M7 Osberstown Interchange & R407 Sallins Bypass Scheme

Soils, Geology and Hydrogeology

Brief of Evidence

by

Marie Fleming and Catherine Buckley

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1. Introduction

1.1 My name is Marie Fleming. I have a Bachelor of Science (Earth Sciences) honours degree from University College Cork and a Master's Degree in Engineering Geology from Imperial College London. I am a Professional Geologist (PGeo) with the Institute of Geologists of Ireland (IGI), a Chartered European Geologist (EurgGeol) with the European Federation of Geologists and a Fellow of the Geological Society of London.

1.2 I have served as a non-Executive Director of the IGI from 2010 to 2013, as an Executive Director from 2013 and I am currently the Vice-President of the IGI. I represented the IGI as the IGI Delegate to the EFG from 2011 to 2013 and am currently serving a three year term directly for the EFG as the Chair of the Registration Authority of the EFG.

1.3 I am a Senior Engineering Geologist in Arup, based in the Dublin office. I have over 12 years' experience working as a consulting geologist including international work experience in Europe and Australia.

1.4 My experience includes large infrastructure projects and public and private developments over a wide range of ground conditions. My expertise covers the full range of project stages from inception to construction with relevant experience including:

- Geotechnical designer and resident engineer for the All Weather Sports Pitches and Pavilion Building at the University of Limerick adjacent to the River Shannon SAC.
- Engineering Geologist for Irish Rail on risk assessments of existing cut and embankment slopes nationwide.
- Engineering Geologist responsible for the investigation and interpretation of ground conditions for numerous sites throughout Ireland, for building developments, including several basements.
- Lead Engineering Geologist for the Grangegorman Public Ream and Campus scheme from concept stage to construction contract award.
- Engineering Geologist for many large infrastructure projects from route selection and planning through construction, including the N22 Tralee Bypass, DART Underground and Ballinlaw to Bellview Pipeline.

1.5 I am the Geotechnical Lead for the M7 Osberstown Interchange & R407 Sallins Bypass Scheme and have been involved in the project throughout, as part of the inter-disciplinary team developing the design and impact statement.

1.6 I am supported by my colleague Catherine Buckley. Catherine has a Bachelor of Arts (Geology) honours degree from Trinity College Dublin and a Master's Degree in Hydrogeology from the University of Leeds. She is Professional Geologist (PGeo) with the Institute of Geologists of Ireland (IGI) and a Chartered European Geologist (EurgGeol) with the European Federation of Geologists.

1.7 Catherine is a Senior Hydrogeologist in Arup, based in the Dublin office with over 8 years of experience. Catherine's project experience includes groundwater flow modelling, contaminant fate transport modelling, groundwater protection assessments (drainage design review), EIS, hydrogeological impact assessments for dewatering operations, geothermal energy, groundwater monitoring, site investigation, human health and controlled water risk assessments and she has undertaken many research projects for the minerals industry.

1.8 Catherine was Chair of the Institute of Geologists working group that recently produced the document "Guidelines for the preparation of soils, geology and hydrogeology chapters of Environmental Impact Statements". She is a non-Executive Board member

of the Institute of Geologists of Ireland and was previously Treasurer of the International Association of Hydrogeologists (Irish Group).

1.9 Catherine has been involved in the assessment of the M7 Osberstown Interchange & R407 Sallins Bypass Scheme on the hydrogeology along the route and its environs.

2. Executive Summary

2.1 The EIS has demonstrated that the once all the recommended mitigation measures have been put in place the residual impacts of the construction phase on the soils, geology and hydrogeology will be imperceptible. The impacts of the on-going operation phase will be negligible.

2.2 A number of submissions were received regarding soils, geology and hydrogeology in relation to the impact on the groundwater aquifer, potential groundwater contamination and the risk of contamination from earthworks. These submissions are addressed as part of this Brief of Evidence which concluded the residual impact on Soils, Geology and Hydrogeology is considered imperceptible and permanent.

2.3 It should be noted that the proposed development is at a distance of 2.41km to the Curragh Aquifer, 7.28km to the Mouds Bog and 11.4km to Pollardstown Fen. Initial work carried out in the preparation of the EIS and in assessing the likely potential for any impact by the scheme on the Mouds Bog SAC and Pollardstown Fen SAC concluded there would be no impacts. However, in order to address the matters raised by DAHG in its submission, a technical note was prepared that expands on the information contained in the EIS to outline the assessment that was carried out to arrive at the conclusion that the scheme would have no impact whatsoever on the Natura 2000 sites of Mouds Bog and Pollardstown Fen. This is also dealt with in Section 7 of this brief and the Technical Note is attached to this brief.

3. Impact Assessment Methodology

3.1 Refer to Section 15.2 of the EIS for the Soils and Geology Impact Assessment Methodology.

3.2 Refer to Section 16.2 of the EIS for the Hydrogeology Impact Assessment Methodology.

4. Existing Environment

4.1 Refer to Section 15.3 of the EIS for the Soils and Geology Impact Assessment Methodology.

4.2 Refer to Section 16.3 of the EIS for the Hydrogeology Impact Assessment Methodology.

5. Impact Assessment

5.1 Detailed discussion of the predicted impacts of the proposed road development on soils, geology and hydrogeology during construction and operation is provided in Section 15.4 and Section 16.4 of the EIS. The assessment considered geological features identified within 250 m of the development boundary of the proposed road development and is summarised below:

Soils and Subsoils

5.2 Excavation of Glacial Till

Excavation of glacial till will be required at the railway crossing, where there is a slight risk of an impact on slope stability. However, the significance of this impact is considered 'slight' due to the relatively shallow nature of the excavation.

5.3 Earthworks

The proposed road development shall require the excavation and importation of material from cut and fill sections along the proposed route. Detailed discussion of the construction traffic associated with the excavation and importation is provided in the EIS (Chapter 4 – Description of the Proposed Road Development).

For the proposed road development, it is estimated that c. 703,000 m^3 of material is required for importation and c. 36,000 m^3 of material will need to be exported. The net deficit of material (c. 667,000 m^3) suggests that the earthworks activities will have a 'slight' impact upon soils and subsoils along the proposed route.

5.4 The operational phase of the M7 Osberstown Interchange and R407 Sallins Bypass will have an overall neutral long term impact on the soils and subsoils along the route.

Solid Geology

5.5 Bedrock Excavation

Bedrock was encountered several meters below the ground surface, with the overburden thickness ranging from 6 m to greater than 14.8 m. It is not likely that bedrock will be excavated along the proposed route and the significance of this impact is considered 'imperceptible'.

5.6 Hydrogeology

The hydrogeological impacts were considered in terms of impacts on groundwater resources, water quality, water supply, karst and groundwater dependent terrestrial eco-systems.

5.7 Groundwater Resources

During the construction stage, temporary dewatering will be required in some areas for a range of activities that may include cuttings, the installation of foundations, the construction of some pipelines crossing beneath the road, or deep manholes. The radius of influence from these activities was calculated on a conservative basis and shown to be limited.

In the EIS the incorrect ranking was assigned to the importance of the aquifer types and the magnitude of the impact on these resources due to dewatering. This in turn affected the Significance rating assigned to the impact.

The Regionally Important Aquifer was assigned a ranking of Very High, however this should be High. The magnitude of the impact was assigned as Small adverse, however as no dewatering will be required in the bedrock aquifer due to the shallow nature of the cuts, the magnitude of the impact should be Negligible. The resultant change to the Significance of the impact is to reduce it to an Imperceptible impact.

The Locally Important Aquifer was assigned a ranking of High, however this should be Medium. The magnitude of the impact was assigned as Small adverse, however as no dewatering will be required in the bedrock aquifer due to the shallow nature of the cuts, the magnitude of the impact should be Negligible. The resultant change to the Significance of the impact is to reduce it to an Imperceptible impact.

5.8 The impact of the proposed road development upon groundwater resources during the operational phase is rated as negligible. Cuts are shallow and dewatering will be temporary. The significance of these impacts is 'imperceptible'.

5.9 Water Quality

During the construction stage, groundwater quality may be impacted by the spillage of fuels or cleaning fluids of machinery on site through accidental spillage or leakage of tanks, or by the storage of contaminated material on site. The error in the EIS where the Regionally Important and Locally Important aquifers were ranked as having a Very High and High Importance respectively, when they should have been High and Medium, also affects the significance rating for the water quality impacts.

The significance rating for the potential water quality impacts on the Regionally Important aquifer during the construction phase should have been classified as 'Moderate/Slight' rather than 'Significant/Moderate'. Once mitigation measures are employed, the significance rating reduces to Imperceptible.

The significance rating for the potential water quality impacts on the Locally Important aquifer during the construction phase should have been classified as 'Slight' rather than 'Moderate/Slight'.

During the operational phase, the groundwater quality may be impacted by contaminated road run-off, e.g. petrol/diesel. The significance of this impact is rated as 'slight/moderate' in areas underlain by Regionally Important aquifers, or close to the River Liffey, or adjacent to springs.

5.10 Water Supply

Potential impacts upon public water supplies and local wells are considered to be 'imperceptible' as they are beyond the potential range of influence.

A number of domestic wells have the potential to be impacted by the proposed road development. However, any affected wells will be assessed and, if necessary, replaced or re-bored to a similar standard.

5.11 Karst Features

No karst features were observed in the site investigation works or are recorded in the GSI database. Springs encountered during the site walkover appear to be seepages at the extremities of gravel deposits rather than karst features.

5.12 Groundwater Dependent Ecosystems

The potential for impacts at these locations arises if the groundwater levels at the feature are impacted by site activities. An ecological assessment is then undertaken to determine if the change in groundwater level will impact the feature itself based on its specific characteristics.

The significance of the impact to the River Liffey groundwater dependent ecosystem during the construction and operational phase of the proposed road development is considered 'moderate/slight'.

The proposed road development will have no impact on the Grand Canal, as the groundwater in the study area does not act as a baseflow to the canal.

The potential impact upon Osberstown Pond is discussed in detail in the EIS (Chapter 17 – Hydrology).

As detailed in the attached technical note, no impacts will occur at the Curragh aquifer, Pollardstown Fen or Mouds Bog due to the site activities. The Curragh aquifer is located 2.41km from the proposed development. The Pollardstown Fen or Mouds Bog are 7.28 km and 11.4 km respectively from the proposed development.

5.13 Legacy Landfills

There are four legacy landfills identified through consultation outside of the study area. There is no impact on these landfills as they are distant from the proposed road development.

5.14 Waste Permitted Sites

The proposed road development will have no impact on the industrial facility with an IPPC licence, located approximately 250 m southeast of the existing M7 overpass which crosses over Canal Road.

6 Mitigation Measures

6.1 Detailed discussion of the proposed mitigation measures of the proposed road development on soils, geology and hydrogeology during construction and operation is provided in the EIS. In brief, these are summarised below:

Soils and Subsoils

6.2 Excavation of Glacial Till

Seepage from excavations in glacial till shall be mitigated by the use of an appropriate drainage system such as herringbone drains on the slope surface with a suitable angle employed to maintain slope stability during construction of the railway crossing.

6.3 Earthworks

Importation of materials from outside the site will be minimised in-so-far as possible by ensuring that materials arising within the site area are used to the greatest extent possible. Where necessary, naturally occurring materials will be processed to reduce moisture content and/or improve grading in order to maximise suitability for use. Inevitably, materials will be encountered which cannot reasonably be processed into unstable fill material.

These materials are generally suitable for other activities such as landscaping within the site area. Any surplus material remaining which cannot be incorporated into the works will be disposed of off-site at suitably licenced facilities.

Local sources for imported material will be used insofar as is possible and traffic movements related to the importation of fill material will be kept to a minimum.These impacts also relate to and interact with other chapters within the EIS namely:

- Chapter 4: Description of the Proposed Development.
- Chapter 5: Traffic & Transportation.
- Chapter 11: Noise & Vibration.
- Chapter 12: Air Quality.

- Chapter 18: Resource and Waste Management.

If encountered, contaminated soils will be excavated and disposed of off-site in accordance with the Waste Management Acts, 1998–2006, and associated regulations and guidance provided in the NRA's Guidelines for the Management of Waste from National Road Construction projects (NRA, 2008).

6.4 With appropriate design and construction, no specific operational mitigation measures are required for the soils and subsoils during the operation of the M7 Osberstown Interchange and R407 Sallins Bypass.

Solid Geology

6.5 Bedrock Excavation

No bedrock excavation is envisaged for the proposed road development.

Hydrogeology

6.6 Groundwater Resources

During the construction phase the groundwater resources are potentially at risk from the dewatering process. Groundwater level monitoring will be put in place 12 months before construction, during the construction phase and 24 months following construction.

Where deep cuts require dewatering, a dewatering plan will be developed based on baseline monitoring data. This will state the optimal time and rate of abstraction to minimise the impacts of dewatering.

6.7 Water Quality

Negative impacts on water quality that occur due to stockpiling of contaminated material and leachate generation will be prevented by not storing contaminated material on site. If any suspected contaminated material is encountered it will be tested and disposed of in an appropriate manner and in line with current water management legislation. If it is not possible to immediately remove contaminated material, then it will be stored on, and covered by, polythene sheeting to prevent rain water infiltrating through the material. The time frame between excavation and removal will be kept to an absolute minimum.

Run-off will be controlled through silt/sediment traps as appropriate to minimise the turbidity of water in outfall areas. Care will be taken to ensure that the bank surfaces are stable to minimise erosion. As mentioned previously, groundwater level monitoring will be put in place to mitigate any adverse impacts.

Once in operation, sealed drainage will be provided where the Quaternary deposits provide insufficient protection to the underlying groundwater. Five new attenuation ponds and six new swales will be constructed along the proposed scheme.

6.8 Water Supply

The only water supply that could potentially be significantly impacted are private wells identified in the well survey located within 100 m of the route, other uncharted wells and springs, and seepage fronts at low elevations which are used for agricultural purposes.

Where private water supply wells are affected these will be replaced or households connected to mains supply where available. Where wells have to be abandoned as part of the proposed road development they will be sealed and abandoned in general accordance with Well Drilling Guidelines produced by the IGI (2007).

6.9 Karst Features

No karst features have been identified within the study area. Any springs that are encountered during construction will need to be incorporated into the drainage network of the route. Sealed drainage will be provided where the Quaternary deposits provide insufficient protection to the underlying karstic aquifer if the alignment is in a cut section.

6.10 Groundwater Dependent Ecosystems

An Environmental Operating Plan will be implemented for the construction of the bridge footings in the river gravels for crossings of the River Liffey and the Grand Canal.

Fuels will not be stored within 100 m of the River Liffey. All fuel containers and diesel operated plant must be positioned on flat bunded surfaces as far from the river as is feasible. Stockpiles will be graded and shall not be located within 100 m of the River Liffey.

Run-off into Osberstown Pond and stream will be controlled through silt/sediment traps as appropriate to minimise the turbidity of water in outfall areas.

7 Residual Impacts

Soils and Geology

7.1 Once all the recommended mitigation measures have been put in place the residual impacts of the construction phase on the soils and subsoils will be imperceptible. The impacts of the on-going operation phase will be negligible.

Hydrogeology

7.2 Once all the recommended mitigation measures relating to the potential for groundwater contamination have been put in place the residual impacts of the construction and operational phases on the hydrogeological features will be imperceptible.

8 Response to Submissions

8.1 A total of 4 submissions were received regarding soils, geology and hydrogeology. These were from the following individuals, organisations and businesses:

- Alan Lloyd;
- Patrick Garvey;
- Department of Arts, Heritage and the Gaeltacht; and
- HSE Environmental Health Service;

8.2 The 4 submissions regarding soils, geology and hydrogeology were in relation to the impact on the groundwater aquifer, potential groundwater contamination and the impact of fill material on the groundwater aquifer. These submissions are addressed as part of this Brief of Evidence which concluded the residual impact on Soils, Geology and Hydrogeology is considered imperceptible and permanent.

8.3 A submission was received by ABP from the Department of Arts, Heritage and the Gaeltacht (DAHG) on 27th February 2014 with respect to the impacts on the Curragh aquifer. As explained in the Executive Summary above, initial work carried out in the preparation of the EIS and in assessing the likely potential for any impact on the Mouds Bog SAC and Pollardstown Fen SAC concluded that there would be no impact.

However, in order to address the matters raised by DAHG in its submission, a technical note (attached) was prepared that expands on the information contained within the EIS to outline the assessment that was carried out to arrive at the conclusion that the scheme would have no impacts whatsoever on the groundwater levels at the two Natural 2000 sites of Pollardstown Fen and Mouds Bog. Further, the proposed development is located at a distance of 2.41km to the Curragh Aquifer, 7.28km to the Mouds Bog and 11.4km to Pollardstown Fen. Mr Paul Murphy, Ecology, also deals in detail with the DAHG submission in relation to Mouds Bog and Pollardstown Fen and concludes that from an ecological perspective the scheme will not have any effects on any European sites.

9 Conclusions

9.1 The residual impact of the scheme on Soils, Geology and Hydrogeology is considered imperceptible and permanent. With appropriate design and construction no specific operational mitigation measures are required.

Technical note – M7 Hydrological Impact Assessment of Cut Sections

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M7 Osberstown Interchange & R407 Bypass Scheme

1 Introduction

An EIS was submitted to An Bord Pleanala (ABP) as part of the planning application for the proposed M7 Osberstown Interchange and R407 Sallins Bypass scheme on 14 January 2014. In the course of preparing the EIS and assessing the environmental impacts of the scheme, detailed consideration was given to the potential for impacts on any SAC. The conclusion reached was that there would be no such impacts.

A submission was received by ABP from the Department of Arts, Heritage and the Gaeltacht (DAHG) on 27th February 2014 with respect to the impacts on the Curragh aquifer:

"*The Department notes that the proposed development is situated over the Curragh Aquifer and that while cuts will be kept to a minimum some de-watering will be necessary. It is not clear if the dewatering will have temporary or permanent impacts on the aquifer or how much water will be pumped out. An Bord Pleanala should note that the Pollardstown Fen, a candidate Special Area of Conservation (cSAC) (site code 000396) designated under the EC Habitats Directive (Council Directive 92/43/EEC), derives its spring fed water supply from the Curragh Aquifer. Therefore it is not clear why it is stated in the Habitats Directive Screening Report that there are no direct hydrological connections with the two nearest Natura 2000 sites (Pollardstown Fen and Mouds Bog) 5km away.*

Because of the nature of Pollardstown Fen cSAC hydrological issues are key to its integrity. Unless there can be certainty that the dewatering of this aquifer will not adversely affect the integrity of Pollardstown Fen, or any other water dependent Natura 2000 sites, the project should not proceed. In addition, cumulative impacts with other projects that could impact on this aquifer need to be considered including any roads already build such as the Kildare Bypass which currently has monitoring in place."

In order to address the matters raised by DAHG in its submission, this technical note expands on the information contained in the EIS to outline the assessment that was carried out to arrive at the conclusion that the scheme would have no impact whatsoever on the two Natura 2000 sites of Pollardstown Fen and Mouds Bog.

At the outset, it should be noted that the proposed development is not actually situated over the Curragh aquifer and is located considerably more than 5 km from Pollardstown Fen (11.4 kms)

2 Impact Assessment

The initial assessment investigated whether the proposed development would temporarily or permanently impact the aquifer and the associated wetlands. An impact on these features may arise if:

- there is a direct hydrogeological connection between the groundwater directly beneath the proposed development and the groundwater at the features of interest, **and**;

- the magnitude of the proposed site activities are such that their influence extended as far as the features of interest.

The site activities for the proposed development which interact with groundwater and ultimately are the potential temporary and permanent impacts from the scheme (and which were the subject of the impact assessment) are:

- Temporary impacts: lowering of groundwater levels due to dewatering of cuts during the construction phase; and
- Permanent impacts: lowering of groundwater levels due to drainage of cuts during the operational phase.

2.1 Background information

As set out in the EIS, the Curragh aquifer is a Regionally Important gravel aquifer which provides baseflow to the Mouds Bog and the Pollardstown Fen. The location of the proposed development relative to the Curragh aquifer[1], Mouds Bog and the Pollardstown Fen is shown on Figure 1. The distances between each of these features of interest and the nearest location requiring dewatering are summarised in Table 1:

Table 1. Relative distances between features of interest and the proposed development

Feature of interest	Distance of the feature to the closest proposed dewatering location (m)
Curragh Aquifer	2410
Mouds Bog	7280
Pollardstown Fen	11400

Some confusion may have been caused whereby the distances quoted in the EIS were approximate, and these approximate distances have now been refined. These refined distances have been submitted to the hearing as Errata.

There are 5 cuts and 6 structures along the proposed development, which may require some dewatering and the locations of these are shown on **Figure 1**. Details of all the cuts, including their maximum depth are presented in **Table 2.** The majority of this information is summarised from Tables 16.5, 16.10 and 16.11 of the EIS as the EIS only included information for Cut 4, which was the deepest, and the sections of the other cuts which were in Regionally Important Aquifers and therefore at highest risk. For clarity and completeness, in this note, all cuts are included, even if they are as shallow as 0.4 m and may not require dewatering. Dewatering will be required below the base of the cut to allow foundations to be constructed and this detail has also been provided in **Table 2.**

[1] The Curragh aquifer boundary has been defined by the Geological Survey of Ireland

Table 2. Details of cuts along the proposed route

Cut / Structure number	Chainage	Total length of cut (m)	Average depth of cut (m)	Max depth of cut (mbgl)	Max depth where dewatering may be required (mbgl)*
C1	CH 0+360 to CH 0+520	160	0.4	0.7	1.2
C2	CH 0+550 to CH 0+640	90	0.5	0.6	1.1
C3	CH 0+740 to CH 0+950	210	0.7	1.0	1.5
C4	CH 1+060 to CH 1+340	280	1.22	2.6	3.1
C5	CH 3+550 to CH 3+640	90	0.6	0.7	1.2
S1	CH 0+000	NA	NA	0.9	1.4
S2	CH 1+050	NA	NA	2.2	2.7
S3	CH 1+257	NA	NA	2.6	3.1
S4	CH 1+577	NA	NA	1.75	2.25
S5	CH 1+980	NA	NA	1.6	2.1
S6	CH 3+050	NA	NA	1.7	2.2

*Max depth of cut plus an additional 0.5m to allow for dewatering of foundations

Full details of the regional and local geology and hydrogeology are presented in Chapters 15 and 16 of the EIS respectively. **Table 3** presents the site investigation information, including geology and water levels at the location of each of the cuts (as presented in Tables 16.7, 16.10 and 16.11, of the EIS). As shown on **Figure 1**, the proposed development is not located on the Curragh aquifer. However, as gravel deposits were detected during the site investigation, particularly in the south of the site, this assessment has assumed that these gavel deposits are hydrogeologically connected to the Curragh aquifer (although this is not the case) to assess the absolute worst case scenario. The depth to the gravel deposits are also noted in **Table 3**.

Table 3. Geology and water levels at locations of cuts

Cut / Structure number	Average depth of cut (m)	Max depth where dewatering may be required (mbgl)*	Geology of zone where dewatering may be required	Approximate depth to sand / gravel deposits (mbgl)	Closest monitoring well ID (response zone lithology)	Maximum measured water level (mbgl)
C1	0.4	0.7	Clay; Clay/Silt (Till)	4.2	RC01 (limestone)	1.55
C2	0.5	0.6	Clay; Clay/Silt (Till)	Not encountered		
C3	0.7	1.0	Clay (Till)	Not encountered		
C4	1.22	2.6	Silt; Clay (Till)	4	RC07 (limestone)	0.75
C5	0.6	0.7	Silt (Till)	Not encountered	RC20 (overburden)	1.69
S1	NA	1.4	Clay (Till)	Not encountered		
S2	NA	2.7	Gravel	0.1	RC04 (limestone)	1.93
S3	NA	3.1	Clay; silt (Till)	Not encountered	RC07 (Limestone)	1.24
S4	NA	2.25	Gravel	0.1	RC10 (Gravel)	0.66
S5	NA	2.1	Sand; Gravel	0.1 (sand); 3.6 (gravel)	RC14 (Gravel)	1.92
S6	NA	2.2	Sand	0.1 (sand)	RC19 (Gravel / Clay)	2.74

In any assessment it is first necessary to establish if there is a direct hydraulic connection between the groundwater beneath the proposed development and the groundwater at the Curragh aquifer, Mouds Bog and the Pollardstown Fen. **Figure 1** clearly establishes that the proposed development lies outside the boundaries of the Curragh aquifer and is distant from the boundaries of the Curragh aquifer.

As mentioned above, the site investigations carried out established that there are gravel deposits on the site beneath the proposed development. In order to undertake a conservative assessment, and investigate a worst case scenario, it was assumed that the groundwater within these gravel deposits are hydrogeologically connected to the groundwater in the Curragh aquifer (although this is unlikely and there is no evidence to support this). On this assumption (which may or may not be correct), the proposed site activities were examined to establish if they could potentially have any interaction with groundwater levels in the Curragh aquifer.

The potential temporary and permanent impacts from the scheme associated with the cuts are outlined above. The information presented in **Tables 2 and 3** indicates that the cuts along the

proposed development are all shallow and do not extend into the gravel deposits. However, as ground conditions are variable, and again being conservative and for completeness and to fully answer the submission from the DAHG, it was assumed for the purposes of this assessment that the cuts will encounter gravel for their full depth (a very conservative assumption).

In order to establish whether the cuts will influence groundwater levels at the Curragh aquifer, the radius of influence for each of the cuts has been calculated. The radius of influence is the area within which groundwater levels are affected by lowering of the water table. Outside the boundary of the radius of influence, the dewatering will have no influence on the groundwater levels.

The radius of influence can be calculated based on the Sichardt empirical formula:

$$Ro = \frac{C(H - hw)}{\sqrt{(K)}}$$

Where,

Ro = radius of influence

C = empirical calibration factor

(H – hw) = drawdown (amount the water table would be lowered)

K = hydraulic conductivity (the rate at which groundwater can flow through the material

Based on this calculation, the greater the drawdown and the hydraulic conductivity, the greater the radius of influence will be.

The calculated radius of influence for each cut is presented in **Table 4** and is graphically shown on **Figure 2**. A number of conservative assumptions were made in this calculation in order to maximise the radius of influence calculated:

1. It was assumed that the drawdown (the amount the water table is lowered) is the full depth of the cut. In this scenario, groundwater level is calculated as being at the surface and this maximises the drawdown required giving a wider radius of influence.
2. A hydraulic conductivity of 0.0001 m/s ($1x10^{-4}$ m/s) was used. This is equivalent to a clean gravel deposit and is a very high value. The site investigation information indicates that the majority of the cuts will be in silt or till deposits which would be expected to have a lower hydraulic conductivity e.g. clay can have a hydraulic conductivity of 0.000000001 m/s ($1x10^{-9}$ m/s). Four of the structures requiring dewatering will be excavating in sand / gravel, and a hydraulic conductivity range of 0.0001 – 0.000001 m/s could be expected. By using a very high hydraulic conductivity the calculated radius of influence is as wide as possible.
3. The radius of influence marked on the figure assumes that the full length of the cut is at the maximum depth, which again is very conservative.

Table 4. Details of cuts along the proposed route

Cut number	Chainage	Total length of cut (m)	Average depth of cut (m)	Max depth of cut (mbgl)	Radius of influence (m)
C1	CH 0+360 to CH 0+520	160	0.4	0.7	35.1
C2	CH 0+550 to CH 0+640	90	0.5	0.6	33
C3	CH 0+740 to CH 0+950	210	0.7	1.0	43.5
C4	CH 1+060 to CH 1+340	280	1.22	2.6	93
C5	CH 3+550 to CH 3+640	90	0.6	0.7	35.1
S1	CH 0+000	NA	NA	0.9	42
S2	CH 1+050	NA	NA	2.2	81
S3	CH 1+257	NA	NA	2.6	93
S4	CH 1+577	NA	NA	1.75	67.5
S5	CH 1+980	NA	NA	1.6	63
S6	CH 3+050	NA	NA	1.7	66

As presented in **Table 4**, the calculated radius of influence of each cut is relatively small. **Figure 2** clearly illustrates that the radius of influence does not extend as far as the Curragh aquifer, Mouds Bog or Pollardstown Fen. This clearly demonstrates that the proposed development will not interact with the Curragh aquifer, Mouds Bog or Pollardstown Fen.

A significance impact assessment, in line with the NRA rating criteria is presented in **Table 5**.

Table 5. Significance impact assessment

Feature name	Importance of feature	Magnitude of impact (temporary and permanent)	Significance of impact
Curragh Aquifer	Extremely High	None predicted	None predicted
Pollardstown Fen	Extremely High	None predicted	None predicted
Mouds Bog	Very High	None predicted	None predicted

This assessment indicates that proposed M7 Osberstown Interchange and Sallins Bypass scheme will have **no impact** on the Curragh aquifer, Mouds Bog and Pollardstown Fen and there is no doubt in relation to this conclusion.

Accordingly, applying best scientific knowledge and having regard to the site conservation objectives of the Mouds Bog and Pollardstown Fen sites, from a hydrogeological perspective, it is clear that this scheme will not have any impact whatsoever on these European sites, still less any likely significant impacts. My colleague Paul Murphy, the project ecologist on the scheme has also confirmed this position.

2.2 Cumulative impacts

In order to assess the potential impacts from the proposed development on the Curragh aquifer, the assessment considered the cumulative impacts of the scheme and any other developments in the area. As concluded above, the proposed development will have no impact on the Curragh aquifer and will not contribute to cumulative impacts.

The M7 Naas to Newbridge Bypass Upgrade Scheme is located on the Curragh Aquifer and 5km from the Pollardstown Fen SAC. An assessment of the impacts which that scheme may have on those features was undertaken by the Project Team for that Scheme with which I have liaised regularly in the assessment of potential impacts. The assessment concluded that, as there will be no dewatering requirement on that scheme because of the fact there is no cut within that scheme, it is impossible for water levels or volumes in the Curragh Aquifer to be altered by that scheme and, therefore, there would be no impact whatsoever on the hydrological regime in either Pollardstown Fen or Mouds Bog.

These assessments demonstrate that there will be no impact, cumulative or otherwise, on the Curragh aquifer, Pollardstown Fen and Mouds Bog.

Accordingly, applying best scientific knowledge and having regard to the site conservation objectives of the Mouds Bog and Pollardstown Fen sites, from a hydrogeological perspective, it is clear that the scheme, either alone or in combination with other plans or projects, will not have any impact whatsoever on these European sites, still less any likely significant impacts.

3 Summary

The impact assessment concluded that the proposed development will have **No impact** on the Curragh aquifer, Mouds Bog and the Pollardstown Fen. The cumulative impacts have been assessed and also conclude that there will be no impact on the Curragh aquifer, Mouds Bog and the Pollardstown Fen. The assessment can be summarised as follows:

- The site is not situated on the Curragh aquifer, which provides baseflow to the Mouds Bog and the Pollardstown Fen, however in order to undertake a conservative assessment and for completeness and to respond in full to the submission form the DAHG it was assumed (although there is no evidence of this) there is a direct hydrogeological connection between the groundwater beneath the proposed development and the groundwater in the Curragh aquifer,
- There will be 5 cuts and 6 structures requiring dewatering along the proposed route, the deepest of which is 2.6 m which will indicate a maximum dewatering depth of 3.1 m,
- All of the cuts are within the shallow overburden material composed of silts and till, none of these cuts will extend into the gravel, however in order to undertake a conservative assessment and for completeness and to respond in full to the submission form the DAHG it has been assumed that the cuts may extend into the gravel and that the groundwater level is at the surface,
- Four of the excavations for structures will extend into sand / gravel deposits and in order to be conservative and for completeness it was assumed (although it is not the case) that the groundwater level is at the surface to generate the maximum radius of influence,
- The maximum radius of influence calculated is 93 m but the Curragh aquifer is 2,410 m from the closest location requiring dewatering, Mouds Bog is 7,280 m from it and Pollardstown Fen is 11,400 m away. This means the activities at the proposed cut cannot extend to the Curragh aquifer.
- Using the most conservative estimates, this indicates that the proposed development will have **no impact** on the Curragh aquifer, Mouds Bog and the Pollardstown Fen.

- This assessment indicates that proposed M7 Osberstown Interchange and Sallins Bypass scheme will have **no impact** on the Curragh aquifer, Mouds Bog and Pollardstown Fen and there is no doubt in relation to this conclusion. Accordingly, applying best scientific knowledge and having regard to the site conservation objectives of the Mouds Bog and Pollardstown Fen sites, from a hydrogeological perspective, it is clear that the scheme, either alone or in combination with other plans or projects, will not have any impact whatsoever on these European sites, still less any likely significant impacts.
- My colleague Paul Murphy, the project ecologist on the scheme has also confirmed this position..