

Galway County Council

N6 Galway City Ring Road

Eco-hydrogeology Summary Report
for Moycullen Bogs NHA
(Letteragh)

GCRR_4.03.34_002

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Appendix A

Cross Sections

1 Introduction

Moycullen Bogs NHA was identified as one of the sixteen Groundwater Dependant Terrestrial Ecosystems in Chapter 10 of the EIAR. The Moycullen Bogs NHA encompasses three separate bog sites including, from west to east, Na Foráí Maola Thiar, Lough Inch, Tonabrocky and Letteragh. The hydrogeology of the peatland water table has been assessed in detail in Section 10.3.3.1 of Chapter 10 of the EIAR and the impact assessment undertaken in Section 10.5.3 of Chapter 10 of the EIAR.

Those areas of the Moycullen Bogs NHA at Na Foráí Maola Thiar and Lough Inch are either in a separate catchment or down gradient of the proposed road development and therefore are not at risk from groundwater drawdown induced from cuttings.

The area of the Moycullen Bogs NHA at Tonabrocky lies in a distinct sub-catchment to that of the proposed road development. Tonabrocky and the proposed road development are separated by a surface watercourse, with the proposed road development located 450m distant from Tonabrocky at its closest and the proposed road development is raised on an embankment in that section. Accordingly, the area of the Moycullen Bogs NHA at Tonabrocky is not at risk from groundwater drawdown induced from cuttings.

The area of the Moycullen Bogs NHA at Letteragh lies on high ground west of the River Corrib. The NHA lies on the catchment divide between (i) groundwater that drains eastward and northwards to the River Corrib and (ii) groundwater that drains southward towards Galway Bay. In the granite area, the surface water and groundwater catchments are the same.

The proposed road development in this location comprises:

- the main alignment, which is in a deep cutting at Letteragh
- the N59 Link Road North, which is at grade, or on embankment close to Moycullen Bogs and then in a cutting just before the N59 Moycullen Road

This Eco-Hydrogeology Report summarises the ecological and hydrogeological assessments which have been undertaken at the Moycullen Bogs NHA (Letteragh) from the mainline of the proposed road development and the N59 Link Road North. The results of this assessment are presented in the application documentation and now, at the Inspector's request, includes four cross sections drawn between the proposed road development at Moycullen Bogs NHA (Letteragh), which are presented in Appendix A. The sections comprise:

- Section A-A: North South section between the mainline Letteragh cutting and the main area of the NHA that is permanently ponded
- Section B-B: North South section between the mainline Letteragh cutting and a satellite area of the NHA that is permanently ponded
- Section C-C: West east section from the N59 North Link Road cutting to both the main and satellite ponded areas

- Section D-D: North south section from N59 North Link Road a closest point to the NHA

2 Groundwater Dependent Qualifying Habitat in Moycullen Bogs NHA

Moycullen Bogs NHA is designated as a Natural Heritage Area under the Wildlife Acts 1976 to 2019 for peatland habitats. The main habitat on the site is the Annex I habitat Blanket bog [*7130] but the site also supports a diversity of other peatland and fen habitats including Wet heath [4010], Dry heath [4030] and Alkaline fen [7230].

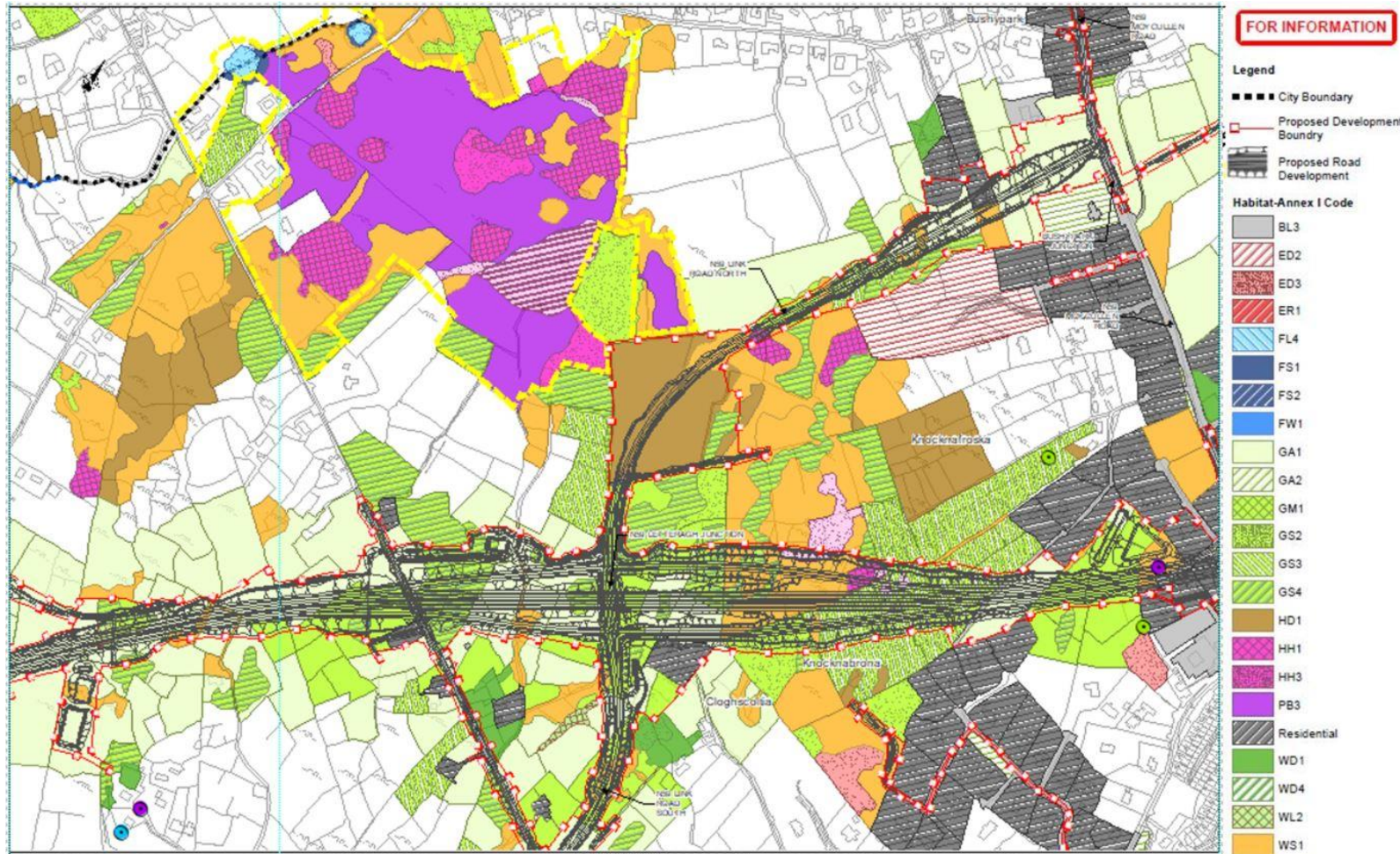
The Moycullen Bogs NHA lies immediately adjacent to the proposed road development boundary at Letteragh. At Letteragh, the NHA comprises a mosaic of habitats including dystrophic lakes (FL1), reed and large sedge swamp (FS1), wet grassland (GS4), dry siliceous heath (HH1), wet heath (HH3), lowland blanket bog (PB3), poor fen and flush, (PF2), transition mire and quaking bog (PF3) and scrub (WS1). The Annex I habitat types present at Tonabrocky are Dystrophic lakes [3160], Wet heath [4010], Dry heath [4030], Blanket bog [*7130], Transition mires [7140] and Rhynchosporion depressions [7150].

The extent, distribution and condition of peatland habitats are predominantly controlled by hydrological processes, with water being supplied by a combination of precipitation, overland flow and flow through the peat layer. The depth of peat and the depth of the water table are also critical components of a peatland ecosystem in determining habitat extent and distribution.

The hydrogeological regime, particularly the natural groundwater table, must be maintained so that the area, distribution and depth of the peatland habitats and their constituent/characteristic vegetation zones and communities are not reduced or compromised in any way.

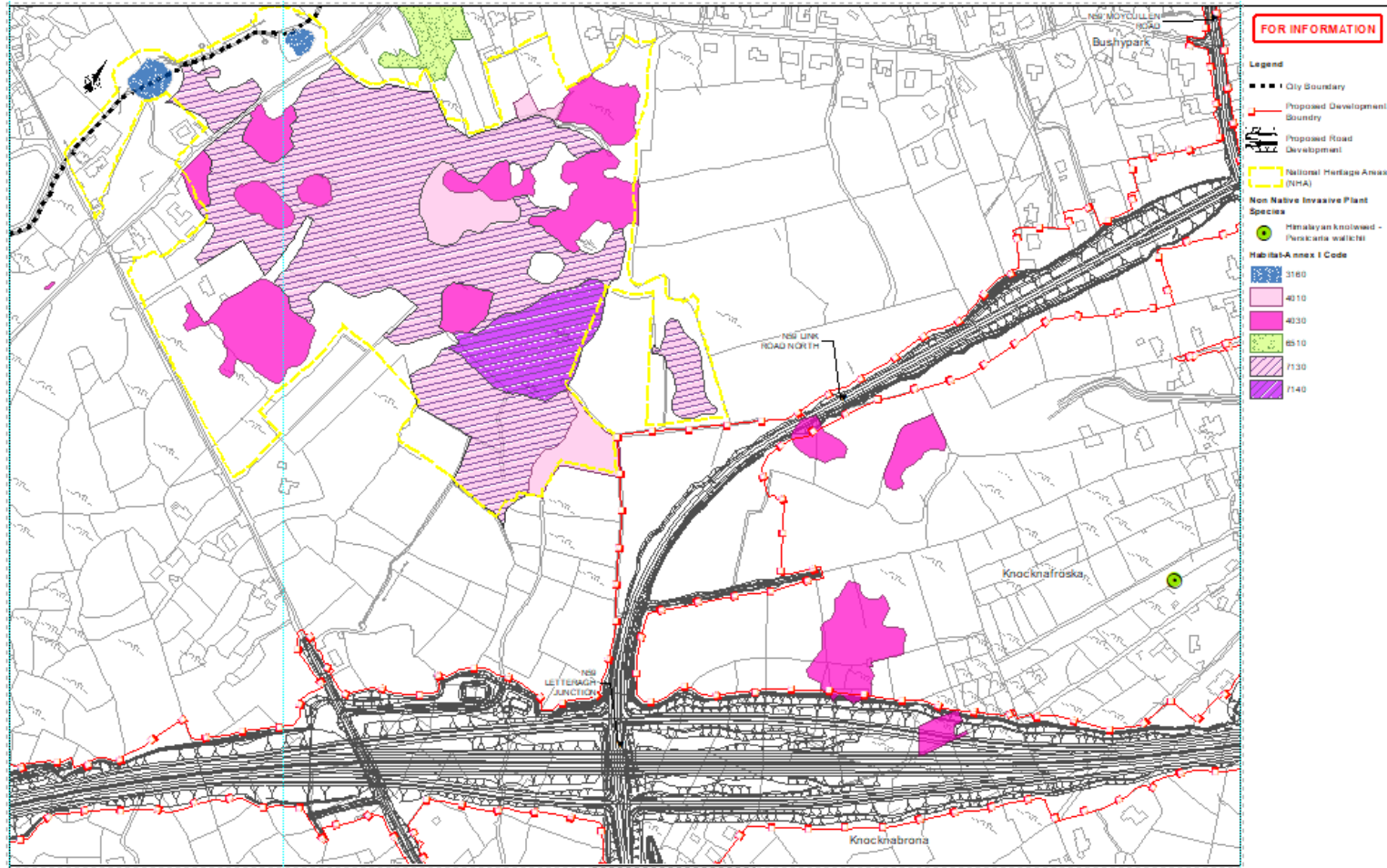
The Fossitt classifications of the habitats within Moycullen Bogs NHA at Letteragh, that lie in the immediate vicinity of the proposed road development, are shown on Figure 8.14.5 and 8.14.6 of the EIAR. For ease of reference the habitats with Fossitt classifications are reproduced below in Figure 1 noting that this was considered in the application documentation (Figure 1 below is a composite of Figure 8.14.5 and 8.14.6 of the EIAR for the purposes of clarification).

Figure 1: Fossitt classifications of the habitats within Moycullen Bogs NHA at Letteragh



The Annex I classifications of the habitats within Moycullen Bogs NHA at Tonabrocky, that lie in the immediate vicinity of the proposed road development, are shown on Figure 8.15.5 and 8.15.6 of the EIAR. For ease of reference the habitats with Annex I classifications are reproduced below in Figure 2 noting that this was considered in the application documentation (Figure 2 below is a composite of Figure 8.15.5. and 8.15.6 of the EIAR for the purposes of clarification).

Figure 2: Annex I classifications of the habitats within Moycullen Bogs NHA at Letteragh



3 Hydrogeology Impact Assessment

The hydrogeology of the Galway Granite Batholith includes areas where there is poor drainage and water ponding at the surface, and these areas include the Moycullen Bogs NHA. Where surface water ponding occurs, there is often little or no seasonal variation in the water level, with most areas remaining ponded throughout the summer.

The undulating topography of the Galway Granite Batholith includes areas of topographic highs where bedrock is near surface and topographic lows where the subsoils are thicker (up to 3m). On the topographic highs, rainfall runs off as overland flow whilst it is the low lying ground where surface ponding, as discussed above, tends to occur.

The GSI vulnerability data and the project ground investigation data together with the Ordnance Survey topographic data show that the granite has an undulating rock topography. As the granite is of low permeability, it will perch surface water and where drainage is poor, such in flat lying areas, surface water will be impounded and ponded. Due to the way that granite weathers, it forms an undulating rounded topography of ridges. The ridges occur where the rock is competent, hard and not weathered. The low points form where the granite has weathered and these are the main areas where water collects and forms permanent ponds. The water level in these areas tends not to vary as it is limited to spill points in the surrounding rock topography.

Connectivity between groundwater and the ponded surface water will be slight. As such, the water ponding on the surface at the Moycullen Bogs is not groundwater from the bedrock but water ponded on the top of the bedrock that has saturated the subsoil, has no natural discharge point, and so breaches the ground surface (i.e. pluvial ponding).

The Letteragh cutting on the mainline is shown on Figure 10.6.006 (plan and profile) of the EIAR with minimum and maximum groundwater levels shown. The drawdown extents calculated for the Letteragh cutting and the N59 Link Road North are shown on Figure 10.7.106 (construction) and 10.8.106 (operation) of the EIAR.

As reference above, four additional cross sections are included in Appendix A of this report to show the extent of drawdown relative to the permanently ponded areas in Moycullen Bogs NHA (Letteragh). These cross sections show drawdown from the mainline Letteragh cutting as well as the N59 Link Road North. Sections A-A and B-B show the drawdown from the mainline Letteragh cutting to the main permanent ponded area in the NHA as well as a satellite ponded area located to the southeast. Sections C-C shows drawdown from the main cutting on the N59 Link Road North and Section D-D shows the proposed road at its closest proximity to the Moycullen Bogs NHA (Letteragh).

For all granite cutting assessments, the lateral extent of drawdown is calculated using the Sichardt calculation, which is an empirical calculation based on the vertical extent to which the groundwater table is lowered at the point of

groundwater dewatering and permeability. The Sichardt calculation is presented in Appendix A.10.6 in Chapter 10, of the EIAR and for clarity also presented below:

$$R_o = 3000 h\sqrt{K} \quad (\text{Sichardt equation})$$

Where,

R_o = Radius of influence (m)

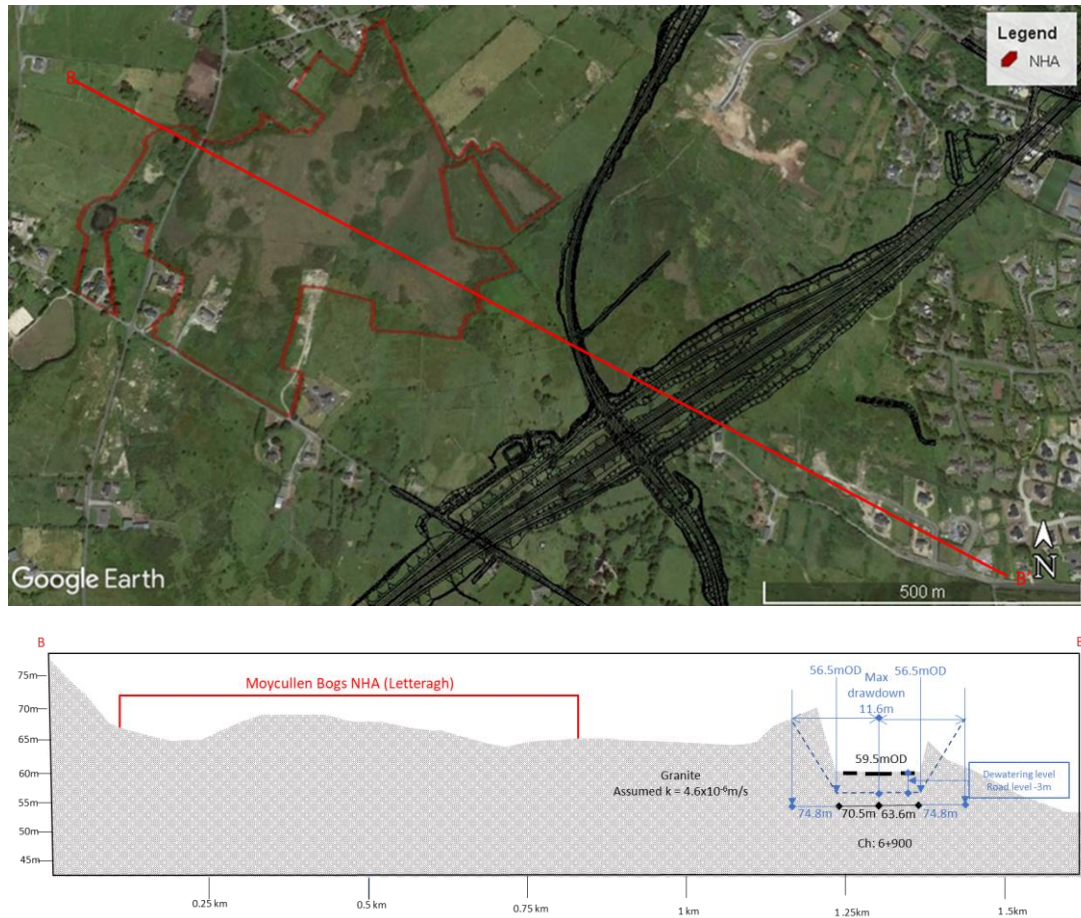
h = Drawdown (m)

k = Hydraulic conductivity (m/sec)

Both the vertical lowering and permeability were assessed conservatively. Vertical lowering is the height difference between drainage invert and peak recorded groundwater table (for granite the water table is often at, or near, surface). The dewatering level along any road level is the invert of trenches excavated for road drainage. In order to ensure that drawdown was assessed conservatively, the drainage invert was set to 1m deeper than the maximum invert level. On this basis a dewatering level of road surface minus 3m was set for the full alignment on granite. A conceptualisation of the cutting assessment is presented in Figure 3 below.

Further conservative measures were accommodated including using a permeability value of 4.6×10^{-6} m/s, which is considered high for granite except where significant fractures are present. It is noted that fracturing is identifiable by geophysics and both seismic and resistivity surveys were completed along the full length of the mainline cutting at Letteragh and the cutting at the N59 Link Road North. The mainline cutting does not show any significant zones of weathering along its length. The N59 Link Road North cutting has a vertical weathering zone at Ch 0+260 but as with the dominant fracture orientation in the area this feature is aligned generally north south and away from the Moycullen Bogs NHA (Letteragh). Managing groundwater inflows at cuttings is included in the Construction Environmental Management Plan (CEMP) in Appendix A.7.5 of the EIAR and Appendix C of the NIS. Where significant inflows occur then the karst protocol detailed in the CEMP will be used to manage flows and prevent impact to receiving waters.

Figure 3: Conceptualisation of the cutting assessment at Letteragh Cutting CH:7+900



Using this assessment, the drawdown extent has been delineated and is presented in Figure 10.7 (construction) and 10.8 (operation) of the EIAR.

As part of the ground investigation undertaken in the area of the Letteragh cutting, boreholes were drilled to prove the depth to bedrock as well as a geophysical survey. This data confirms that the bedrock at the Letteragh cutting is either at or consistently close to surface. On this basis, groundwater levels will not be lowered beyond the maximum conservative drawdown presented in the EIAR. Based on the assessment there is no risk to the Moycullen Bogs NHA at Letteragh from drawdown in the bedrock groundwater induced by the Letteragh cutting or N59 Link Road North cutting.

4 Conclusion

The proposed road development poses no risk of affecting the hydrogeological/hydrological regimes supporting the peatland habitats in Moycullen Bogs NHA (Letteragh).

Mitigation measures proposed ensure that the proposed road development does not affect the hydrogeological regime supporting the groundwater dependent habitats in Moycullen Bogs NHA (Letteragh).

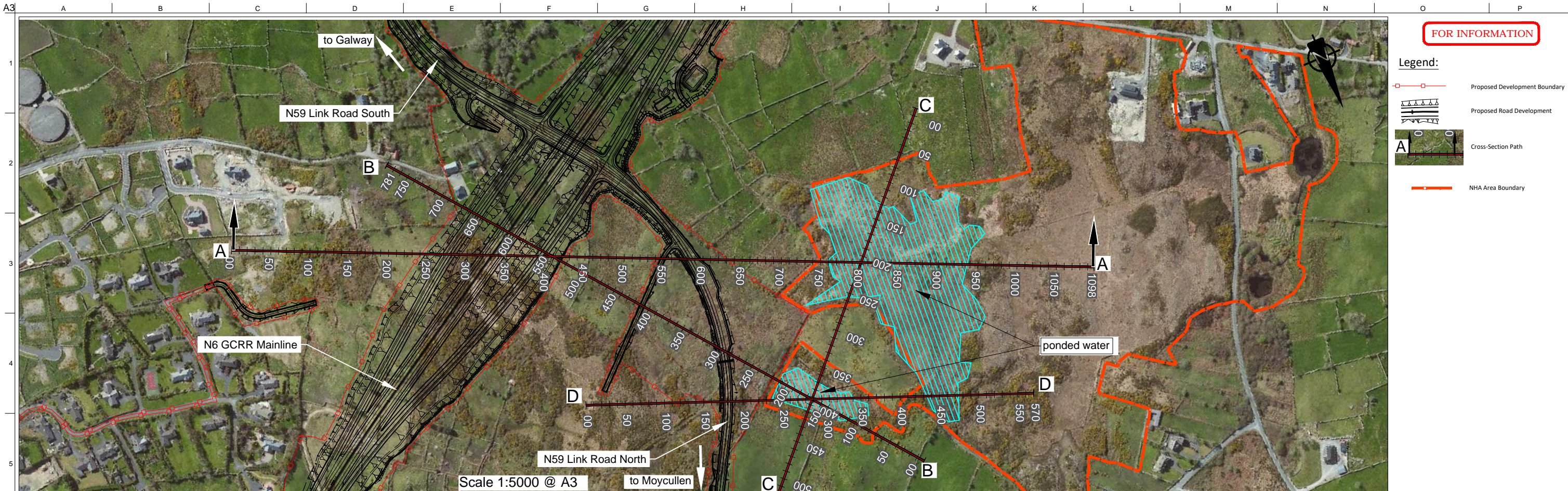
In circumstance where the hydrogeological zone of influence does not extend to Moycullen Bogs NHA, and where neither construction nor operation of the proposed road development will have any effect on the hydrogeological regime within Moycullen Bogs NHA, habitat degradation as a result of impacts on the existing groundwater regime in Moycullen Bogs NHA will not arise. Therefore, there are no residual direct or indirect groundwater related impacts that could have any likely significant residual effects on Moycullen Bogs NHA.

In conclusion, there will be no groundwater related impacts to the Moycullen Bogs NHA (Letteragh).

Appendix A

Cross Sections

A1



FOR INFORMATION

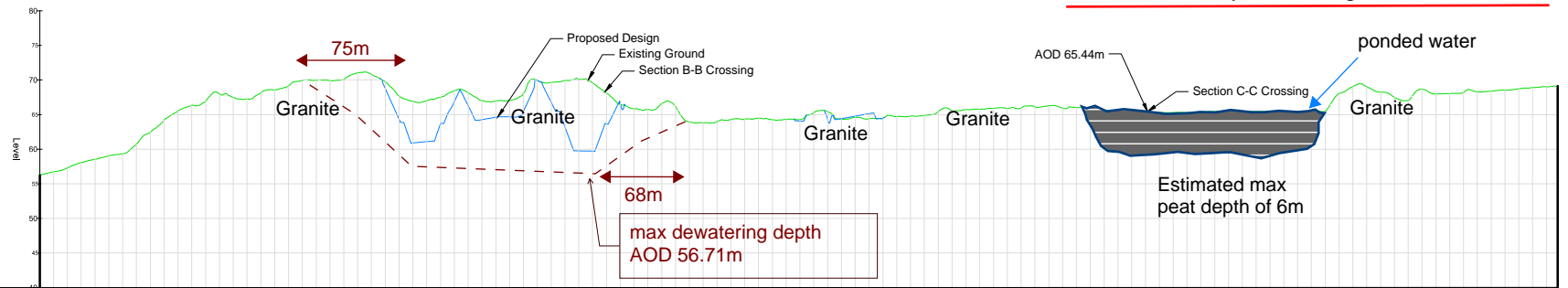
Legend:

- Proposed Development Boundary
- Proposed Road Development
- Cross-Section Path
- NHA Area Boundary

Scale 1:5000 @ A3

Chainage	Existing Levels	Proposed Levels
00.000	56.237	
10.000	56.743	
20.000	57.283	
30.000	58.041	
40.000	58.941	
50.000	59.051	
60.000	59.331	
70.000	60.722	
80.000	62.436	
90.000	64.193	
100.000	65.482	
110.000	66.357	
120.000	67.003	
130.000	67.899	
140.000	67.489	
150.000	67.277	
160.000	68.180	
170.000	68.596	
180.000	69.144	
190.000	69.940	
200.000	70.089	
210.000	70.089	
220.000	71.041	
230.000	70.811	
240.000	70.811	
250.000	68.741	68.741
260.000	67.712	64.275
270.000	66.925	60.925
280.000	67.004	61.091
290.000	67.993	61.964
300.000	68.440	62.360
310.000	68.167	66.270
320.000	67.033	64.277
330.000	66.967	64.641
340.000	67.036	64.662
350.000	65.464	65.464
360.000	69.930	69.930
370.000	69.642	68.771
380.000	69.342	68.164
390.000	69.208	68.164
400.000	69.566	69.208
410.000	68.114	63.654
420.000	66.454	66.679
430.000	65.826	
440.000	65.730	
450.000	66.588	
460.000	66.149	
470.000	66.006	
480.000	63.978	
490.000	63.978	
500.000	64.300	
510.000	64.348	
520.000	64.460	
530.000	64.258	
540.000	64.390	
550.000	64.390	
560.000	65.273	64.081
570.000	65.420	64.258
580.000	64.345	64.428
590.000	64.594	64.771
600.000	64.389	65.117
610.000	64.470	
620.000	610.000	
630.000	64.785	
640.000	65.000	
650.000	65.412	
660.000	65.550	
670.000	65.713	
680.000	65.785	
690.000	65.918	
700.000	65.882	
710.000	65.918	
720.000	66.097	
730.000	65.903	
740.000	65.903	
750.000	65.020	
760.000	66.008	
770.000	65.729	
780.000	65.671	
790.000	65.657	
800.000	65.477	
810.000	65.323	
820.000	65.289	
830.000	65.289	
840.000	65.308	
850.000	65.444	
860.000	65.508	
870.000	65.492	
880.000	65.456	
890.000	65.479	
900.000	65.479	
910.000	65.409	
920.000	65.526	
930.000	65.493	
940.000	68.047	
950.000	68.044	
960.000	68.020	
970.000	68.229	
980.000	67.488	
990.000	68.229	
1000.000	68.655	
1010.000	67.989	
1020.000	68.038	
1030.000	68.203	
1040.000	68.281	
1050.000	68.400	
1060.000	68.518	
1070.000	68.724	
1080.000	68.896	
1090.000	68.915	
1098.000	68.915	

ALIGNMENT - A-A - LONGSECTION in Natural Scale
SCALE @ A3: H 1:5000, V 1:5000. DATUM: 40m AOD



Chainage	Existing Levels	Proposed Levels
00.000	56.237	
10.000	56.743	
20.000	57.283	
30.000	58.041	
40.000	58.941	
50.000	59.051	
60.000	59.331	
70.000	60.722	
80.000	62.436	
90.000	64.193	
100.000	65.482	
110.000	66.357	
120.000	67.003	
130.000	67.899	
140.000	67.489	
150.000	67.277	
160.000	68.180	
170.000	68.596	
180.000	69.144	
190.000	69.940	
200.000	70.089	
210.000	70.089	
220.000	71.041	
230.000	70.811	
240.000	70.811	
250.000	68.741	68.741
260.000	67.712	64.275
270.000	66.925	60.925
280.000	67.004	61.091
290.000	67.993	61.964
300.000	68.440	62.360
310.000	68.167	66.270
320.000	67.033	64.277
330.000	66.967	64.641
340.000	67.036	64.662
350.000	65.464	65.464
360.000	69.930	69.930
370.000	69.642	68.771
380.000	69.342	68.164
390.000	69.208	68.164
400.000	69.566	69.208
410.000	68.114	63.654
420.000	66.454	66.679
430.000	65.826	
440.000	65.730	
450.000	66.588	
460.000	66.149	
470.000	66.006	
480.000	63.978	
490.000	63.978	
500.000	64.300	
510.000	64.348	
520.000	64.460	
530.000	64.258	
540.000	64.390	
550.000	64.390	
560.000	65.273	64.081
570.000	65.420	64.258
580.000	64.345	64.428
590.000	64.594	64.771
600.000	64.389	65.117
610.000	64.470	
620.000	610.000	
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640.000	65.000	
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660.000	65.550	
670.000	65.713	
680.000	65.785	
690.000	65.918	
700.000	65.882	
710.000	65.918	
720.000	66.097	
730.000	65.903	
740.000	65.903	
750.000	65.020	
760.000	66.008	
770.000	65.729	
780.000	65.671	
790.000	65.657	
800.000	65.477	
810.000	65.323	
820.000	65.289	
830.000	65.289	
840.000	65.308	
850.000	65.444	
860.000	65.508	
870.000	65.492	
880.000	65.456	
890.000	65.479	
900.000	65.479	
910.000	65.409	
920.000	65.526	
930.000	65.493	
940.000	68.047	
950.000	68.044	
960.000	68.020	
970.000	68.229	
980.000	67.488	
990.000	68.229	
1000.000	68.655	
1010.000	67.989	
1020.000	68.038	
1030.000	68.203	
1040.000	68.281	
1050.000	68.400	
1060.000	68.518	
1070.000	68.724	
1080.000	68.896	
1090.000	68.915	
1098.000	68.915	

ALIGNMENT - A-A - LONGSECTION in 5x Exaggeration Scale
SCALE @ A3: H 1:5000, V 1:1000. DATUM: 40m AOD

San díreámh tá sonraíocht Shuirbhíreacht Orlánáis Éireann arna atáirgeadh fós Cheadúnas OSÍ Uimh. 2010/20CCMA/Comhairle Contae na Gaillimhe. Sírúinn atáirgeadh neamhdaraithe cóipeacht Shuirbhíreacht Orlánáis Éireann agus Rialtas na hÉireann. © Shuirbhíreacht Orlánáis Éireann, 2010.

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Job Title
N6 Galway City Ring Road

Scale
@A3 H 1:5000, V - See Profile Scale

Date:
March 2020

Issue	Date	By	Chkd	Appd
I2	05/03/2020	KJ	LB	EMC
I1	02/03/2020	KJ	LB	EMC

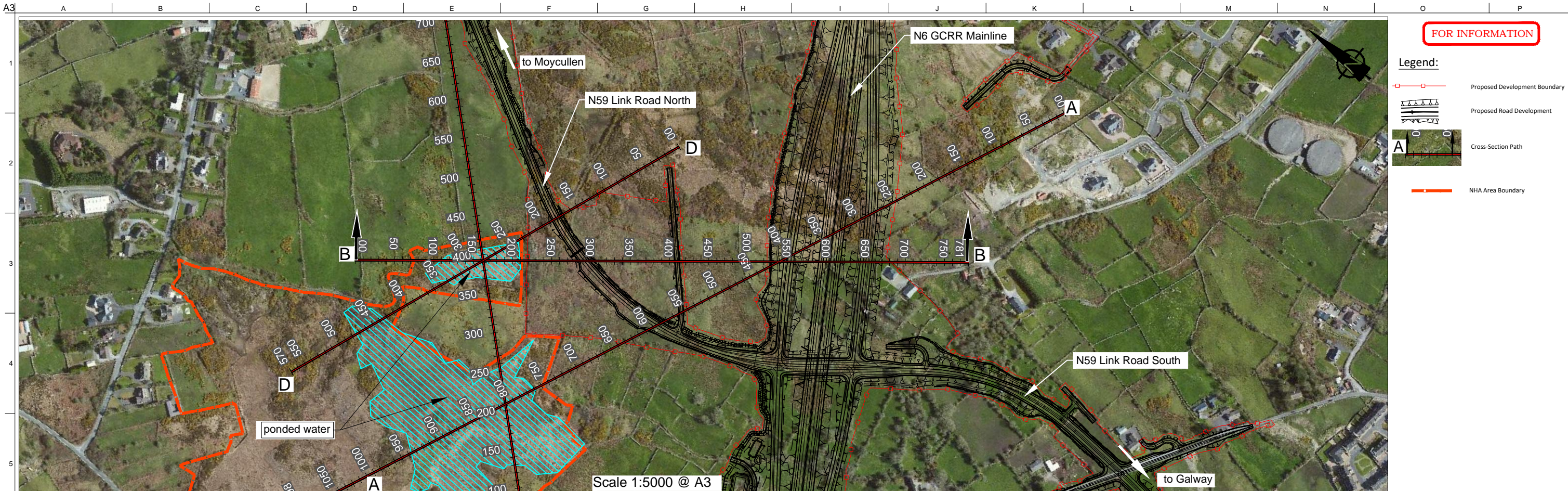
Drawing Title
Existing Ground & Proposed Design

Cross Section Letteragh A-A

Drawing Status

For Information

Job No	Drawing No	Issue
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FOR INFORMATION

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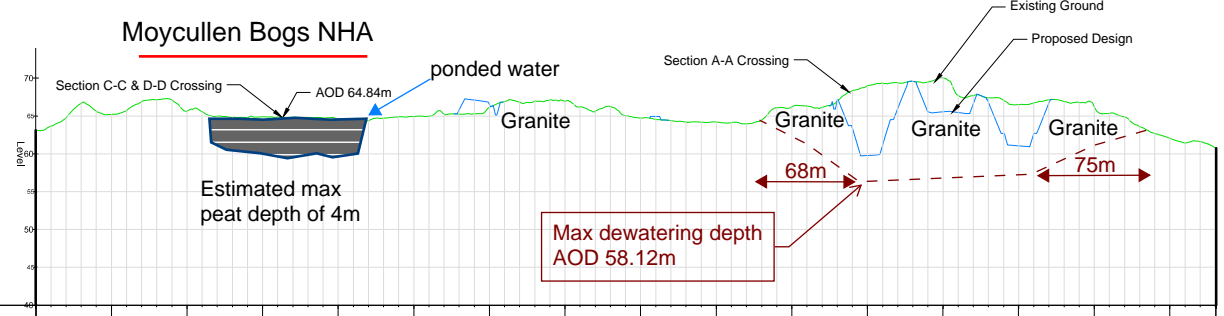
- Proposed Development Boundary
- Proposed Road Development
- Cross-Section Path
- NHA Area Boundary

Section C-C & D-D Crossing AOD 64.84m

Section A-A Crossing

Chainage	Existing Levels	Proposed Levels
00.000	63.119	
10.000	63.656	
20.000	64.785	
30.000	66.698	
40.000	66.698	
50.000	65.625	
60.000	65.714	
70.000	66.900	
80.000	67.086	
90.000	67.086	
100.000	65.646	
110.000	65.663	
120.000	64.970	
130.000	64.835	
140.000	64.794	
150.000	64.868	
160.000	64.859	
170.000	64.831	
180.000	64.754	
190.000	64.601	
200.000	64.634	
210.000	64.396	
220.000	64.707	
230.000	64.893	
240.000	64.974	
250.000	65.245	
260.000	65.260	
270.000	65.282	
280.000	65.162	
290.000	66.901	
300.000	66.808	
310.000	66.989	
320.000	66.989	
330.000	66.934	
340.000	66.226	
350.000	65.602	
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380.000	64.744	
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500.000	68.335	
510.000	68.988	
520.000	61.124	
530.000	69.339	
540.000	69.386	
550.000	69.590	
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570.000	69.590	
580.000	69.590	
590.000	69.590	
600.000	69.590	
610.000	69.590	
620.000	69.590	
630.000	69.590	
640.000	69.590	
650.000	69.590	
660.000	69.590	
670.000	69.590	
680.000	69.590	
690.000	69.590	
700.000	69.590	
710.000	69.590	
720.000	69.590	
730.000	69.590	
740.000	69.590	
750.000	69.590	
760.000	69.590	
770.000	69.590	
780.000	69.590	
790.000	69.590	
800.000	69.590	

ALIGNMENT - B-B - LONGSECTION in Natural Scale
SCALE @ A3: H 1:5000, V 1:5000, DATUM: 40m AOD



Chainage	Existing Levels	Proposed Levels
00.000	63.119	
10.000	63.656	
20.000	64.785	
30.000	66.698	
40.000	66.698	
50.000	65.625	
60.000	65.714	
70.000	66.900	
80.000	67.086	
90.000	67.086	
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110.000	65.663	
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480.000	66.15	
490.000	66.950	
500.000	68.335	
510.000	68.988	
520.000	61.124	
530.000	69.339	
540.000	69.386	
550.000	69.590	
560.000	69.590	
570.000	69.590	
580.000	69.590	
590.000	69.590	
600.000	69.590	
610.000	69.590	
620.000	69.590	
630.000	69.590	
640.000	69.590	
650.000	69.590	
660.000	69.590	
670.000	69.590	
680.000	69.590	
690.000	69.590	
700.000	69.590	
710.000	69.590	
720.000	69.590	
730.000	69.590	
740.000	69.590	
750.000	69.590	
760.000	69.590	
770.000	69.590	
780.000	69.590	
790.000	69.590	
800.000	69.590	

ALIGNMENT - B-B - LONGSECTION in 5x Exaggeration Scale
SCALE @ A3: H 1:5000, V 1:1000, DATUM: 40m AOD

San díreámh tá sonraíocht Shuirbhíreacht Ordnáis Éireann arna atáirgeadh fust Cheadúnas OSÍ Uimh. 2010/20CCMA/Comhairle Contae na Gaillimhe. Sírúinn atáirgeadh neamhdaraithe cóipeacht Shuirbhíreacht Ordnáis Éireann agus Rialtas na hÉireann. © Suirbhíreacht Ordnáis Éireann, 2010.

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Clients

An Roinn Iompair, Tarsáireacht agus Spóirt
Galway City Transport Project

Project Ireland 2040
Galway County Council

Comhairle Chontae na Gaillimhe
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www.arup.ie

Job Title
N6 Galway City Ring Road

Scale
@A3 H 1:5000, V - See Profile Scale

Date
March 2020

Issue	Date	By	Chkd	Appd
I2	05/03/2020	KJ	LB	EMC
I1	02/03/2020	KJ	LB	EMC

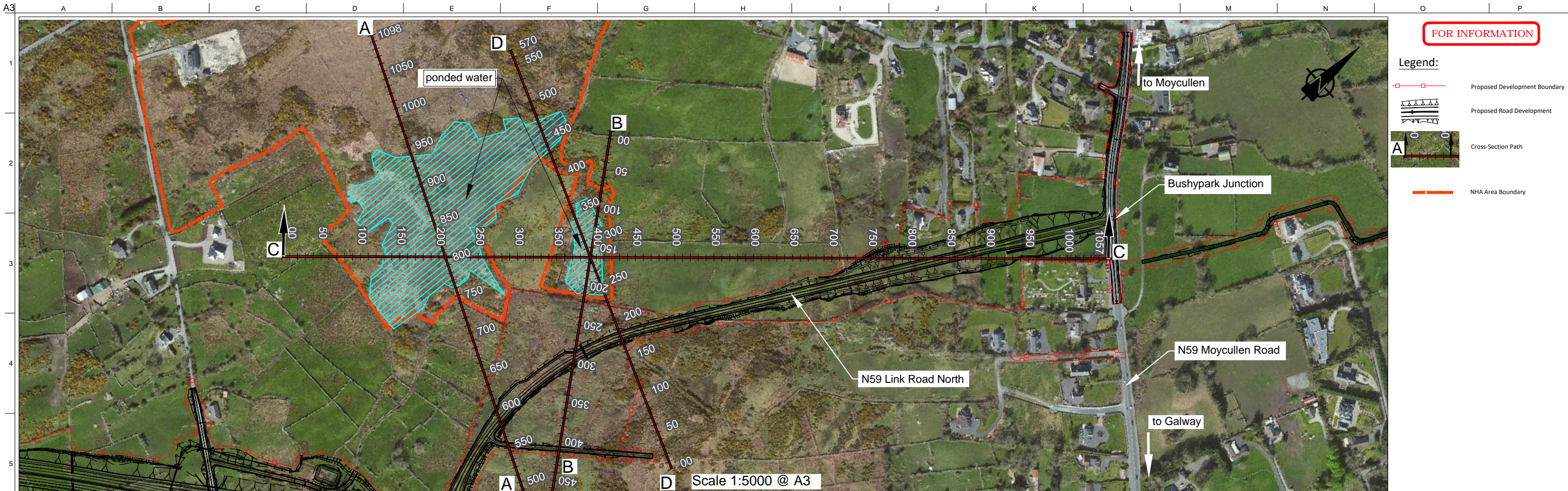
Drawing Title
Existing Ground & Proposed Design

Cross Section Letteragh B-B

Drawing Status

For Information

Job No	Drawing No	Issue
233985-00	GCOB-SK-OH-034	12

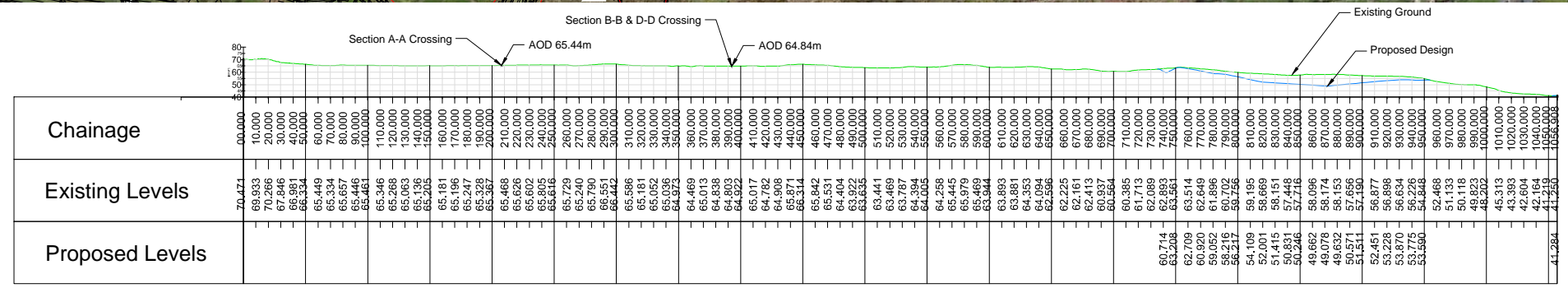


FOR INFORMATION

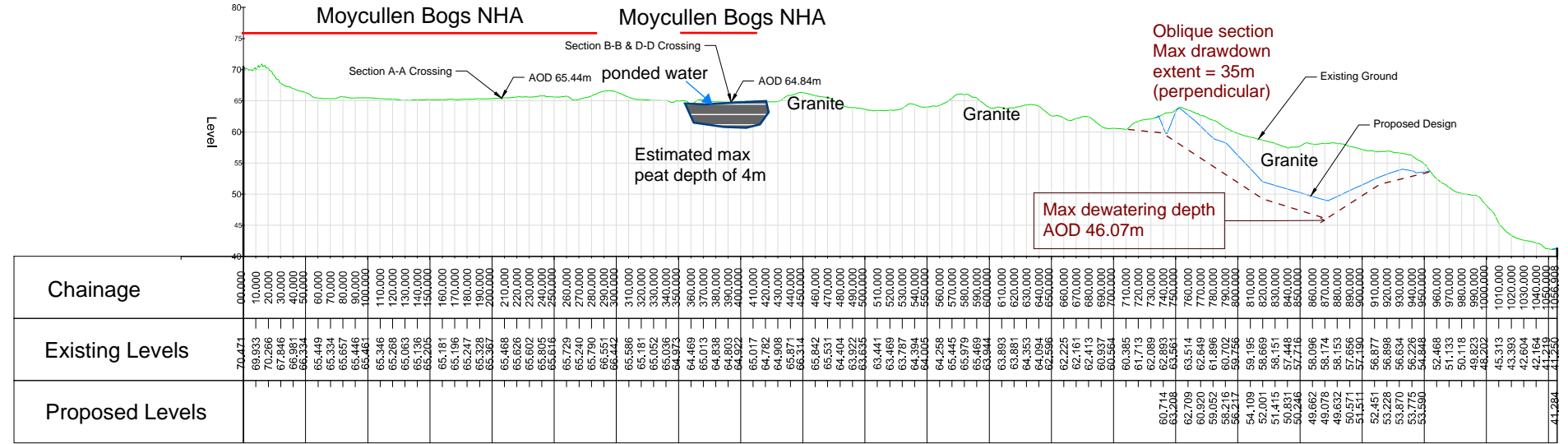
Legend:

- Proposed Development Boundary
- Proposed Road Development
- Cross-Section Path
- NHA Area Boundary

Scale 1:5000 @ A3



ALIGNMENT - C-C - LONGSECTION in Natural Scale
SCALE @ A3: H 1:5000, V 1:5000. DATUM: 40m AOD



ALIGNMENT - C-C - LONGSECTION in 5x Exaggeration Scale
SCALE @ A3: H 1:5000, V 1:1000. DATUM: 40m AOD

San áireamh tá sonraíocht Shuirbhíreacht Orlánáis Éireann arna áitirgeadh fust Cheadúnas OSi Uimh. 2010/20CCMA/Comhairle Contae na Gaillimhe. Sírúisinn áitirgeadh neamhdaraithe cóipeacht Shuirbhíreacht Orlánáis Éireann agus Rialtas na hÉireann. © Suirbhíreacht Orlánáis Éireann, 2010.

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Clients

An Roinn Iompair, Tarsáireacht agus Spóirt
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Galway City Transport Project

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Job Title
N6 Galway City Ring Road

Scale
@A3 H 1:5000, V - See Profile Scale

Date
March 2020

Drawing Title
Existing Ground & Proposed Design

Cross Section Letteragh C-C

Drawing Status

For Information

I2	05/03/2020	KJ	LB	EMC
I1	02/03/2020	KJ	LB	EMC
Issue	Date	By	Chkd	Appd

Job No
233985-00

Drawing No
GCOB-SK-OH-035

Issue
12

