A-PH3	209376	260116	3.8	0-3.8	3.8->4.0		0-1.0		1
Derrycolumb	Sep-18	T1A	Piezo	T1A-P3	209376	260116						3.2-3.5	0.97
Derrycolumb	Sep-18	T1A	phreatic	T1A-PH4	209394	260143	4	>4.0			0-1.0		0.93
Derrycolumb	Sep-18	T1A	Piezo	T1A-P4	209394	260143						2.3-2.6	0.8
Derrycolumb	Aug-18	T3	phreatic	T3-PH1	209264	259702	3.5	0-3.5	3.5-4.1	4.1->5.0	0-2.0		1
Derrycolumb	Aug-18	T3	piezo	T3-P1	209264	259702						3.0-3.3	0.13
Derrycolumb	Aug-18	T3	phreatic	T3-PH2	209271	259698	3.5	0-3.5			0-1.0		0.66
Derrycolumb	Aug-18	T3	phreatic	T3-PH3	209273	259696	3.7	0-3.7	3.7-4.0	4.0->5	0-1.0		1.03
Derrycolumb	Aug-18	T3	Piezo	T3-P2	209273	259696						2.97-3.27	0.17
Derrycolumb	Aug-18	T3	phreatic	T3-PH4	209296	259685	4.56	0-4.56	4.56->5.0	-	0-1.0		1
Derrycolumb	Aug-18	T3	Piezo	T3-P3	209296	259685						4.17-4.47	0.93
Derrycolumb	Aug-18	T3	phreatic	T3-PH5	209319	259672	5.5	0-5.5	5.5->6.0	-	0-1.0		1.02
Derrycolumb	Aug-18	T3	Piezo	T3-P4	209319	259672						4.6-4.9	0.5
Derrycolumb	Aug-18	T3	phreatic	T3-PH6	209341	259663	5.2	0-5.2	5.2->6.0	-	0-1.0		1.04
Derrycolumb	Aug-18	T3	Piezo	T3-P5	209341	259663						4.88-5.18	0.67
Derrycolumb	Aug-18	T3	phreatic	T3-PH7	209362	259651	5.45	0-5.45	5.45->6.0	-	0-1.0		1.01
Derrycolumb	Aug-18	T3	Piezo	T3-P6	209362	259651						4.9-5.2	0.54
Derrycolumb	Aug-18	T3	phreatic	T3-PH8	209384	259641	3.7	0-3.7	3.7->5.2	-	0-1.0		1.05
Derrycolumb	Aug-18	T3	Piezo	T3-P7	209384	259641						3.10-3.40	0.14
Derrycolumb	Sep-18	T4	phreatic	DC-Pump-PH1	209244	260107	3.4	0-3.4	3.4->4.0		0.3-1.3		0.7
Derrycolumb	Sep-18	T4	Piezo	DC-Pump-P1	209244	260107						2.8-3.1	0.27

Bog	Date	Transect	Piezo type	Location ID	Easting	Northing	peat depth (m)	peat interval(mbgl)	marl interval (mbgl)	lacustrine clay interval (mbgl)	standpipe screen (mbgl)	piezoemter screen (mbgl)	upstand (m)
Mongan	Aug-18	T1	phreatic	T1-PH1	204306	230832	5.48	0-5.48	none	5.48->5.78	0-1.0		1.00
Mongan	Aug-18	T1	Piezo	T1-P1	204306	230832						4.8-5.1	1.29
Mongan	Aug-18	T1	phreatic	T1-PH2	204299	230859	5.09	0-5.09	none	5.09->5.34	0.5-1.5		0.50
Mongan	Aug-18	T1	Piezo	T1-P2	204299	230859						4.7-5.0	1.06
Mongan	Aug-18	T1	phreatic	T1-PH3	204295	230868	4.41	0-4.41	none		0.5-1.5		0.50
Mongan	Aug-18	T1	Piezo	T1-P3	204295	230868						3.9-4.2	0.98
Mongan	Aug-18	T1	phreatic	T1-PH4	204292	230880	5.1	0-5.10	none	5.1->5.35	0.5-1.5		0.50
Mongan	Aug-18	T1	Piezo	T1-P4	204292	230880						4.7-5.0	1.43
Mongan	Aug-18	T1	phreatic	T1-PH5	204289	230888	5	>5.0			0-1.0		1.00
Mongan	Aug-18	T1	phreatic	T1-PH6	204287	230896	5.28	0-5.28	none		0-1.0		1.02
Mongan	Aug-18	T1	Piezo	T1-P5	204287	230896						4.7-5.0	1.43
Mongan	Aug-18	T1	phreatic	T1-PH7	204286	230900	5	>5.0			0-1.0		0.98
Mongan	Aug-18	T1	phreatic	T1-PH8	204284	230905	5.4	0-5.4	none		0-1.0		0.60
Mongan	Aug-18	T1	Piezo	T1-P6	204284	230905						5.0-5.3	1.09
Mongan	Aug-18	T1	phreatic	T1-PH9	204278	230924	5.2	>5.2			0-1.0		1.00
Mongan	Aug-18	T1	phreatic	T3-PH10	204271	230946	6.5	0-6.5	none	6.5->6.8	0-1.0		1.02
Mongan	Aug-18	T1	Piezo	T1-P7	204271	230946						4.85-5.15	1.27
Mongan	Aug-18	T2	phreatic	T2-PH1	204187	230763	4.7	0-4.7	none	4.7->4.95	0.5-1.5		0.5
Mongan	Aug-18	T2	piezo	T2-P1	204187	230763						3.75-4.05	0.96
Mongan	Aug-18	T2	phreatic	T2-PH2	204183	230769	4.72	0-4.72	none	4.7->5.0	0.5-1.5		0.48
Mongan	Aug-18	T2	piezo	T2-P2	204183	230769						4.1-4.4	0.98
Mongan	Aug-18	T2	phreatic	T2-PH3	204170	230760	4.75	0-4.75	none		0.5-1.5		0.5
Mongan	Aug-18	T2	piezo	T2-P3	204170	230760						4.4-4.7	0.68
Mongan	Aug-18	T2	phreatic	T2-PH4	204163	230788	5.05	0-5.05	none	4.05->4.35	0-1.0		1
Mongan	Aug-18	T2	piezo	T2-P4	204163	230788						4.7-5.0	0.9
Mongan	Aug-18	T2	phreatic	T2-PH5	204160	230790	4	>4.0			0-1.0		0.95
Mongan	Aug-18	T2	phreatic	T2-PH6	204143	230807	5.3	0-5.3	none	4.3->4.65	0-1.0		1
Mongan	Aug-18	T2	piezo	T2-P5	204143	230807						4.6-4.9	0.52
Mongan	Aug-18	T2	phreatic	T2-PH7	204124	230826	5.45	0-5.45	none	5.45->5.68	0-1.0		0.98
Mongan	Aug-18	T2	piezo	T2-P6	204124	230826						5.05-5.35	1.05
Mongan	Aug-18	T2	phreatic	T2-PH8	204106	230842	5.7	0-5.7	none	5.7->5.95	0-1.0		1.05
Mongan	Aug-18	T2	piezo	T2-P7	204106	230842						5-5.3	0.8
Mongan	Aug-18	T3	phreatic	T3-PH1	204085	230664	3.3	0-3.3	none	3.3->3.65	0.5-1.5		1.18
Mongan	Aug-18	T3	Piezo	T3-P1	204085	230664						2.43-2.73	0.67
Mongan	Aug-18	T3	phreatic	T3-PH2	204077	230669	3.4	0-3.4	none	3.4->3.8	0.5-1.5		1
Mongan	Aug-18	T3	Piezo	T3-P2	204077	230669						2.5-2.8	0.6
Mongan	Aug-18	T3	phreatic	T3-PH3	204071	230675	4.62	0-4.62	none	4.62->4.9	0-1.0		1.2
Mongan	Aug-18	T3	Piezo	T3-P3	204071	230675						4.05-4.35	1
Mongan	Aug-18	T3	phreatic	T3-PH4	204063	230680	4.7	0-4.7	none	4.7->5.0	0-1.0		1.01
Mongan	Aug-18	T3	Piezo	T3-P4	204063	230680						4.25-4.55	0.6
Mongan	Aug-18	T3	phreatic	T3-PH5	204059	230685	4.85	0-4.85	none	4.85->5.25	0-1.0		1.06
Mongan	Aug-18	T3	Piezo	T3-P5	204059	230685						4.4-4.7	0.7
Mongan	Aug-18	T3	phreatic	T3-PH6	204041	230703	5.2	0-5.2	none	5.2->5.45	0-1.0		1
Mongan	Aug-18	T3	Piezo	T3-P6	204041	230703						4.4-4.7	0.7
Mongan	Aug-18	T3	phreatic	T3-PH7	204022	230719	5.7	0-5.7	none	5.7->5.99	0-1.0		1
Mongan	Aug-18	T3	Piezo	T3-P7	204022	230719						5.1-5.4	1
Mongan	Aug-18	T3	phreatic	T3-PH8	204004	230736	5.75	0-5.75	none	5.75->6.0	0-1.0		1.2
Mongan	Aug-18	T3	Piezo	T3-P8	204004	230736						4.95-5.25	1.16

APPENDIX II: MONGAN BOG – AUGERING DATA

Bog	Location	Easting	Northing	peat depth (mbgl)	Mineral Soil Depth (mbgl) and description	Base type
Mongan	GC2	204493	230953	3.70	no clay	hard base @ 3.7mbgl
Mongan	GC3	204543	230969	4.20	4.2-4.5 - lacustrine clay	hard base at 4.5mbgl
Mongan	GC4	204592	230989	4.60	4.6-4.8 - lacustrine clay	hard base at 4.8mbgl
Mongan	GC5	204386	230931	4.74	no clay	hard base @ 4.74mbgl
Mongan	GC6	204436	230938	4.90	4.9-5.2 - soft lacustrine clay	hard base @ 5.2mbgl
Mongan	GC7	204470	230923	3.80	grey fine soft clay	hard base @ 3.8mbgl
Mongan	GC8	204497	230928	4.05	4.05-4.15 - lacustrine clay	hard base @ 4.15mbgl
Mongan	GC9	204546	230943	3.80	no clay	hard gravel @ 3.8mbgl
Mongan	GC10	204594	230952	4.62	4.62-4.82 - lacustrine clay	hard base @ 4.82mbgl
Mongan	GC11	204644	230964	4.60	sandy/gravelly base	hard base @ 4.6mbgl
Mongan	GC12	204692	230971	2.75	2.75-2.95 - soft lacustrine clay	hard base @ 2.95mbgl
Mongan	GC13	204395	230885	5.25	5.25-5.35 - wet sand and gravel 5.35-5.55 - Lacustrine clay	hard base @ 5.55mbgl
Mongan	GC14	204439	230892	2.85	2.85-2.95 - light brown sand	hard base @ 2.95mbgl
Mongan	GC15	204479	230876	2.40	no clay	hard base @ 2.4mbgl
Mongan	GC16	204507	230884	5.02	5.02-5.22- lacustrine clay	hard base @ 5.22mbgl
Mongan	GC16a	204555	230883	4.60	no clay	hard base @ 4.6mbgl
Mongan	GC17	204550	230912	3.35	3.35-3.55 - black lacustrine clay	hard base @ 3.55mbgl
Mongan	GC18	204597	230907	2.90	2.9-3.1 - lacustrine clay	hard base @ 3.10mbgl
Mongan	GC19	204636	230904	3.75	3.75-3.85 - lacustrine lay	hard base @ 3.85mbgl
Mongan	GC20	204682	230919	3.00	no clay	hard base @ 3.0mbgl
Mongan	GC21	204404	230833	5.40	5.4-5.6 - grey lacustrine clay	hard base @ 5.6mbgl
Mongan	GC22	204454	230838	5.42	5.42-5.6 - grey lacustrine clay	hard base @ 5.6mbgl
Mongan	GC23	204485	230826	4.00	4.0-4.1 - grey sand 4.1-4.4 - grey lacustrine clay	hard base @ 4.4mbgl
Mongan	GC24	204516	230834	4.25	4.25-4.65 - light brown clay	hard base @ 4.65mbgl
Mongan	GC25	204565	230844	5.37	5.37-5.6 - lacustrine clay	hard base @ 5.6mbgl
Mongan	GC26	204613	230854	5.55	no clay	hard base @ 5.55mbgl
Mongan	GC27	204657	230863	5.40	5.4-5.6 - lacustrine clay	hard base @ 5.6mbgl
Mongan	GC28	204710	230870	3.50	3.5-3.7 - lacustrine clay	hard base @ 3.7mbgl
Mongan	GC29	204408	230791	5.70	no clay	hard base @ 5.7mbgl
Mongan	GC30	204458	230796	5.55	no clay	hard base @ 5.55mbgl
Mongan	GC31	204489	230778	4.67	4.67-5.0 - grey lacustrine clay	hard base @ 5.0mbgl
Mongan	GC32	204522	230798	4.40	4.4-4.6 - lacustrine clay	hard base @ 4.6mbgl
Mongan	GC33	204573	230798	1.55	1.55-1.77 - lacustrine clay	hard base @ 1.77mbgl
Mongan	GC34	204617	230810	2.15	no clay	hard base @ 2.15mbgl

APPENDIX III: GARRYDUFF WS LOGS



CAMERA SURVEY LOG

WELL NUMBER: GW1

PROJECT NUMBER: P1420-1

DATE STARTED: 02/08/2018

EASTING: 196606

SITE: Garyduff, Clonfert, Co. Galway

DATE FINISHED: 09/08/2018

NORTHING: 222257

CLIENT: Bord na Mona

LOGGED BY: M. Gill

ELEVATION: 33.884 mOD

DRILLING CONTRACTOR: HES

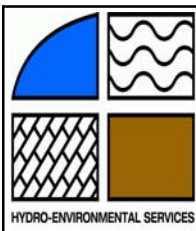
DRILLING TYPE: Hand augering and window sampling

Well Completion Description	Comments	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
	3" PVC casing installed from ground level to top of mineral soil. Deep piezometer is installed within this casing, with screened section installed below the base of the 3" casing. The 3" casing was pushed into the ground using a 360 excavator, and the inside of the casing was cleaned out using handheld auger and bailer.		33.88	0		Ground Surface
						Peat
			32.08			Light brown, soft Shell Marl
			29.73			Grey, sticky Lacustrine CLAY
			29.21			Hard, grey gravelly Silt/Clay - Limestone Till
	GW1: bentonite seal from 5.5mbgl to ground level GW1: coarse sand installed from 6.61 to 5.5mbgl		27.27	5		
						E.O.H 6.61mbgl
						Total Depth of Borehole

REMARKS

PAGE 1 of 1

SCALE



CAMERA SURVEY LOG

WELL NUMBER: GW2

PROJECT NUMBER: P1420-1

DATE STARTED: 02/08/2018

EASTING: 196640

SITE: Garyduff, Clonfert, Co. Galway

DATE FINISHED: 09/08/2018

NORTHING: 222266

CLIENT: Bord na Mona

LOGGED BY: M. Gill

ELEVATION: 33.901mOD

DRILLING CONTRACTOR: HES

DRILLING TYPE: Hand augering and window sampling

Well Completion Description	Comments	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
GW2 34.385mOD G/L 0.18mbgl 1.18mbgl 32mm screen with geosock 19mm Piezo 4.53mbgl 5.53mbgl 19mm Screen/geosock	3" PVC casing installed from ground level to top of mineral soil. Deep piezometer is installed within and below this casing. Screened section installed below base of 3" casing. The 3" casing was pushed into the ground using a 360 excavator, and the inside of the casing was cleaned out using handheld auger and bailer. GW2: bentonite seal from 4.4mbgl to ground level GW2: Coarse sand from 4.4mbgl to 5.53mbgl		33.90	0		Ground Surface
						Dry, hard Peat
			32.80			Softer, damp brown Peat
			32.10			Light brown, soft Shell Marl
			29.65			
			29.30			Grey sticky Clay - Lacustine deposits
				5		Wet, Sandy Mineral Soil - Limestone Till
			28.37			
						E.O.H 5.53mbgl Total Depth of Borehole

REMARKS

PAGE 1 of 1

SCALE



CAMERA SURVEY LOG

WELL NUMBER: GW3

PROJECT NUMBER: P1420-1

DATE STARTED: 02/08/2018

EASTING: 196655

SITE: Garyduff, Clonfert, Co. Galway

DATE FINISHED: 09/08/2018

NORTHING: 222275

CLIENT: Bord na Mona

LOGGED BY: M. Gill

ELEVATION: 33.914mOD

DRILLING CONTRACTOR: HES

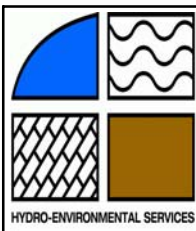
DRILLING TYPE: Hand augering and window sampling

Well Completion Description	Comments	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
	3" PVC casing installed from ground level to top of mineral soil. Deep piezometer is installed within and below this casing. Screened section installed below base of 3" casing. The 3" casing was pushed into the ground using a 360 excavator, and the inside of the casing was cleaned out using handheld auger and bailer. GW3: bentonite seal from 4.6mbgl to ground level GW3: Coarse sand from 4.6mbgl to 5.71mbgl		0.00	0		Ground Surface
			-1.20			Dry, hard Peat
			-1.80			Softer, damp brown Peat
			-4.00			Light brown, soft Shell Marl
			-4.60			Grey, soft, sticky Silt/Clay - Lacustine deposits
			-5.71	5		Wet, grey, sandy Mineral Soil - Limestone Till
						E.O.H 5.71mbgl Total Depth of Borehole

REMARKS

PAGE 1 of 1

SCALE



CAMERA SURVEY LOG

WELL NUMBER: GW4

PROJECT NUMBER: P1420-1

DATE STARTED: 02/08/2018

EASTING: 196702

SITE: Garyduff, Clonfert, Co. Galway

DATE FINISHED: 09/08/2018

NORTHING: 222272

CLIENT: Bord na Mona

LOGGED BY: M. Gill

ELEVATION: 35.645mOD

DRILLING CONTRACTOR: HES

DRILLING TYPE: Hand augering and window sampling

Well Completion Description	Comments	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
35.927mOD GW4 GPH4 36.158mOD G/L 0.47mbgl 1.47mbgl 19mm Piezo 32mm screen with geosock 5.92mbgl 6.92mbgl 19mm Screen/geosock	3" PVC casing installed from ground level to top of mineral soil. Deep piezometer is installed within and below this casing. Screened section installed below base of 3" casing. The 3" casing was pushed into the ground using a 360 excavator, and the inside of the casing was cleaned out using handheld auger and bailer. GW4: bentonite seal from 4.8mbgl to ground level GW4: Coarse sand from 4.8mbgl to 6.92		35.65	0		Ground Surface
			34.55			Dry, hard dark brown Peat
			32.55			Damp, brown soft Peat
			30.75			Light brown, soft Shell Marl
			28.73	5		Stiff, grey, clayey, gravelly SILT - Limestone Till (Hammering in hard gravel)
						E.O.H 6.92mbgl
						Total Depth of Borehole

REMARKS

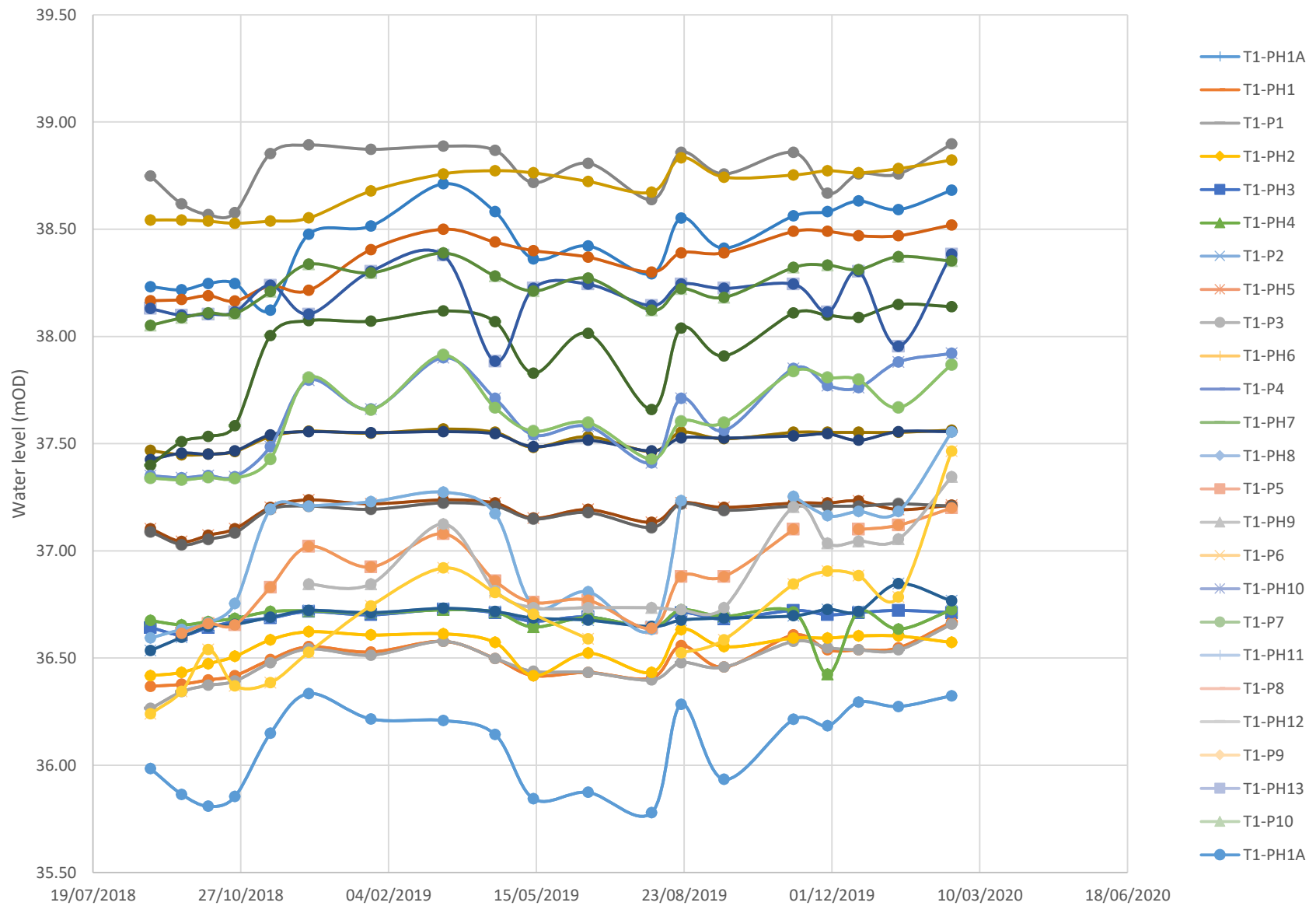
PAGE 1 of 1

SCALE

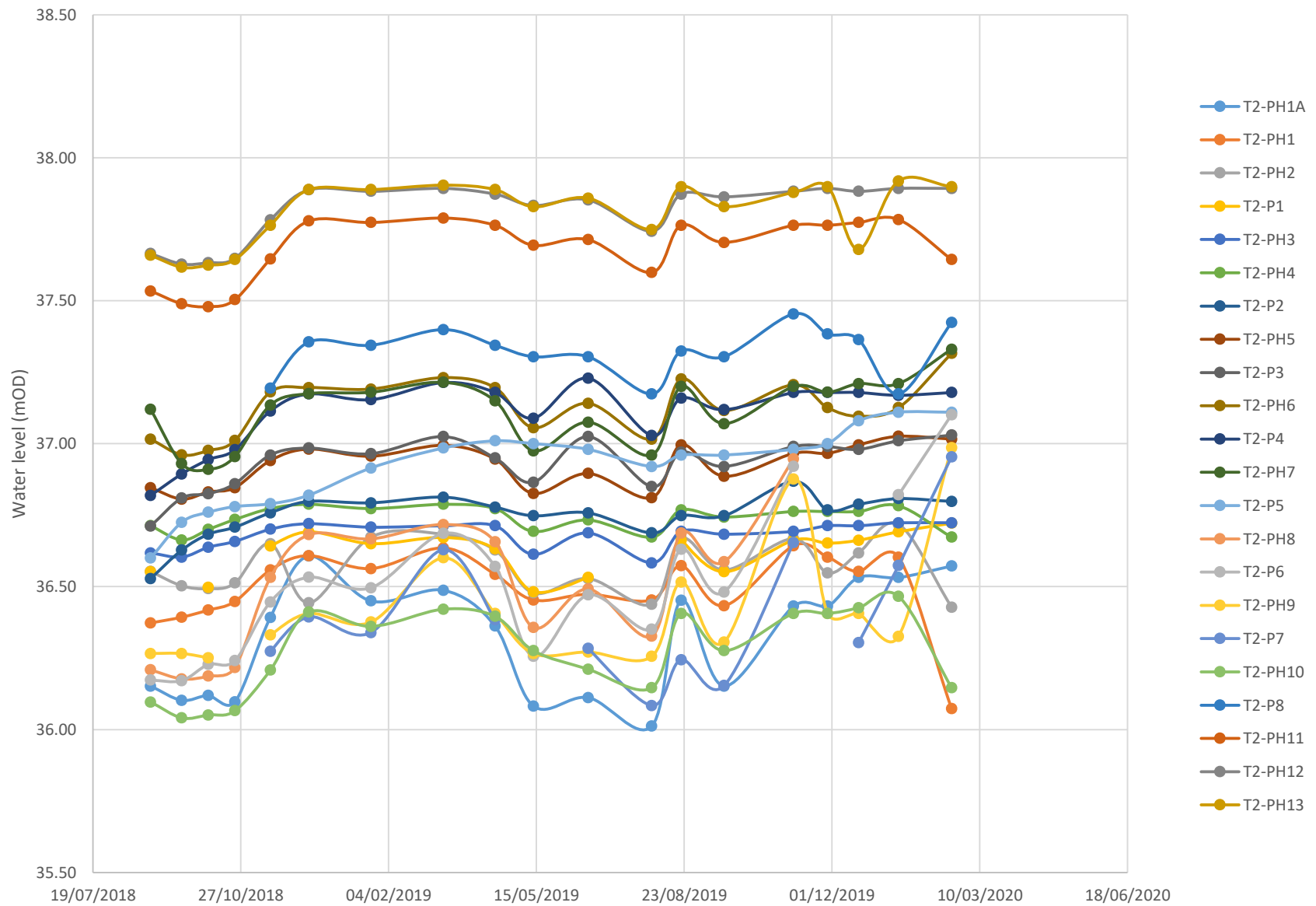
APPENDIX IV: SUMMARY OF BNM WATER LEVEL DATA – BLACKWATER

Location ID	27/08/2018	17/09/2018	05/10/2018	23/10/2018	16/11/2018	12/12/2018	23/01/2019	13/03/2019	17/04/2019	13/05/2019	19/06/2019	01/08/2019	21/08/2019	19/09/2019	05/11/2019	28/11/2019	19/12/2019	15/01/2020	20/02/2020
T1-PH1A	35.98	35.86	35.81	35.85	36.15	36.33	36.22	36.21	36.14	35.84	35.87	35.78	36.28	35.93	36.21	36.18	36.29	36.27	36.32
T1-PH1	36.37	36.38	36.40	36.42	36.49	36.55	36.53	36.58	36.50	36.42	36.43	36.41	36.56	36.46	36.61	36.54	36.54	36.55	36.67
T1-P1	36.27	36.34	36.37	36.39	36.48	36.54	36.51	36.58	36.50	36.44	36.43	36.40	36.48	36.46	36.58	36.55	36.54	36.54	36.66
T1-PH2	36.42	36.43	36.47	36.51	36.59	36.62	36.61	36.61	36.57	36.42	36.52	36.43	36.63	36.55	36.59	36.59	36.60	36.60	36.57
T1-PH3	36.64	36.61	36.64	36.67	36.69	36.72	36.70	36.73	36.71	36.67	36.69	36.64	36.71	36.68	36.72	36.70	36.71	36.72	36.71
T1-PH4	36.68	36.66	36.67	36.69	36.72	36.72	36.71	36.73	36.72	36.65	36.69	36.65	36.73	36.70	36.72	36.72	36.72	36.64	36.73
T1-P2	36.54	36.60	36.65	36.66	36.69	36.72	36.71	36.73	36.72	36.69	36.68	36.65	36.68	36.69	36.70	36.73	36.72	36.85	36.77
T1-PH5	37.10	37.04	37.07	37.10	37.20	37.24	37.22	37.24	37.22	37.15	37.19	37.13	37.22	37.20	37.22	37.22	37.23	37.19	37.21
T1-P3	37.09	37.03	37.05	37.08	37.19	37.21	37.19	37.22	37.21	37.15	37.18	37.11	37.22	37.19	37.21	37.21	37.21	37.22	37.21
T1-PH6	37.47	37.45	37.45	37.46	37.53	37.56	37.55	37.57	37.55	37.48	37.53	37.46	37.55	37.52	37.55	37.55	37.55	37.55	37.56
T1-P4	37.43	37.46	37.45	37.47	37.54	37.56	37.55	37.56	37.55	37.49	37.52	37.47	37.53	37.53	37.54	37.55	37.52	37.56	37.56
T1-PH7	37.40	37.51	37.53	37.58	38.00	38.07	38.07	38.12	38.07	37.83	38.01	37.66	38.04	37.91	38.11	38.10	38.09	38.15	38.14
T1-PH8	36.59	36.63	36.66	36.75	37.19	37.21	37.23	37.27	37.17	36.74	36.81	36.63	37.23		37.25	37.16	37.18	37.18	37.55
T1-P5		36.62	36.66	36.66	36.83	37.02	36.93	37.08	36.86	36.76	36.77	36.64	36.88	36.88	37.10		37.10	37.12	37.20
T1-PH9						36.85	36.85	37.13	36.82	36.74	36.74	36.74	36.73	36.74	37.21	37.04	37.05	37.06	37.35
T1-P6	36.24	36.35	36.54	36.37	36.39	36.53	36.74	36.92	36.81	36.71	36.59		36.53	36.59	36.85	36.91	36.89	36.79	37.47
T1-PH10	37.35	37.34	37.35	37.35	37.49	37.80	37.66	37.90	37.71	37.54	37.58	37.41	37.71	37.56	37.85	37.77	37.76	37.88	37.92
T1-P7	37.34	37.33	37.34	37.34	37.43	37.81	37.66	37.91	37.67	37.56	37.60	37.43	37.60	37.60	37.84	37.81	37.80	37.67	37.87
T1-PH11	38.23	38.22	38.25	38.25	38.12	38.48	38.52	38.71	38.58	38.36	38.42	38.29	38.55	38.41	38.56	38.58	38.63	38.59	38.68
T1-P8	38.17	38.17	38.19	38.17	38.24	38.22	38.41	38.50	38.44	38.40	38.37	38.30	38.39	38.39	38.49	38.49	38.47	38.47	38.52
T1-PH12	38.75	38.62	38.57	38.58	38.85	38.89	38.87	38.89	38.87	38.72	38.81	38.64	38.86	38.76	38.86	38.67	38.76	38.76	38.90
T1-P9	38.54	38.54	38.54	38.53	38.54	38.55	38.68	38.76	38.77	38.76	38.72	38.67	38.83	38.74	38.75	38.77	38.76	38.78	38.82
T1-PH13	38.13	38.10	38.10	38.11	38.24	38.10	38.30	38.38	37.88	38.22	38.24	38.14	38.24	38.22	38.24	38.11	38.30	37.95	38.38
T1-P10	38.05	38.09	38.11	38.11	38.21	38.34	38.30	38.39	38.28	38.21	38.27	38.12	38.22	38.18	38.32	38.33	38.31	38.37	38.35
T2-PH1A	36.15	36.10	36.12	36.10	36.39	36.61	36.45	36.49	36.36	36.08	36.11	36.01	36.45	36.15	36.43	36.43	36.53	36.53	36.57
T2-PH1	36.37	36.39	36.42	36.45	36.56	36.61	36.56	36.64	36.54	36.45	36.47	36.45	36.57	36.43	36.64	36.60	36.55	36.60	36.07
T2-PH2	36.55	36.50	36.49	36.51	36.65	36.44	36.67	36.68	36.63	36.48	36.53	36.44	36.67	36.56	36.67	36.55	36.62	36.72	36.43
T2-P1	36.55		36.50		36.64	36.69	36.65	36.67	36.63	36.48	36.53		36.66	36.55	36.66	36.65	36.66	36.69	36.72
T2-PH3	36.62	36.60	36.64	36.66	36.70	36.72	36.71	36.71	36.71	36.61	36.69	36.58	36.69	36.68	36.69	36.71	36.71	36.72	36.72
T2-PH4	36.71	36.66	36.70	36.74	36.77	36.79	36.77	36.79	36.77	36.69	36.73	36.67	36.77	36.74	36.76	36.76	36.76	36.78	36.67
T2-P2	36.53	36.63	36.68	36.71	36.76	36.80	36.79	36.81	36.78	36.75	36.76	36.69	36.75	36.75	36.87	36.77	36.79	36.81	36.80
T2-PH5	36.85	36.81	36.83	36.85	36.94	36.98	36.96	36.99	36.95	36.83	36.90	36.81	37.00	36.89	36.97	36.97	37.00	37.03	37.02
T2-P3	36.71	36.81	36.83	36.86	36.96	36.99	36.97	37.03	36.95	36.87	37.03	36.85	36.97	36.92	36.99	36.99	36.98	37.01	37.03
T2-PH6	37.02	36.96	36.98	37.01	37.18	37.20	37.19	37.23	37.20	37.06	37.14	37.02	37.23	37.12	37.21	37.13	37.10	37.13	37.32
T2-P4	36.82	36.89	36.94	36.98	37.11	37.17	37.15	37.21	37.18	37.09	37.23	37.03	37.16	37.12	37.18	37.18	37.18	37.17	37.18
T2-PH7	37.12	36.93	36.91	36.96	37.14	37.18	37.18	37.22	37.15	36.98	37.08	36.96	37.20	37.07	37.20	37.18	37.21	37.21	37.33
T2-P5	36.60	36.73	36.76	36.78	36.79	36.82	36.92	36.99	37.01	37.00	36.98	36.92	36.96	36.96	36.98	37.00	37.08	37.11	37.11
T2-PH8	36.21	36.18	36.19	36.22	36.53	36.68	36.67	36.72	36.66	36.36	36.49	36.33	36.69	36.59	36.95				
T2-P6	36.17	36.17	36.23	36.24	36.45	36.53	36.50	36.69	36.57	36.26	36.47	36.35	36.63	36.48	36.92			36.82	37.10
T2-PH9	36.27	36.27	36.25		36.33	36.41	36.38	36.60	36.41	36.27	36.27	36.26	36.52	36.31	36.88	36.41	36.41	36.33	36.99
T2-P7					36.27	36.39	36.34	36.63	36.38		36.28	36.08	36.24	36.15	36.65		36.30	36.57	36.95
T2-PH10	36.10	36.04	36.05	36.07	36.21	36.41	36.36	36.42	36.40	36.28	36.21	36.15	36.41	36.28	36.41	36.41	36.43	36.47	36.15
T2-P8					37.19	37.36	37.34	37.40	37.34	37.30	37.30	37.17	37.32	37.30	37.45	37.38	37.36	37.17	37.42
T2-PH11	37.53	37.49	37.48	37.50	37.65	37.78	37.77	37.79	37.76	37.69	37.71	37.60	37.76	37.70	37.76	37.76	37.77	37.78	37.64
T2-PH12	37.67	37.63	37.63	37.65	37.78	37.89	37.88	37.89	37.87	37.83	37.85	37.74	37.87	37.86	37.88	37.89	37.88	37.89	37.89
T2-PH13	37.66	37.62	37.62	37.64	37.76	37.89	37.89	37.90	37.89	37.83	37.86	37.75	37.90	37.83	37.88	37.90	37.68	37.92	37.90
T3-PH1	36.217	36.178	36.128	36.183	36.405	36.408									36.628	36.618	36.658	36.648	36.728
T3-PH2	36.735	36.692	36.682	36.722	37.032	37.062	37.047	37.077	37.017	36.807	36.837	36.737	37.057	36.877	37.047	37.037	37.047	37.067	37.127
T3-P1	36.647	36.677	36.712	36.727	36.897	37.027	36.989	37.072	36.987	36.817	36.827	36.757	36.907	36.887	37.037	37.047	37.027	37.027	37.097
T3-PH3		36.78	36.83	36.84	37.17	37.365	37.265	37.35	37.265	37.005	37.08	36.955	37.335	37.095	37.305	37.475	37.295	37.265	37.355
T3-P2	36.682	36.779	36.799	36.814	36.899	37.099	37.147	37.229	37.164	37.134	37.054	36.994	37.044	37.104	37.184	37.274	37.244	37.224	37.234
T3-PH4	36.488	36.508	36.533	36.543	36.708	36.838	36.888	36.928	36.873	36.843	36.818	36.723	36.833	36.823	36.883	36.893	36.903	36.913	36.923
T3-P3	36.515	36.5	36.51	36.56	36.778	36.88	36.867	36.895	36.88	36.8	36.82	36.7	36.85	36.82	36.88	36.86	36.87	36.87	36.93
T3-PH5	36.393				36.559	37.056	37.006	37.046	37.011	36.841	36.871	36.641	37.031	36.861	37.041	37.011	37.031	37.051	37.521
T3-P4	36.528	36.554	36.534	36.517	36.519	36.789	36.919	36.999	36.954	36.944	36.894	36.824	36.824	36.904	36.924	36.944	36.964	36.994	36.974
T3-PH6	36.943	36.938	36.935	36.968	37.19	37.288	37.233	37.268	37.213	37.043	37.093	37.003	37.283	37.113	37.253	37.243	37.273	37.313	37.313
T3-P5	36.798	36.888	36.958	36.973	37.17	37.223	37.198	37.273	37.198	37.058	37.113	37.028	37.198	37.128	37.228	37.198	37.228	37.198	37.218
T3-PH7	36.808	36.838	36.823	36.875	37.053	37.173	37.098	37.143	37.088	36.948	37.018	36.918	37.058	37.008	37.118	36.848	37.078	37.148	37.188
T3-P6	36.722	36.777	36.847	36.867	37.032	37.097	37.067	37.142	37.092	36.992	37.002	36.922	37.062	37.032	37.092	37.092	37.102	37.082	37.112
T3-PH8		36.676	36.699</																

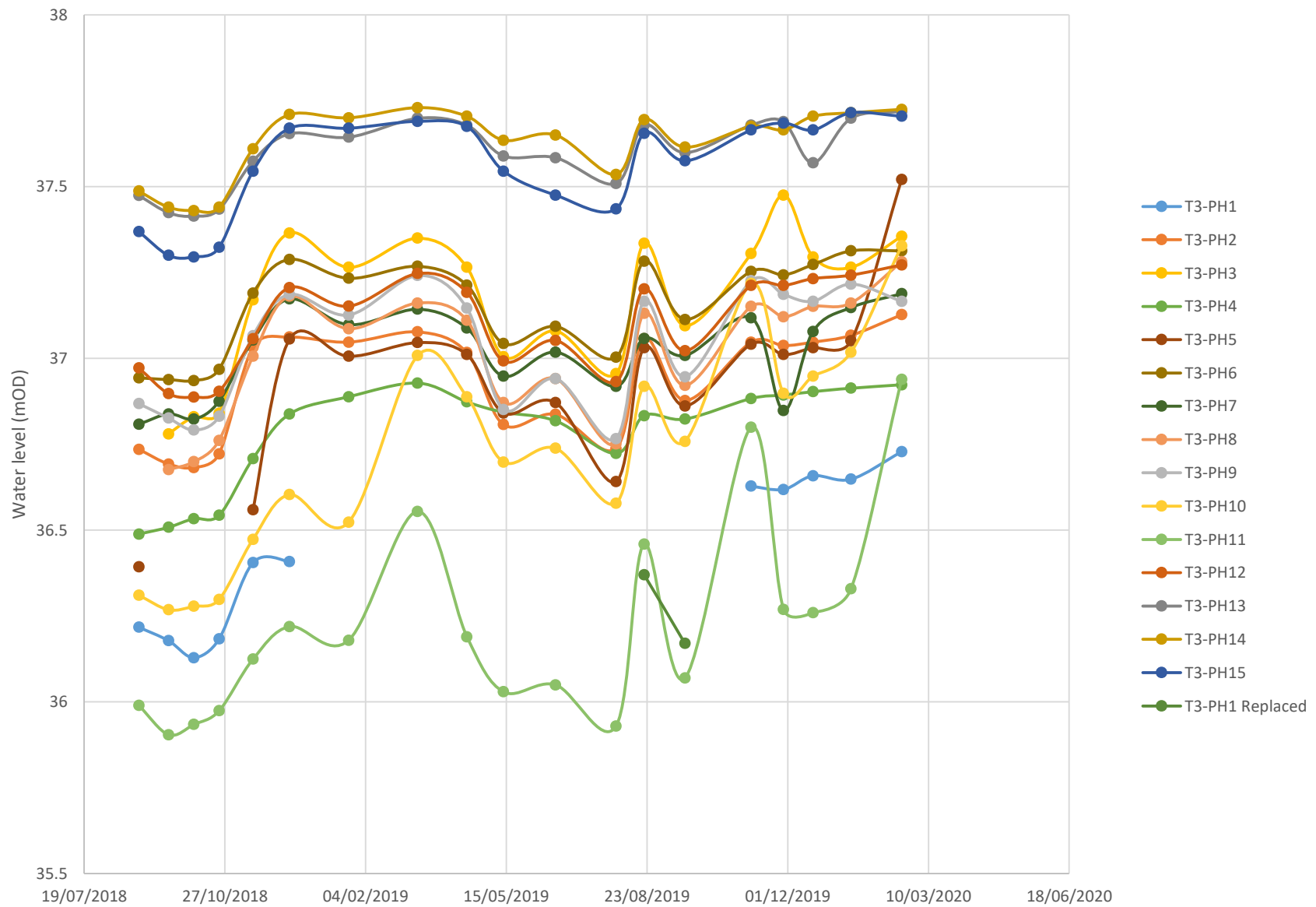
Blackwater Transect 1



Blackwater Transect 2



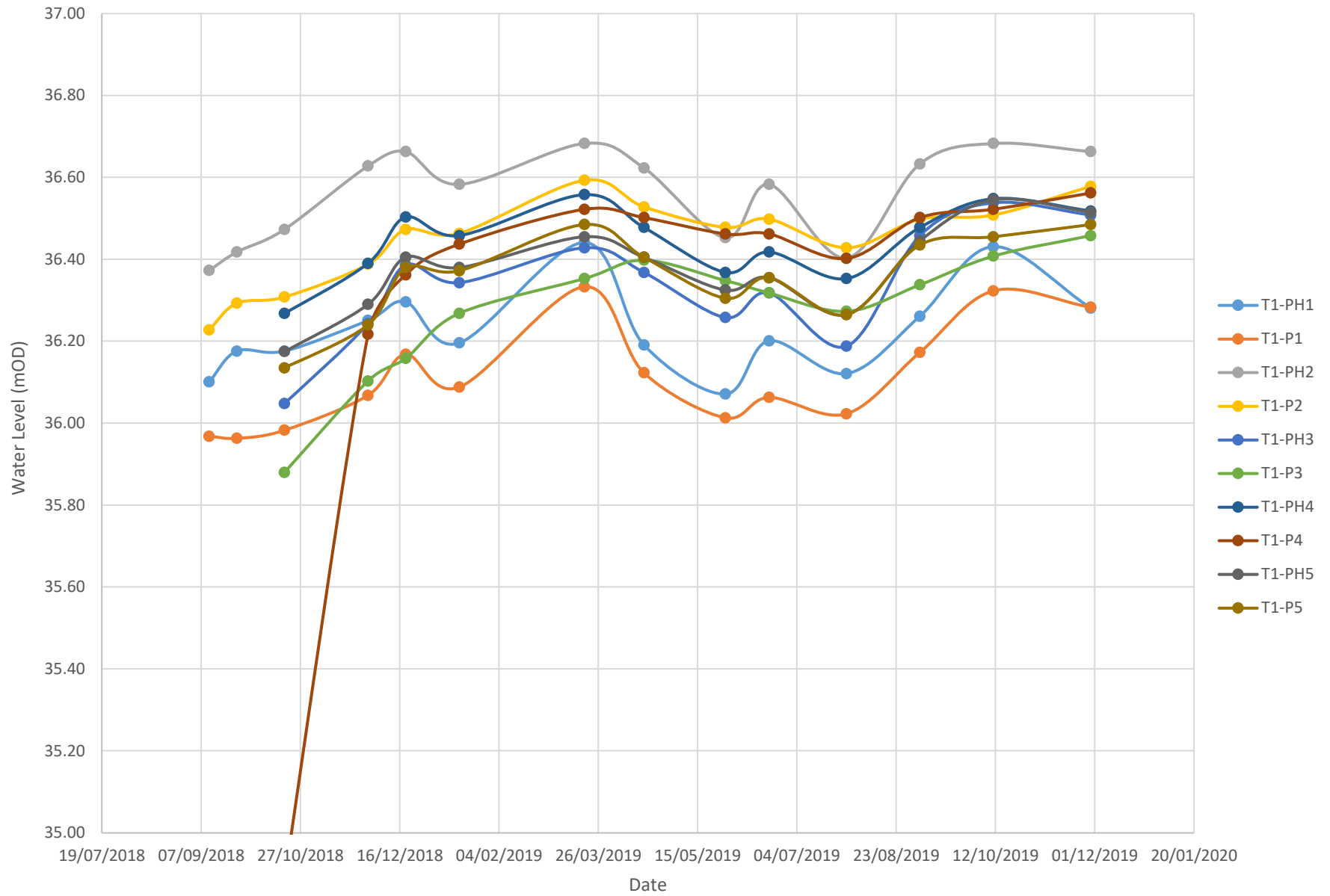
Blackwater Transect 3



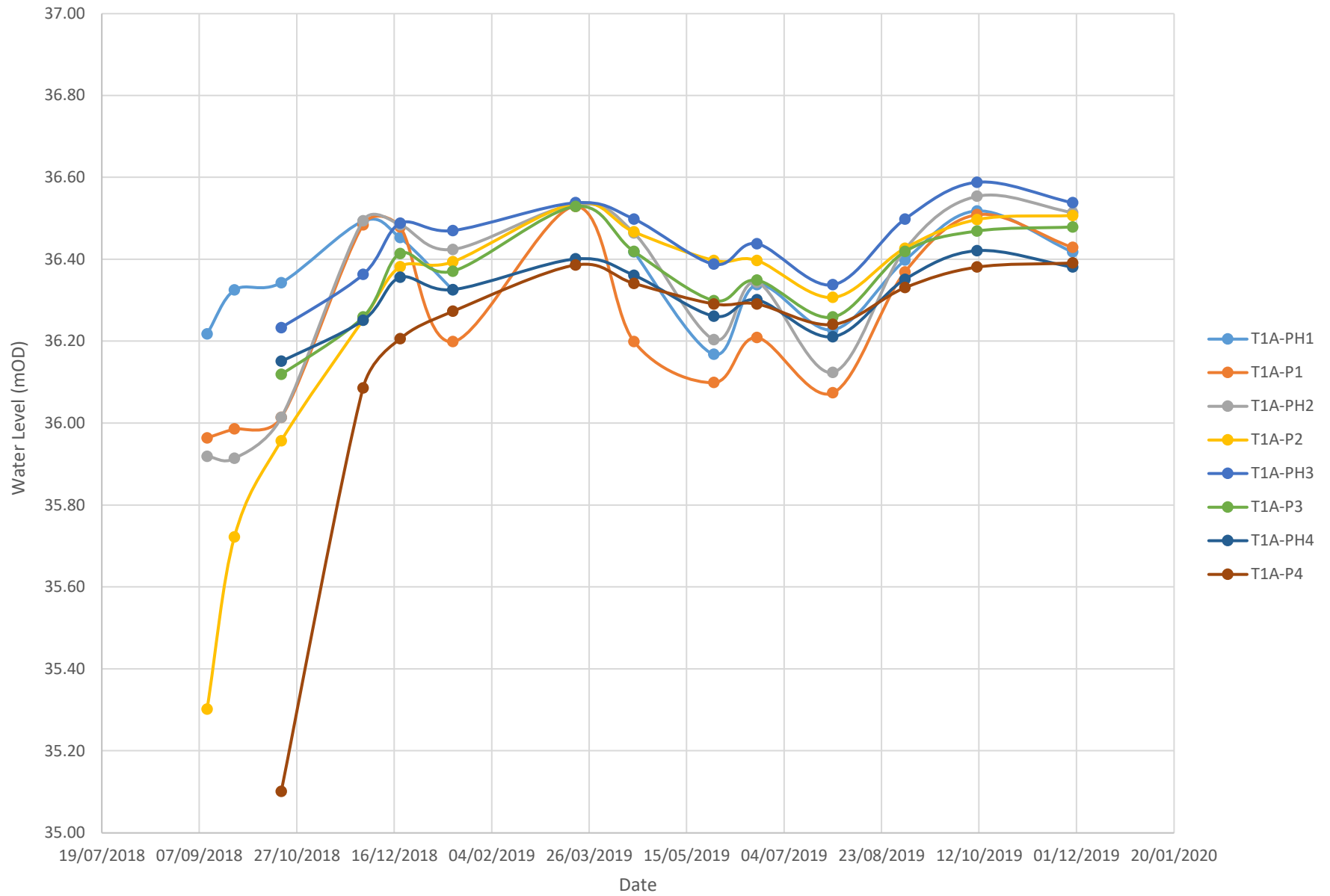
APPENDIX V: SUMMARY OF BNM WATER LEVEL DATA – DERRYCOLUMB

Location ID	11/09/2018	25/09/2018	19/10/2018	30/11/2018	19/12/2018	15/01/2019	19/03/2019	18/04/2019	29/05/2019	20/06/2019	29/07/2019	04/09/2019	11/10/2019	29/11/2019
T1-PH1	36.10	36.18	36.18	36.25	36.30	36.20	36.44	36.19	36.07	36.20	36.12	36.261	36.431	36.281
T1-P1	35.97	35.96	35.98	36.07	36.17	36.09	36.33	36.12	36.01	36.06	36.02	36.173	36.323	36.283
T1-PH2	36.37	36.42	36.47	36.63	36.66	36.58	36.68	36.62	36.45	36.58	36.40	36.633	36.683	36.663
T1-P2	36.23	36.29	36.31	36.39	36.47	36.46	36.59	36.53	36.48	36.50	36.43	36.498	36.508	36.578
T1-PH3			36.05	36.24	36.39	36.34	36.43	36.37	36.26	36.32	36.19	36.458	36.538	36.508
T1-P3			35.88	36.10	36.16	36.27	36.35	36.40	36.35	36.32	36.27	36.338	36.408	36.458
T1-PH4			36.27	36.39	36.50	36.46	36.56	36.48	36.37	36.42	36.35	36.478	36.548	36.518
T1-P4			34.89	36.22	36.36	36.44	36.52	36.50	36.46	36.46	36.40	36.502	36.522	36.562
T1-PH5			36.18	36.29	36.41	36.38	36.46	36.41	36.33	36.36	36.27	36.445	36.545	36.515
T1-P5			36.14	36.24	36.38	36.37	36.49	36.41	36.31	36.36	36.27	36.435	36.455	36.485
T1A-PH1	36.22	36.33	36.34	36.49	36.45	36.33		36.42	36.17	36.34	36.23	36.398	36.518	36.418
T1A-P1	35.96	35.99	36.01	36.48	36.48	36.20	36.53	36.20	36.10	36.21	36.07	36.369	36.509	36.429
T1A-PH2	35.92	35.91	36.01	36.49	36.48	36.42	36.53	36.46	36.20	36.34	36.12	36.424	36.554	36.514
T1A-P2	35.30	35.72	35.96	36.25	36.38	36.39	36.54	36.47	36.40	36.40	36.31	36.427	36.497	36.507
T1A-PH3			36.23	36.36	36.49	36.47	36.54	36.50	36.39	36.44	36.34	36.498	36.588	36.538
T1A-P3			36.12	36.26	36.41	36.37	36.53	36.42	36.30	36.35	36.26	36.419	36.469	36.479
T1A-PH4			36.15	36.25	36.36	36.33	36.40	36.36	36.26	36.30	36.21	36.351	36.421	36.381
T1A-P4			35.10	36.09	36.21	36.27	36.39	36.34	36.29	36.29	36.24	36.331	36.381	36.391
T3-PH1	36.517	36.552	36.639	36.827	37.012	36.807		36.737	36.627	36.737	36.627	36.787	36.957	36.857
T3-P1	36.526	36.546	36.606	36.739	36.961	36.811	37.041	36.726	36.686	36.776	36.676	36.856	36.936	36.846
T3-PH2	37.052	37.177	37.232	37.332	37.472	37.297	37.417	37.317	37.097	37.267	37.097	37.307	37.447	37.347
T3-PH3	37.435	37.595	37.62	37.71	37.805	37.655	37.75	37.71	37.41	37.65	37.470	37.700	37.800	37.750
T3-P2	37.129	37.169	37.219	37.361	37.544	37.379	37.604	37.339	37.239	37.349	37.239	37.419	37.509	37.419
T3-PH4	38.308	38.348	38.375	38.428	38.488	38.483	38.493	38.463	38.323	38.423	38.343	38.463	38.493	38.473
T3-P3	38.242	38.267	38.287	38.367	38.462	38.44	38.482	38.442	38.372	38.412	38.352	38.472	38.482	38.482
T3-PH5	38.655	38.653	38.657	38.72	38.725	38.73	38.715	38.695	38.555	38.635	38.535	38.705	38.715	38.725
T3-P4	38.543	38.543	38.563	38.603	38.648	38.638	38.678	38.658	38.618	38.638	38.598	38.698	38.638	38.648
T3-PH6	38.61	38.652	38.65	38.675	38.695	38.64		38.675	38.585	38.585	38.59	38.685	38.705	38.625
T3-P5	38.566	38.574	38.591	38.626	38.681	38.651	38.701	38.671	38.641	38.671	38.611	38.671	38.701	38.671
T3-PH7	38.489	38.569	38.549	38.609	38.659	38.609	38.649	38.609	38.459		38.489	38.609	38.659	38.559
T3-P6	38.421	38.434	38.446	38.491	38.561	38.528	38.566	38.546	38.506	38.536	38.486	38.556	38.536	38.556
T3-PH8	38.246	38.161	38.166	38.251	38.256	38.196	38.261	38.251	38.081	38.201	38.081	38.241	38.261	38.251
T3-P7	38.009	38.016	38.034	38.084	38.134	38.124	38.184	38.154	38.114	38.124	38.089	38.144	38.174	38.194
DC-Pump-PH1			36.27	36.56	36.565	36.335	36.735	36.255	36.265	36.325	36.265	36.435	37.005	
DC-Pump-P1			36.126	36.343	36.221	36.153	36.386			36.191	36.171	36.221	36.461	

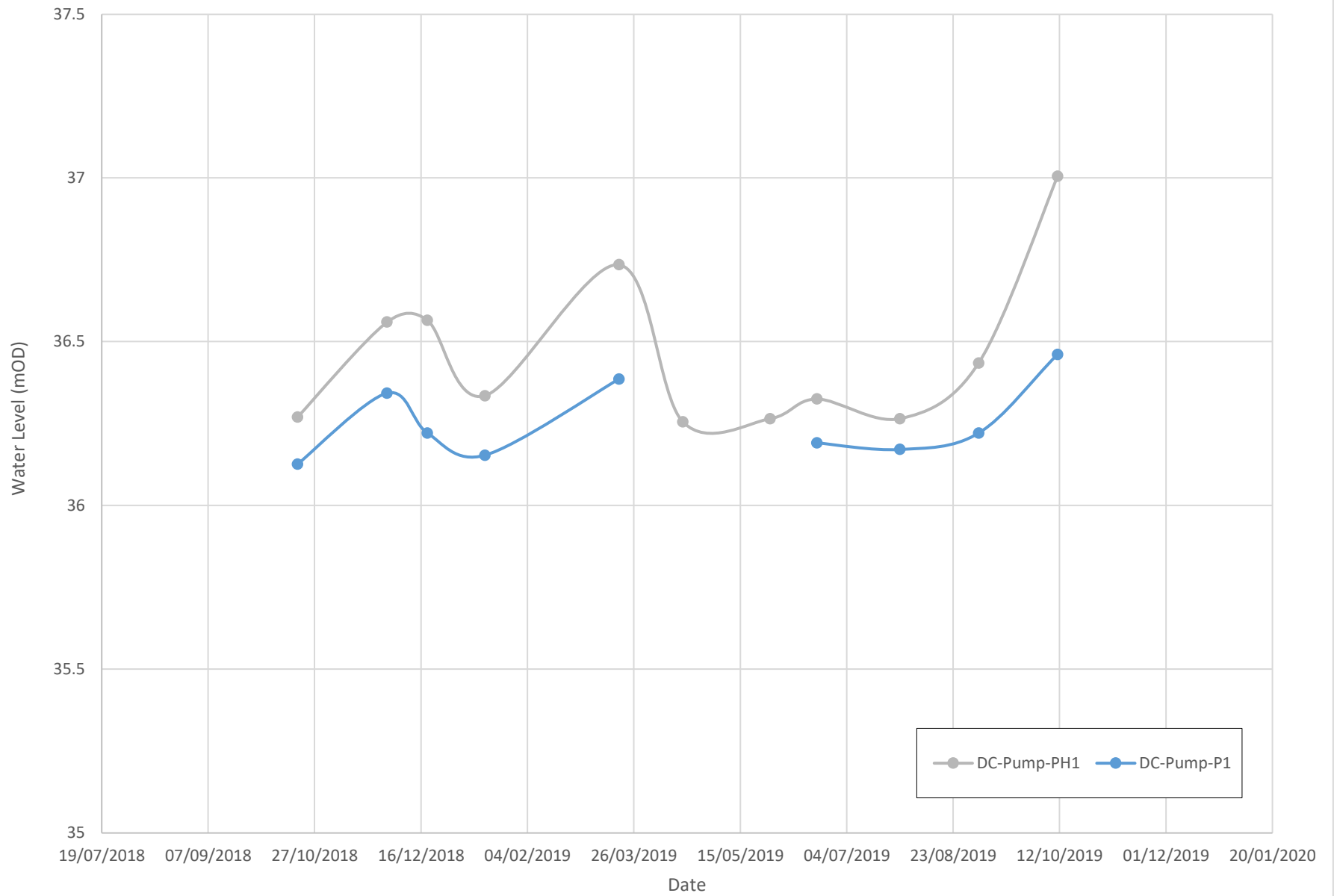
Derrycolumb Transect 1



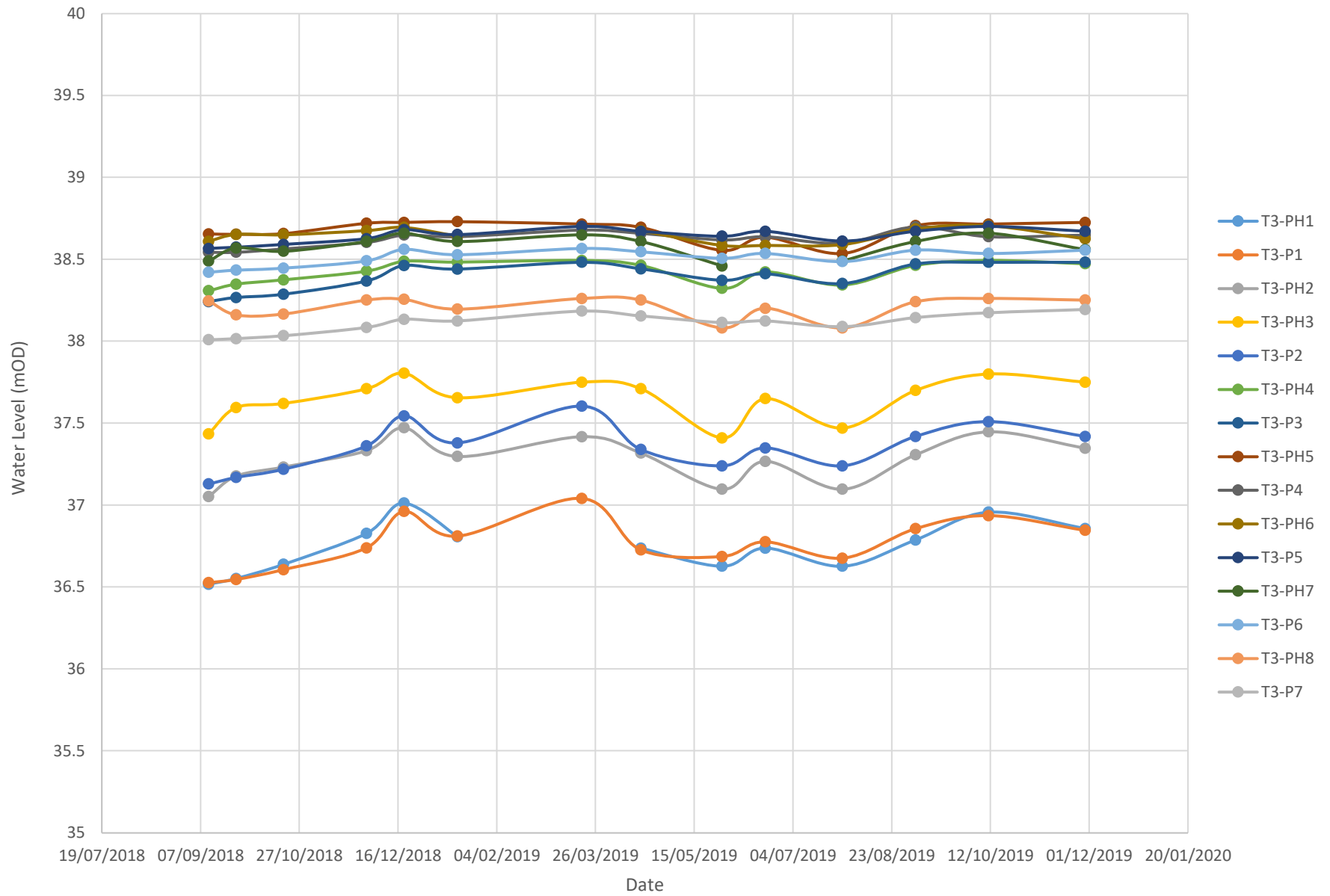
Derrycolumb Transect 1A



Derrycolumb Transect 1C - pump station P05-031



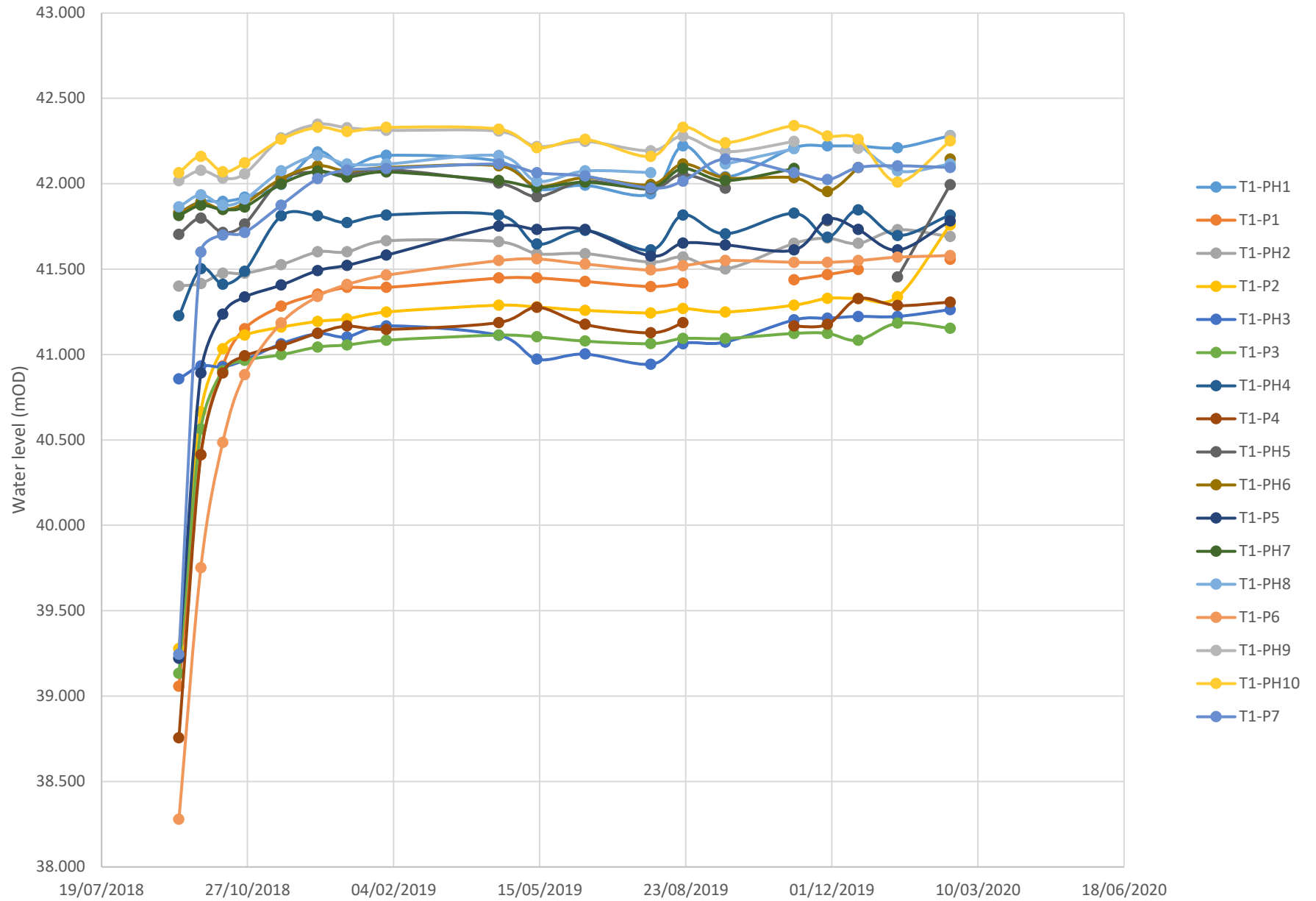
Derrycolumb Transect 3



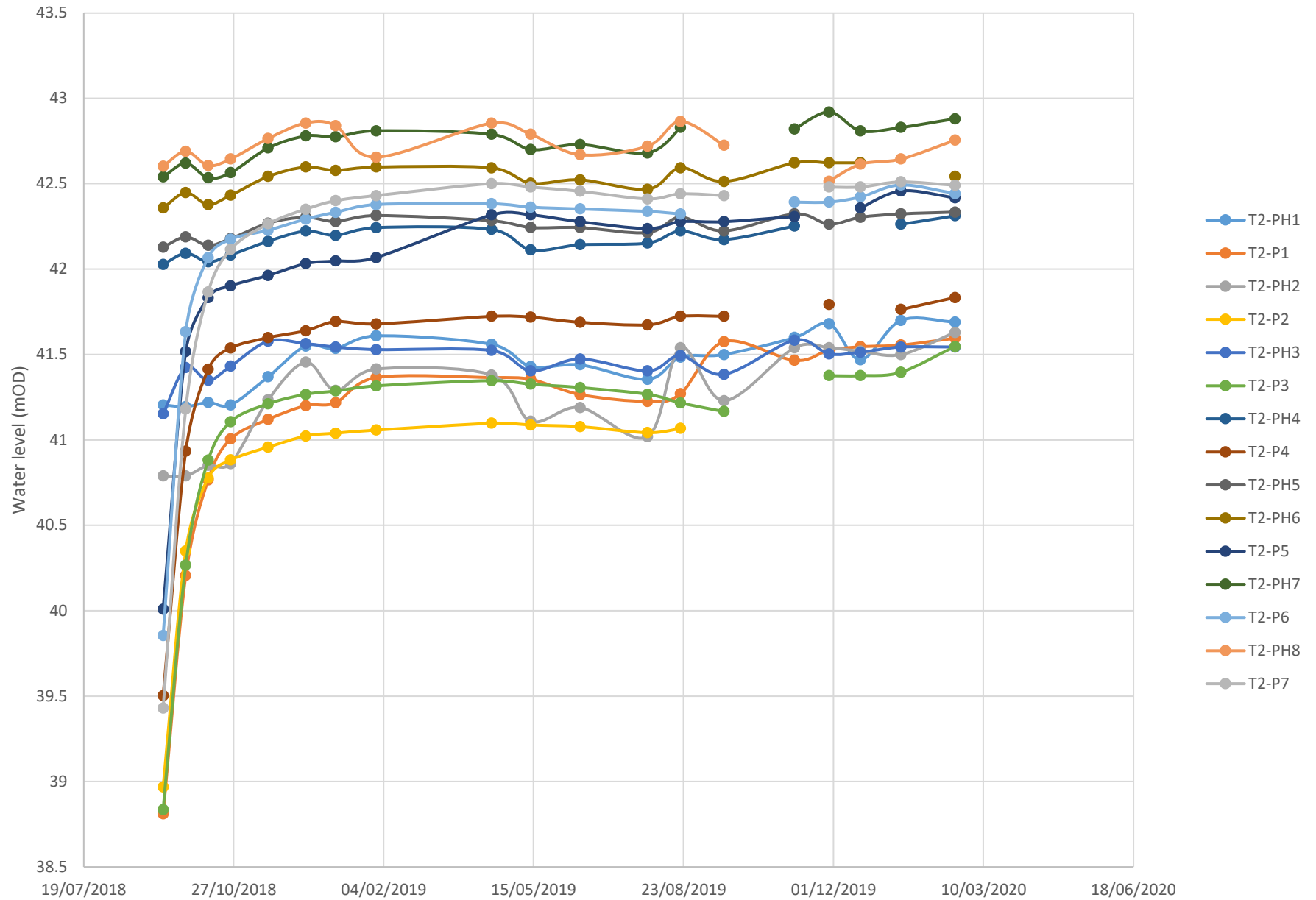
APPENDIX VI: SUMMARY OF BNM WATER LEVEL DATA – MONGAN

Bog	Transect	Piezo type	Location ID	Easting	Northing	Peat depth (m)	peat interval(mbgl)	marl interval (mbgl)	lacustrine clay interval (mbgl)	standpipe screen (mbgl)	piezoemter screen (mbgl)	Ground Level (mOD)	Top pf Pipe (mOD)	upstand (m)
Mongan	T1	phreatic	T1-PH1	204305.5	230829.3	5.5	0-5.48	none	5.48->5.78	0-1.0		42.33	43.30	1.00
Mongan	T1	Piezo	T1-P1	204305.8	230829.5						4.8-5.1	42.31	43.59	1.29
Mongan	T1	phreatic	T1-PH2	204295.7	230857.3	5.1	0-5.09	none	5.09->5.34	0.5-1.5		42.00	42.49	0.50
Mongan	T1	Piezo	T1-P2	204296.0	230857.5						4.7-5.0	41.96	43.01	1.06
Mongan	T1	phreatic	T1-PH3	204293.2	230865.6	4.4	0-4.41	none		0.5-1.5		41.32	41.81	0.50
Mongan	T1	Piezo	T1-P3	204293.6	230865.7						3.9-4.2	41.33	42.29	0.98
Mongan	T1	phreatic	T1-PH4	204290.0	230878.1	5.1	0-5.10	none	5.1->5.35	0.5-1.5		41.92	42.57	0.50
Mongan	T1	Piezo	T1-P4	204289.6	230877.9						4.7-5.0	41.91	43.34	1.43
Mongan	T1	phreatic	T1-PH5	204287.3	230885.8	>5.0	>5.0			0-1.0		42.08	43.13	1.00
Mongan	T1	phreatic	T1-PH6	204284.1	230895.1	5.3	0-5.28	none		0-1.0		42.24	43.25	1.02
Mongan	T1	Piezo	T1-P5	204284.4	230895.2						4.7-5.0	42.07	43.48	1.43
Mongan	T1	phreatic	T1-PH7	204282.8	230898.4	>5.0	>5.0			0-1.0		42.11	43.07	0.98
Mongan	T1	phreatic	T1-PH8	204281.3	230904.5	5.4	0-5.4	none		0-1.0		42.20	42.82	0.60
Mongan	T1	Piezo	T1-P6	204280.9	230904.5						5.0-5.3	42.30	43.42	1.09
Mongan	T1	phreatic	T1-PH9	204274.6	230923.3	>5.2	>5.2			0-1.0		42.40	43.38	1.00
Mongan	T1	phreatic	T1-PH10	204268.5	230943.2	6.5	0-6.5	none	6.5->6.8	0-1.0		42.39	43.40	1.02
Mongan	T1	Piezo	T1-P7	204268.8	230943.1						4.85-5.15	42.37	43.65	1.27
Mongan	T2	phreatic	T2-PH1	204186.7	230760.4	4.7	0-4.7	none	4.7->4.95	0.5-1.5		41.893	42.41	0.5
Mongan	T2	piezo	T2-P1	204187.0	230760.7						3.75-4.05	41.908	42.846	0.96
Mongan	T2	phreatic	T2-PH2	204180.7	230765.9	4.7	0-4.72	none	4.7->5.0	0.5-1.5		41.892	42.36	0.48
Mongan	T2	piezo	T2-P2	204180.9	230766.2						4.1-4.4	41.902	42.878	0.98
Mongan	T2	phreatic	T2-PH3	204168.1	230777.6	4.8	0-4.75	none		0.5-1.5		42.002	42.494	0.5
Mongan	T2	piezo	T2-P3	204168.2	230777.8						4.4-4.7	42.002	42.677	0.68
Mongan	T2	phreatic	T2-PH4	204160.8	230784.9	5.1	0-5.05	none	4.05->4.35	0-1.0		42.322	43.363	1
Mongan	T2	piezo	T2-P4	204160.6	230784.7						4.7-5.0	42.357	43.244	0.9
Mongan	T2	phreatic	T2-PH5	204157.6	230787.7	>4.0	>4.0			0-1.0		42.413	43.384	0.95
Mongan	T2	phreatic	T2-PH6	204139.9	230804.8	5.3	0-5.3	none	4.3->4.65	0-1.0		42.686	43.603	1
Mongan	T2	piezo	T2-P5	204140.2	230805.0						4.6-4.9	42.588	43.118	0.52
Mongan	T2	phreatic	T2-PH7	204121.9	230822.1	5.5	0-5.45	none	5.45->5.68	0-1.0		42.802	43.81	0.98
Mongan	T2	piezo	T2-P6	204122.3	230822.2						5.05-5.35	42.784	43.873	1.05
Mongan	T2	phreatic	T2-PH8	204103.7	230839.5	5.7	0-5.7	none	5.7->5.95	0-1.0		42.875	43.905	1.05
Mongan	T2	piezo	T2-P7	204104.2	230839.8						5-5.3	42.863	43.701	0.8
Mongan	T3	phreatic	T3-PH1	204082.1	230661.7	3.3	0-3.3	none	3.3->3.65	0.5-1.5		41.243	42.411	1.18
Mongan	T3	Piezo	T3-P1	204082.5	230662.0						2.43-2.73	41.256	41.921	0.67
Mongan	T3	phreatic	T3-PH2	204076.3	230666.5	3.4	0-3.4	none	3.4->3.8	0.5-1.5		41.118	42.138	1
Mongan	T3	Piezo	T3-P2	204076.5	230666.6						2.5-2.8	41.167	41.736	0.6
Mongan	T3	phreatic	T3-PH3	204067.3	230674.4	4.6	0-4.62	none	4.62->4.9	0-1.0		42.117	43.274	1.2
Mongan	T3	Piezo	T3-P3	204067.4	230674.1						4.05-4.35	42.105	43.089	1
Mongan	T3	phreatic	T3-PH4	204061.4	230678.2	4.7	0-4.7	none	4.7->5.0	0-1.0		42.381	43.367	1.01
Mongan	T3	Piezo	T3-P4	204061.5	230678.4						4.25-4.55	42.353	42.972	0.6
Mongan	T3	phreatic	T3-PH5	204056.6	230682.6	4.9	0-4.85	none	4.85->5.25	0-1.0		42.822	43.84	1.06
Mongan	T3	Piezo	T3-P5	204056.8	230682.7						4.4-4.7	42.813	43.428	0.7
Mongan	T3	phreatic	T3-PH6	204038.5	230699.2	5.2	0-5.2	none	5.2->5.45	0-1.0		43.317	44.004	1
Mongan	T3	Piezo	T3-P6	204038.2	230698.9						4.4-4.7	43.319	44.317	0.7
Mongan	T3	phreatic	T3-PH7	204020.0	230716.1	5.7	0-5.7	none	5.7->5.99	0-1.0		43.551	44.549	1
Mongan	T3	Piezo	T3-P7	204020.2	230716.4						5.1-5.4	43.595	44.577	1
Mongan	T3	phreatic	T3-PH8	204001.7	230732.7	5.8	0-5.75	none	5.75->6.0	0-1.0		43.886	44.905	1.2
Mongan	T3	Piezo	T3-P8	204001.9	230732.9						4.95-5.25	43.87	45.039	1.16
Mongan	T3	Piezo	T3-PH3 Replaced									41.947	42.962	1.16
Mongan	T3	Piezo	T3-P3 Replaced									41.939	42.464	1.16

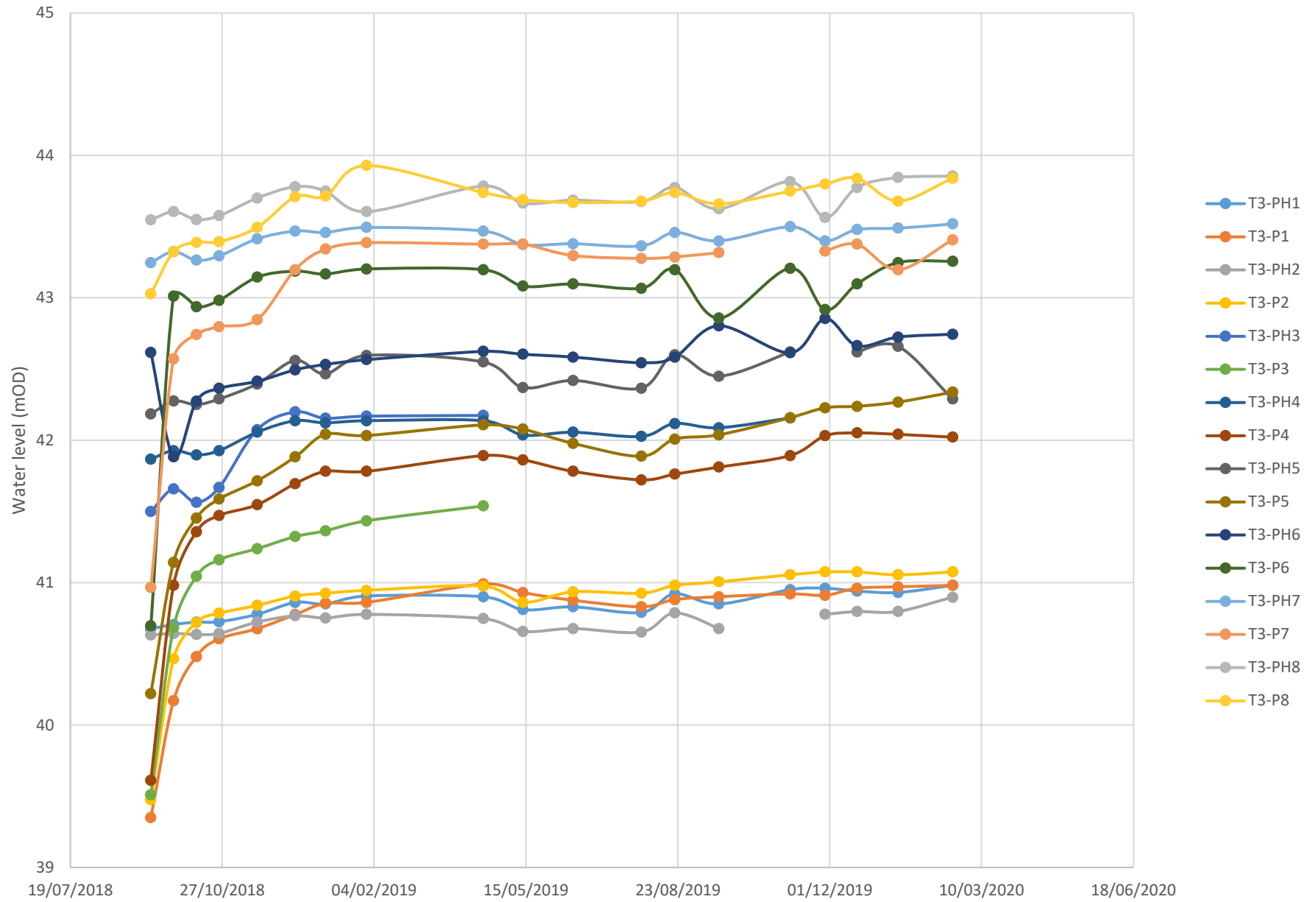
Mongan T1



Mongan T2



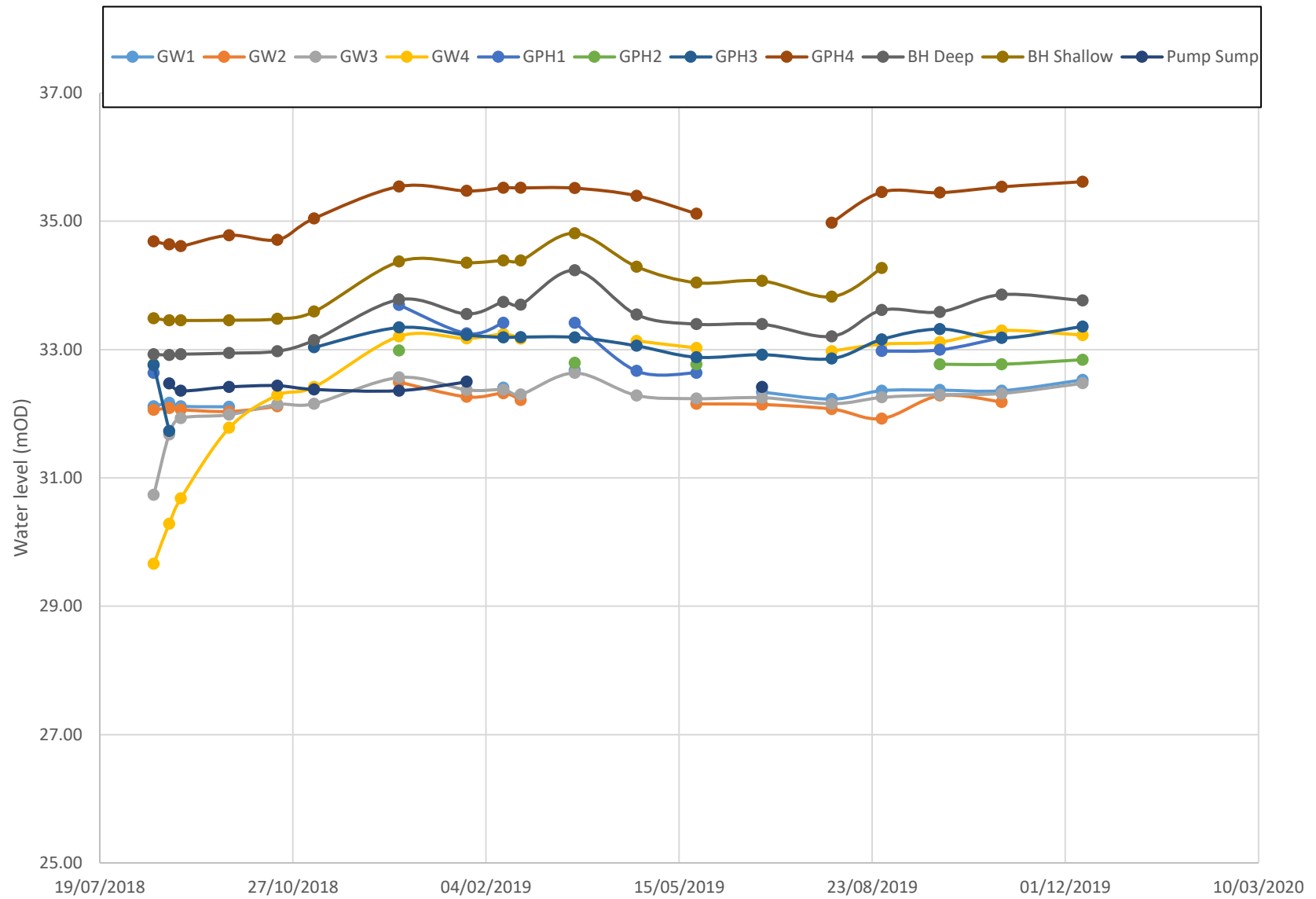
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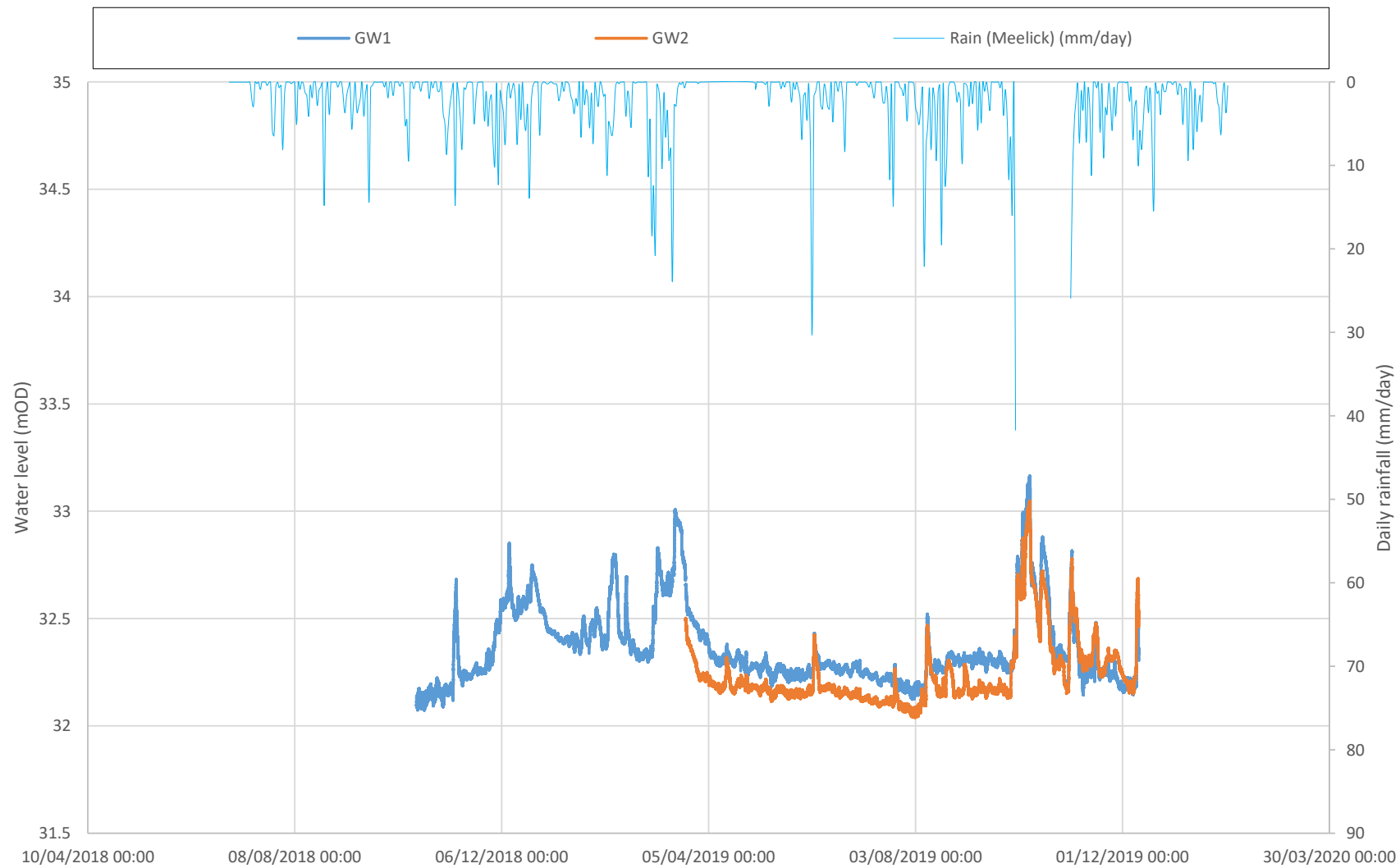
APPENDIX VII: SUMMARY OF BNM WATER LEVEL DATA – GARRYDUFF

Surveyed Levels Top of Pipes	Surveyed Levels - ground levels	Well ID	16/08/2018	24/08/2018	30/08/2018	24/09/2018	19/10/2018	07/11/2018	21/12/2018	25/01/2019	13/02/2019	22/02/2019	22/03/2019	23/04/2019	24/05/2019	27/06/2019	02/08/2019	28/08/2019	27/09/2019	29/10/2019	10/12/2019
34.28	33.884	GW1	32.12	32.17	32.12	32.11			32.41				32.68			32.34	32.23	32.36	32.37	32.36	32.53
34.385	33.901	GW2	32.06	32.09	32.07	32.04	32.12		32.50	32.27	32.32	32.22			32.16	32.15	32.08	31.93	32.29	32.19	
34.657	33.914	GW3	30.74	31.68	31.93	31.99	32.15	32.16	32.57	32.37	32.38	32.30	32.64	32.29	32.24	32.25	32.16	32.26	32.30	32.32	32.48
35.927	35.645	GW4	29.66	30.29	30.68	31.78	32.29	32.42	33.21	33.18	33.24	33.17		33.14	33.03		32.98	33.09	33.12	33.30	33.23
34.588	33.923	GPH1	32.64						33.70	33.25	33.42		33.42	32.67	32.64			32.98	33.00	33.19	
34.753	33.904	GPH2	32.77						32.99				32.79		32.77				32.77	32.77	32.84
34.711	33.942	GPH3	32.76	31.73				33.04	33.35	33.23	33.19	33.20	33.19	33.06	32.88	32.92	32.86	33.16	33.32	33.18	33.36
36.158	35.633	GPH4	34.69	34.64	34.61	34.78	34.71	35.05	35.54	35.48	35.52	35.52	35.52	35.40	35.12		34.98	35.46	35.45	35.54	35.62
35.137	35.037	BH Deep	32.93	32.92	32.93	32.95	32.98	33.15	33.78	33.56	33.74	33.70	34.24	33.55	33.40	33.40	33.21	33.62	33.59	33.86	33.77
35.074	35.024	BH Shallow	33.49	33.46	33.46	33.46	33.48	33.59	34.37	34.35	34.39	34.39	34.81	34.29	34.04	34.07	33.82	34.27			
35.56		Pump Sump		32.48	32.36	32.42	32.44	32.38	32.36	32.50						32.42					

Garryduff Pumping Station



Garryduff Pumping Station



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