PRIORITY GEOTECHNICAL LTD.

PROPOSED DEVELOPMENT SITE AT CROSS WEST, CLAREMORRIS, CO. MAYO

SITE SPECIFIC FLOOD RISK ASSESSMENT

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

Integrated Engineering Consulting

PRIORITY GEOTECHNICAL LTD.

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1 Introduction

IE Consulting was requested by Priority Geotechnical Ltd to undertake a Site Specific Flood Risk Assessment (SSFRA) for a proposed development Cross West, Co. Mayo.

The purpose of this SSFRA is to assess the potential flood risk to the proposed development site and to assess the impact that the development as proposed may or may not have on the hydrological regime of the area, in accordance with the OPW Guidelines.

Quoted ground levels or estimated flood levels relate to ordinance datum (Malin) unless stated otherwise.

This SSFRA has been undertaken in consideration of the following guidance document:-

'The Planning System and Flood Risk Management – Guidelines for Planning Authorities' DOEHLG 2009.

2 Proposed Site Description

2.1 General

The site is located 4 km west of the town of Cong in County Mayo and has a total area of approximately 1.1 hectares. The L1614 runs along the southern boundary of the site, to the east and west is developed residential land and to the north is undeveloped land. The site is earmarked for a proposed social housing development. This SSFRA will be used to inform the layout of the proposed residential properties and all associated works at the site.

The location of the proposed development site is illustrated on *Figure 1* below and shown on *Drawing Number IE1946-001-A in Appendix A*.

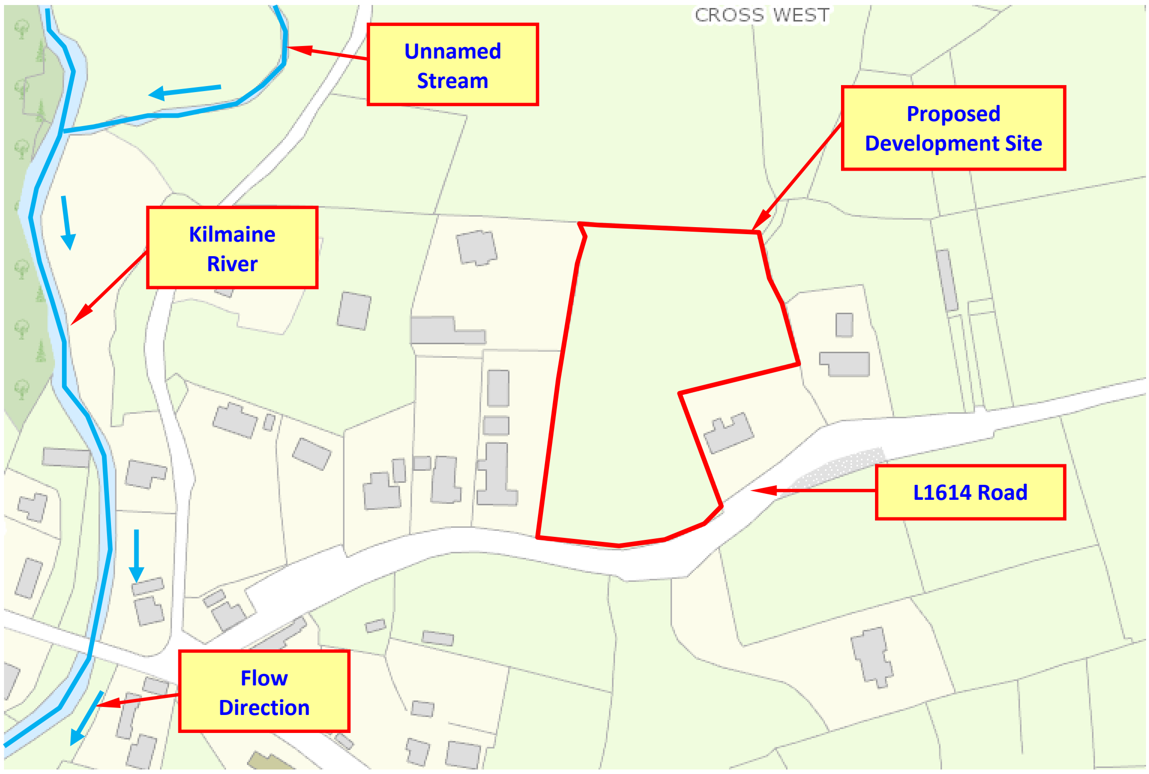

Figure 1 - Site Location

2.2 Existing Topography Levels at Site

The proposed development site slopes from the north eastern side of the site towards the south western corner of the site.

Existing ground elevations range from approximately 24.5 m OD (Malin) in the north eastern area of the site to 17.16 m OD (Malin) at the south western boundary of the site.

2.3 Local Hydrology, Landuse & Existing Drainage

The most significant hydrological feature in the vicinity of the proposed development site is the Kilmaine River, which is located approximately 220m beyond the western boundary of the site.

At its closest position to the proposed development site the Kilmaine River generally flows in a north to south direction. Utilising the OPW Flood Studies Update (FSU) Portal software, the catchment area of the Kilmaine Stream was delineated. The total catchment area of the stream was found to be approximately **32.37km^2** to a point downstream of the site. Assessment of the Kilmaine River upstream catchment area indicates that the catchment is predominantly rural in nature with urban development accounting for approximately 1.04% of the total catchment area.

3 Initial Flood Risk Assessment

The flood risk assessment for the proposed development site is undertaken in three principle stages, these being *'Step 1 – Screening'*, *'Step 2 – Scoping'* and *'Step 3 – Assessing'*.

3.1 Possible Flooding Mechanisms

Table 1 below summarises the possible flooding mechanisms in consideration of the proposed development site:-

Source/Pathway	Significant?	Comment/Reason
Tidal/Coastal	No	The site is not located close to a coastal area.
Fluvial	No	The nearest watercourse to the site is the Kilmaine River, which is located approximately 220m beyond the western boundary of the site.
Pluvial (urban drainage)	Possible	There is urban drainage/water supply infrastructure located in the vicinity of the site.
Pluvial (overland flow)	Possible	The south western area of the proposed development is located 0.8 – 0.9m below the adjacent road level.
Blockage	No	There are no significant or restrictive hydraulic structures located in the vicinity of the site
Groundwater	Possible	Based on anecdotal evidence from local landowners a portion of the south western section of the site is known to flood. The water tends to remain for a long period of time in the site and appears after a prolonged rainfall event the previous days.

Table 1

The primary potential flood risk to the proposed development site can be attributed to potential groundwater flooding. Pluvial flooding from overland flow from the surrounding catchment and topography may also present a pluvial flood risk to the site. Secondary or residual flood risk can be attributed to a potential surcharge of the urban infrastructure located in the vicinity of the site.

In accordance with 'The Planning System and Flood Risk Management – Guidelines for Planning Authorities - DOEHLG 2009' these potential flood risks are analysed in the subsequent 'Screening Assessment' and ''Scoping Assessment'' section of this study report.

4 Screening Assessment

The purpose of the screening assessment is to establish the level of flooding risk that may or may not exist for a particular site and to collate and assess existing current or historical information and data which may indicate the level or extent of any flood risk.

If there is a potential flood risk issue then the flood risk assessment procedure should move to *'Step 2 – Scoping Assessment'* or if no potential flood risk is identified from the screening stage then the overall flood risk assessment can end at *'Step 1'*.

The following information and data was collated as part of the flood risk screening assessment for the proposed development site:-

4.1 OPW/EPA/Local Authority Hydrometric Data

Existing sources of OPW, EPA and local authority hydrometric data were investigated. As illustrated in *Figure 2* below, this assessment has determined that there is one hydrometric gauging station (30104) located on the Kilmaine River in the vicinity of the proposed development site. Gauging Station 30104 is located approximately 200 m south west of the site and is entered into the Register of Hydrometric Stations in Ireland as an inactive flow measure staff station, with hydrometric data available for years March 1997 - August 2007.

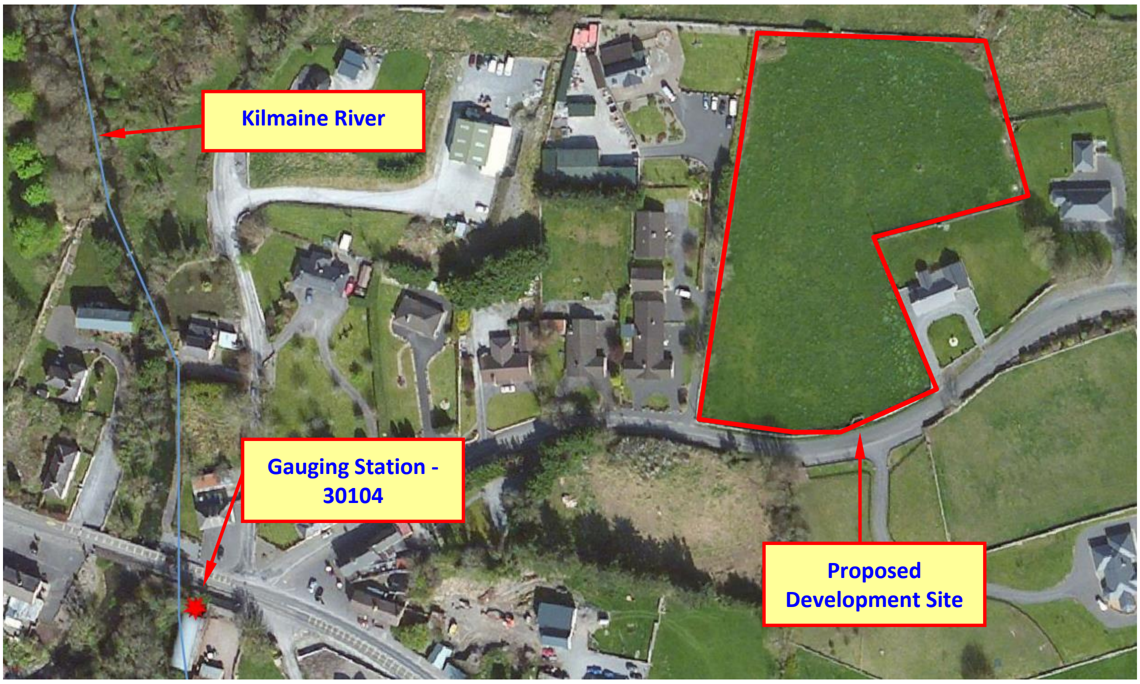

Figure 2 – Hydrometric Gauging Stations

4.2 OPW PFRA Indicative Flood Mapping

Preliminary Flood Risk Assessment (PFRA) Mapping for Ireland was produced by the OPW in 2011. OPW PFRA flood mapping illustrates indicative flood zones within this area of Co. Mayo. *Figure 3* below illustrates the indicative PFRA flood zones in the vicinity of the proposed development site.

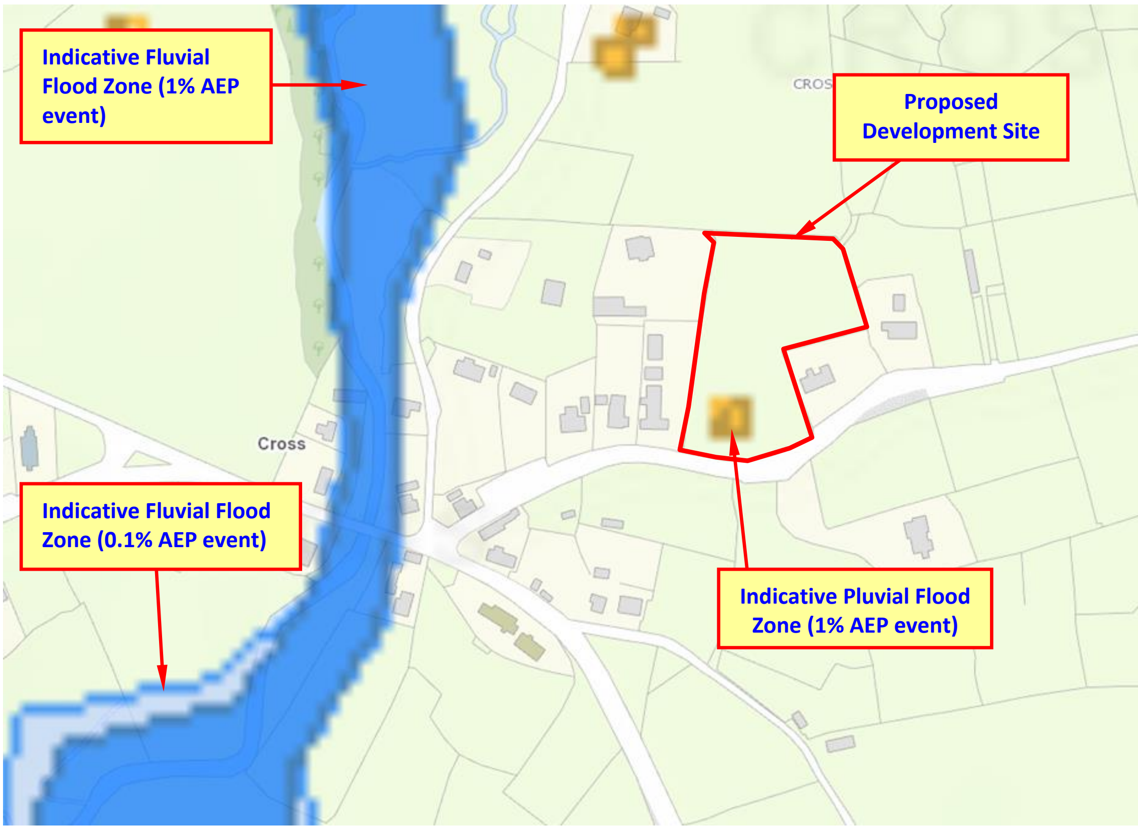

Figure 3 – PFRA Fluvial Mapping

The PFRA flood mapping indicates an indicative pluvial flood zone within the south western boundary of the proposed development site. Anecdotal evidence from surrounding land owners suggests that a limited area in the south western corner of that site is known to flood due to either pluvial or groundwater flooding.

There is no records of fluvial flood zones within or adjacent to the boundary of the proposed development site.

It should be noted that the indicated extent of flooding illustrated on these maps was developed using a low resolution digital terrain model (DTM) and are intended to be indicative only. The flood extents mapped on the PFRA maps are not intended to be used on a site specific basis.

4.3 OPW Flood Maps Website

The OPW Flood Maps Website (www.floods.ie) was consulted in relation to available historical or anecdotal information on any flooding incidences or occurrences in the vicinity of the proposed development site. *Figure 4* below illustrates mapping from the Flood Maps website in the vicinity of the site.

OPW National Flood Hazard Mapping

Summary Local Area Report

This Flood Report summarises all flood events within 2.5 kilometres of the map centre.

The map centre is in:

County: Mayo

NGR: M 200 559

This Flood Report has been downloaded from the Web site www.floodmaps.ie. The users should take account of the restrictions and limitations relating to the content and use of this Web site that are explained in the Disclaimer box when entering the site. It is a condition of use of the Web site that you accept the User Declaration and the Disclaimer.

Map Scale 1:34,014

Map Legend
- Flood Points
- Multiple / Recurring Flood Points
- Areas Flooded
- Hydrometric Stations
- Rivers
- Lakes
- River Catchment Areas
- Land Commission *
- Drainage Districts *
- Benefiting Lands *

* Important: These maps do not indicate flood hazard or flood extent. Thier purpose and scope is explained in the Glossary.

Figure 4 – OPW Flood Maps

Figure 4 above indicates that there are no recorded or anecdotal instances of flooding at or in the immediate vicinity of the proposed development site.

4.4 Ordnance Survey Historic Mapping

Available historic mapping for the area was consulted, as this can provide evidence of historical flooding incidences or occurrences. The maps that were consulted were the historical 6-inch maps (pre-1900), and the historic 25-inch map series.

Figure 5 and *Figure 6* below illustrate the historic mapping for the area of the proposed development site.

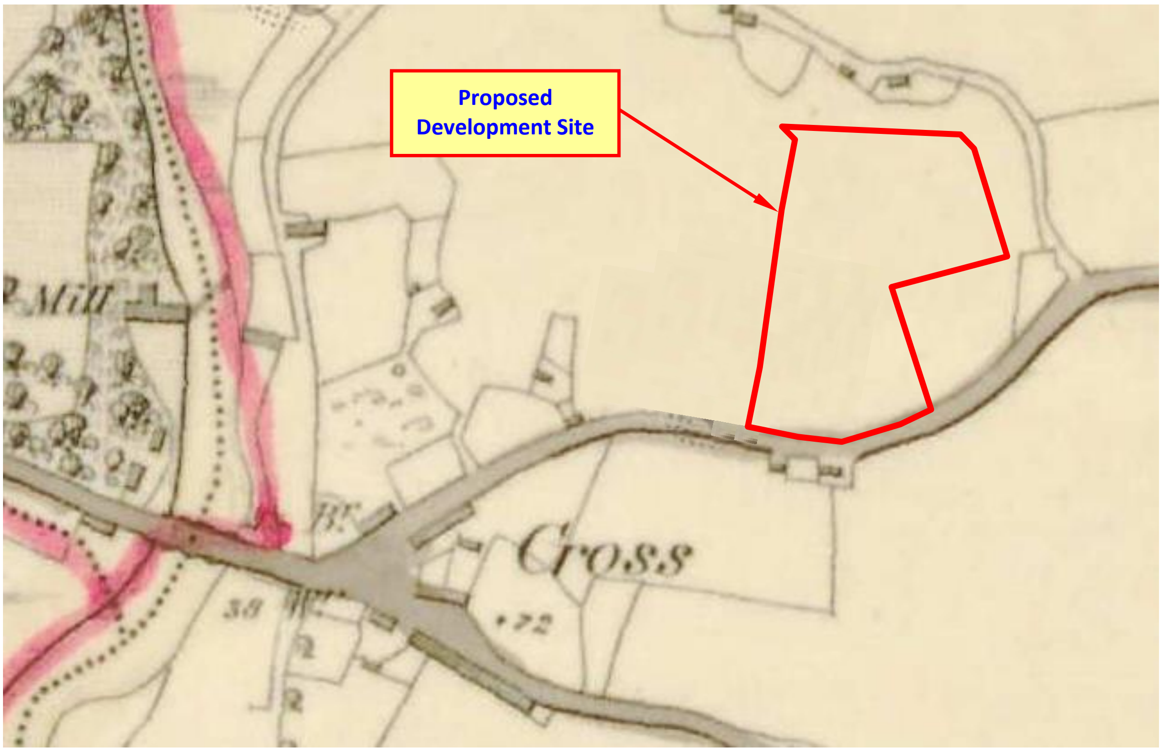

Figure 5 – Historic 6-Inch Mapping

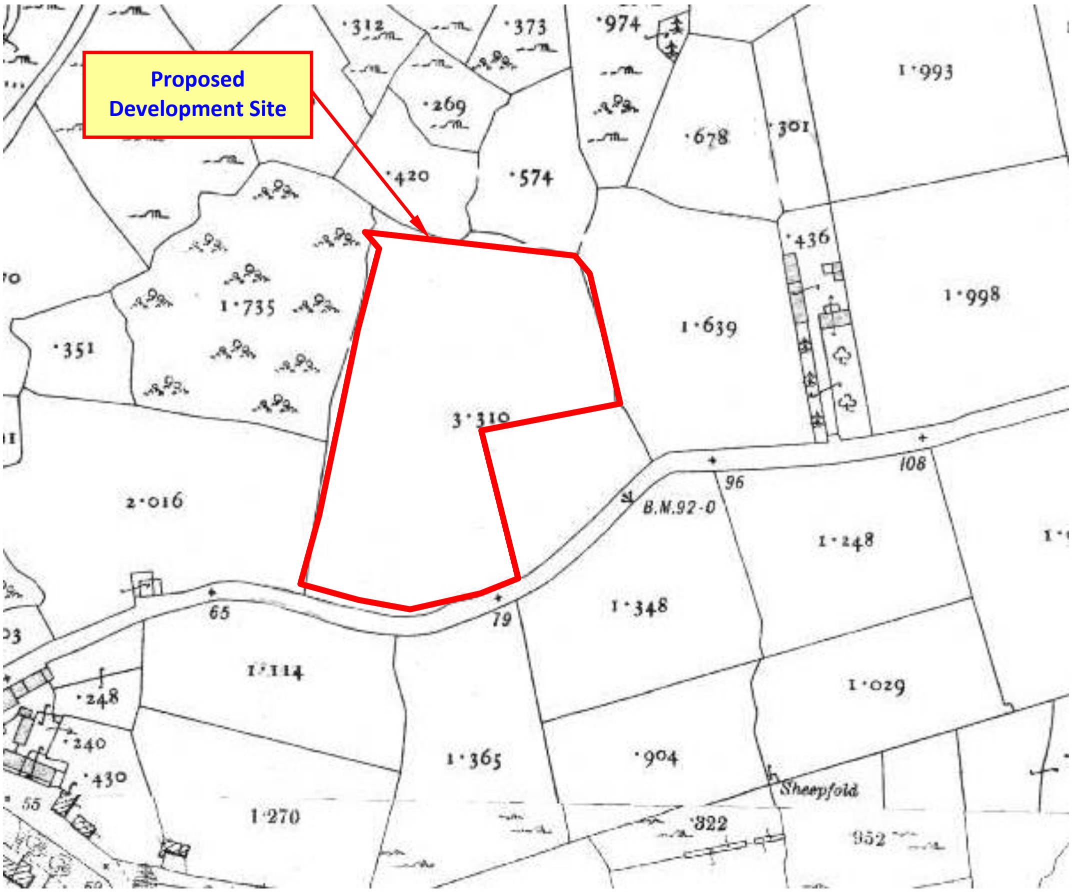

Figure 6 – Historic 25-Inch Mapping

The historic 6 inch and 25 inch mapping do not indicate any historical or anecdotal instances of flooding within or adjacent to the boundary of the proposed development site.

4.5 Geological Survey of Ireland Mapping

The alluvial deposit maps of the Geological Survey of Ireland (GSI) were consulted to assess the extent of any alluvial deposits in the vicinity of the proposed development site. Alluvial deposits can be an indicator of areas that have been subject to flooding in the recent geological past.

Figure 7 below illustrates the sub-soils mapping for the general area of the site.

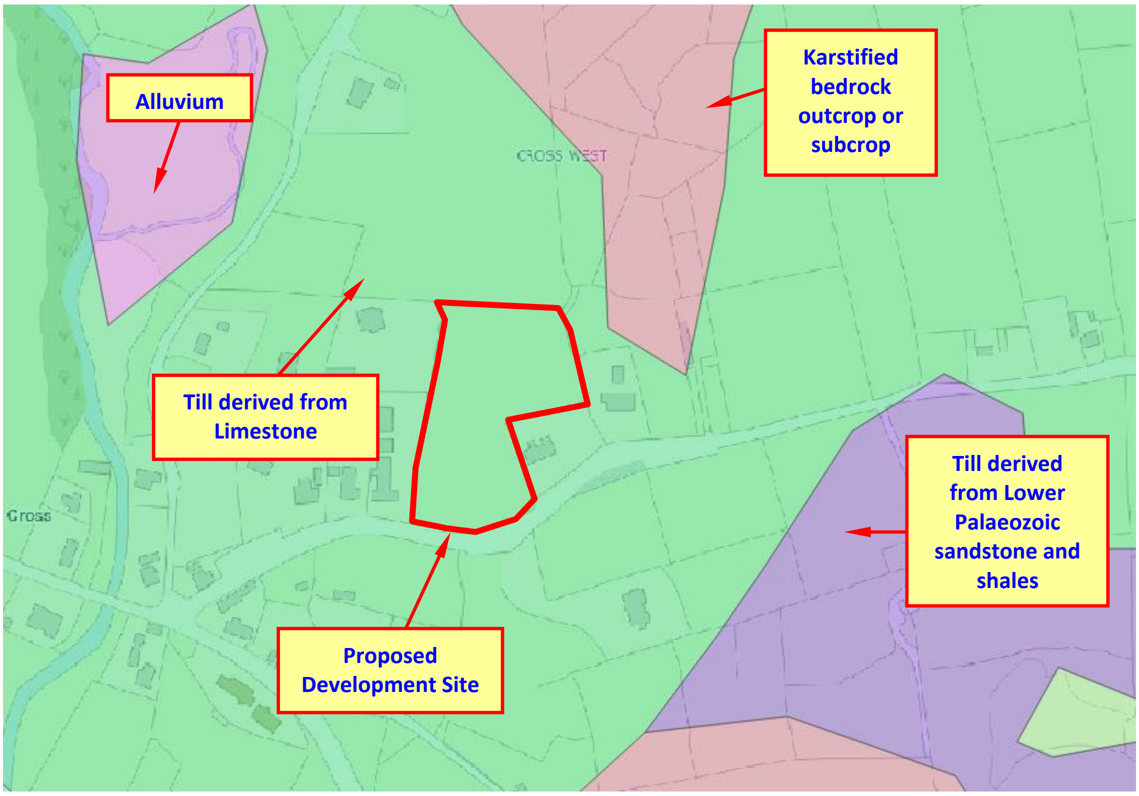

Figure 7 – GSI Subsoil Mapping

Figure 7 above indicates that the proposed development site is underlain by Till derived from Limestone. No alluvial deposits are mapped within or in the vicinity of the site boundary.

4.6 Western CFRAM Study

This area of County Mayo has not been included as an area of further assessment as part of the Western CFRAM study.

5 Screening assessment

The purpose of the scoping stage is to identify possible flood risks and to implement the necessary level of detail and assessment to assess these possible risks, and to ensure these can be adequately addressed in the flood risk assessment. The scoping exercise should also identify that sufficient quantitative information is already available to complete a flood risk assessment appropriate to the scale and nature of the development proposed.

The above screening assessment indicates that an area in the south west of the proposed development site may be impacted by a 1% AEP (1 in 100 year) and 0.1% AEP (1 in 1000 year) pluvial and/or groundwater flood event. Anecdotal evidence collected from local land owners also indicates a limited section in the south western corner of the site floods. The screening assessment indicates that the site is not at risk of primary and direct fluvial flooding.

In consideration of the information collated as part of the screening exercise, and the availability of other information and data specific to the proposed development site, it is considered that sufficient quantitative information to complete an appropriate flood risk assessment for the proposed development site can be derived from the information collated as part of the screening exercise alone.

The specific flood risk to and from the proposed development site is assessed in the subsequent ‘Assessing Flood Risk’ stage of this study report.

6 Assessing Flood Risk

The following sections present an analysis and assessment of the overland flow paths and potential pluvial flood risk to and from the proposed development site. In addition, potential groundwater flood risk to the development site is also assessed.

6.1 Topographic Survey and Mapping

In order to assist in the assessment of any potential flooding in the general area of the proposed development site, topographical survey information was utilised to develop a Digital Terrain Model (DTM) of the proposed development site area. The contour mapping and DTM developed for the area is illustrated in *Figure 11 and Figure 12* below.

Figure 11 – Contour mapping (0.5m contours)

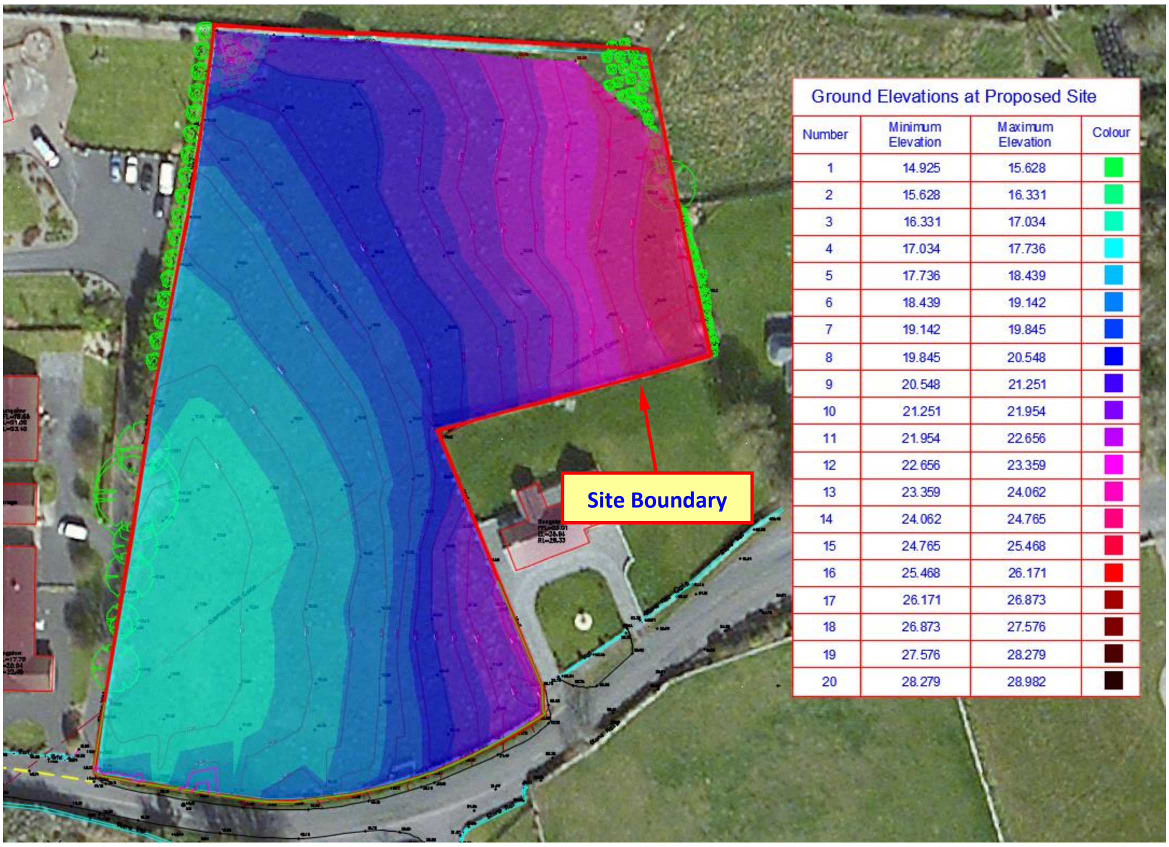

Figure 12 – DTM Mapping

6.2 Assessment of Pluvial Flood Risk

The OPW PFRA map (*Figure 3* above) indicates an area of indicative pluvial flooding located within the boundary of the proposed development site. The PFRA pluvial flood maps are indicative maps only and were developed using a low-resolution DTM suitable for a regional spatial analysis as opposed to a site specific analysis.

The pluvial flooding regime and overland flow paths in the vicinity of the site were assessed and examined by a hydrological engineer from IE Consulting. The purpose of the site assessment works was to obtain a greater understanding of the potential pluvial flood mechanisms at and in the vicinity of the site, to assess the potential for predictive pluvial flooding in the area to impact the proposed development site and the surrounding lands and the effect that the proposed development may or may not have on the hydrological regime of the area.

As the OPW PFRA maps are indicative only a more accurate site specific analysis is required.

6.3 2D Surface Water Model

A 2D Surface Water Runoff Model was developed to provide a more accurate determination of pluvial flood risk to the site by assessing surface water runoff characteristics over a significant precipitation event, determine areas where surface water ponding and flooding may occur and to determine the depth and volume of any pluvial flooding within the area of the proposed development site.

The 2D hydraulic surface water model developed is based on an appropriate computer software package that utilises a detailed Digital Terrain Model (DTM) of the site area and surrounding lands and specific extreme rainfall data for the area obtained from Met Éireann, (refer to *Appendix B*).

6.3.1 Surface Water Model Extent

The extent of the surface water run-off modelled area is illustrated in *Figure 13* below:-

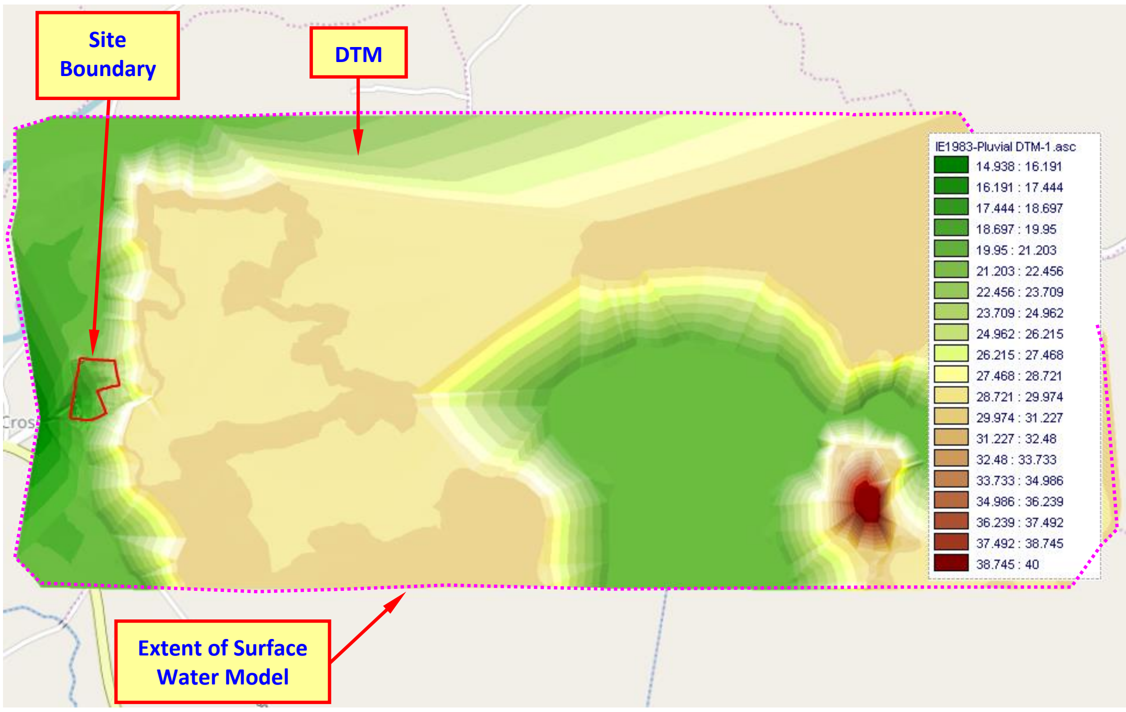

Figure 13 – Surface Water Model Extent

The surface water modelled area illustrated above includes the topographical catchment area that may be expected to drain towards the area of the proposed development site. The catchment area is approximately 272 hectares and was delineated from a topographical survey derived Digital Terrain Model (DTM) and OSI 1:50,000 scale Discovery Series contour mapping.

6.3.2 Surface Water Runoff Model Selection

A number of computer based hydraulic surface water runoff models are available, which analyse and predict pluvial surface water flooding, including surface water velocities, flood depth and flood volume. For this particular assessment the Flood Modeller 2D (formally known as ISIS) computer model, developed by CH2M Hill, was employed.

The computational engine of the Flood Modeller 2D surface water model is based on a set of rules to simulate spreading of surface waters and flood waters over a given land surface area. The model relies on the data provided to it as a detailed DTM or DTM of the study area to estimate the response that the area will produce upon receiving a certain amount of water as input.

The Flood Modeller 2D surface water model inundation method routes water over the study area through a series of depressions. These depressions can fill with water either from sources (e.g. rainfall) or by spilling in from neighbouring depressions.

A depression is defined in terms of its lowest point, and all water with a source within that depression will drain into that point.

To run the Flood Modeller 2D surface water model, a description of the land surface in terms of these depressions is required, which is generated by a pre-processing stage. The following information is required for this:

- A map giving depression ID for each DTM cell;

For each depression:-

- A stage vs. area relationship
- A stage vs. volume relationship
- A list of neighbouring depressions
- The lowest elevation at which water can flow between the depression and its neighbour

In addition, the model requires:-

- Roughness estimates of the land surface (Manning's 'n' values)
- Runoff co-efficients for differing land surfaces

The following section describes the methods utilised within Flood Modeller 2D surface water model for generating the required model input datasets.

DTM Preparation

The DTM/DTM code works on the assumption that the natural surface has variation in elevation from cell to cell. Thus, the code will have difficulties in working on rather flat surfaces. This is avoided by modifying the DTM / DTM using the formula below:

$$z_{ij} = (1 - \alpha)z_{ij} + \frac{\alpha}{9}\sum_{3\times3\ \text{Window}} z_{ij}$$

The averaging window distorts the flat surfaces slightly so that points are not on the same elevation. The parameter defining the scale of distortion is provided as the filter parameter.

Identify Depression Low Points

This step marks the start of depression delineation by identifying points that have neighbouring points all at a higher elevation.

Find Surface Water Drainage Directions

For each cell of the DTM, a drainage direction is then determined. This can be any of eight possible directions, i.e. into any of the surrounding cells (including diagonal directions), namely travelling in directions: north, south, east, west, north-east, north-west, south-east or south-west. The selected direction is based on the highest gradient with neighbouring cells.

Determine Depression ID Map

As ultimately, water will follow these drainage directions towards a low point, this is used to define the initial 'depression area' of each low point.

Merge Neighbouring Depressions

Many of the above generated depressions will be separated by a barrier of small elevation difference, which in reality might not block the exchange of water to a large extent and thus, it would be easier (computationally) to merge these depressions. This minimum elevation difference (as illustrated in *Figure 14* below) is specified as the 'merge parameter'.

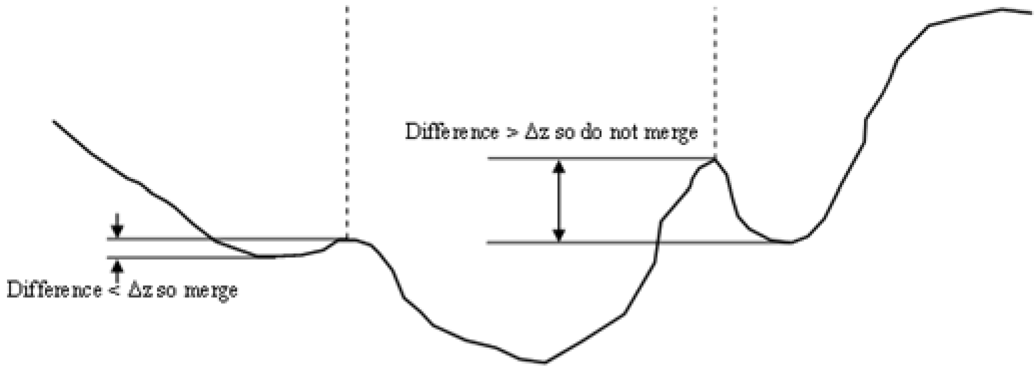

Figure 14 – Merge Neighbour depressions

Compile Stage-Area-Volume Tables

This penultimate step uses the catchment boundaries set in the above step to find each depression's stage-area-volume relationship along with the number of neighbours it has. The discretisation parameter sets the minimum distance between recorded stages for the relationship.

Write Results to File

The depression ID grid is written as an ASCII raster file. The depression information is written as separate text files for the depression neighbours, stages, areas, volumes and connection levels.

6.3.3 Derived Digital Terrain Model (DTM)

The DTM mapping was developed using a topographical survey of the site and surrounding lands and OSI Discovery Series contour mapping using a specialist computer software package employed by IE Consulting. The DTM and contour mapping developed for the area of the proposed development site is illustrated in *Figure 15* and *Figure 16* below.

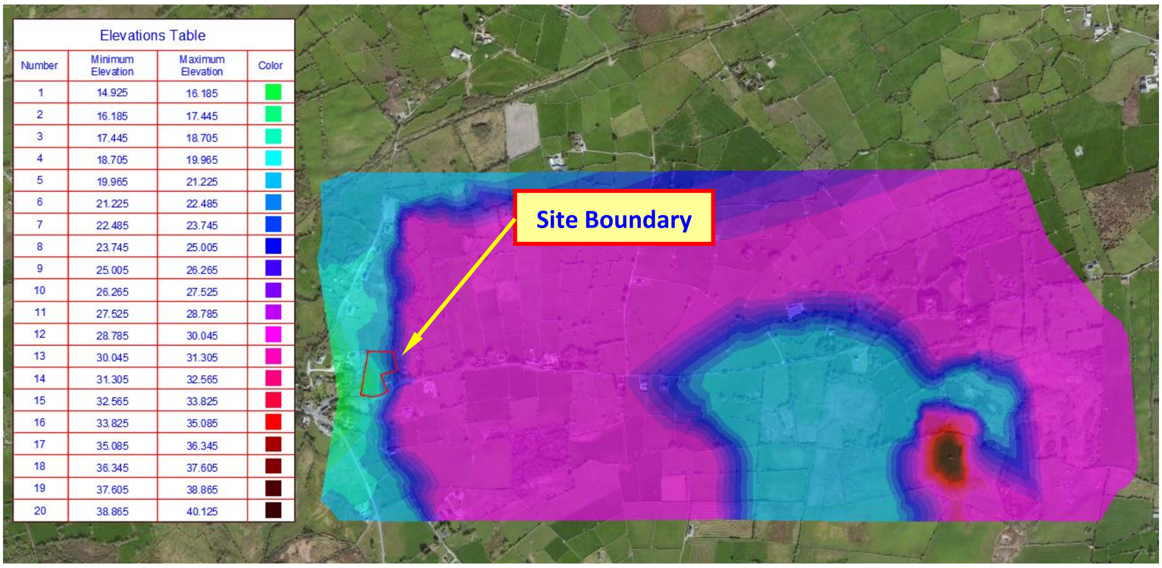

Figure 15 – DTM

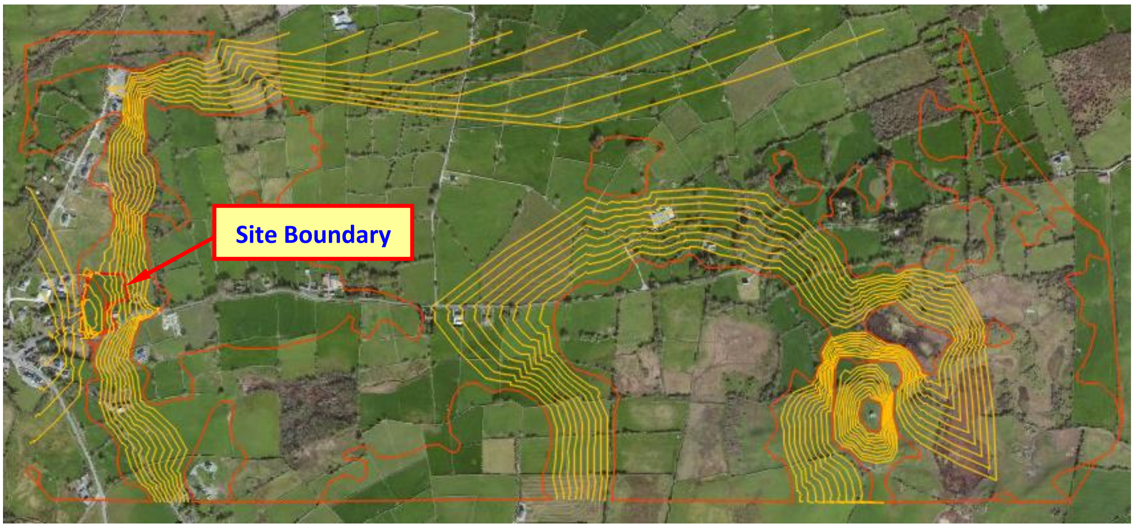

Figure 16 – Contour Mapping

6.3.4 Roughness

Roughness values are used to allow the model to determine the nature of the flood flows across the surface of the ground as surface water will flow more slowly over vegetated areas in comparison to hard-standing areas. Manning's roughness coefficients for various surfaces are based on a detailed walkover survey of the modelled area and are standardised throughout the model. A global roughness value of 0.035 was employed, reflecting mainly long grassland areas.

6.3.5 Surface Water Model Build

A model was developed based on a resolution cell size of 4m x 4m. The surface water model was run in Flood Modeller Pro by applying a time series rainfall event over the modelled area as illustrated in *Figure 15* above.

The time series rainfall event utilised was the 1 in 100 year event, which was applied for a duration of 5 minutes to 6 hours. The rural loss model methodology described in the OPW 'National Pluvial Screening Project Report – November 2010' was implemented into the model. An additional 10% was including accounting for the effects of potential future climate change.

Site specific Intensity-Duration-Frequency (IDF) rainfall data was obtained from Met Éireann and utilising the OPW Flood Studies Update Rainfall DDF module. A copy of the IDF rainfall data for the area is included in *Appendix B*.

The surface water model was based on a 'bare earth' derived Digital Terrain Model (DTM), with vegetation digitally removed.

6.3.6 Model Results

The extents of the surface water modelling results utilising the topographical survey data were thematically mapped in GIS (Flood Modeller 2D Mapper) over a range of resultant surface water depths according to the following minimum and maximum depth classifications as illustrated in *Figure 17* below:-

Figure 17 – 2D Modelled Pluvial Flood Extents and Depths

As illustrated in *Figure 17* above, an area of pluvial flooding is predicted to occur within the boundary of the proposed development site with maximum predicted depths of 0.4m. The pluvial flood extent illustrated above is based on the results of a 2D surface water runoff analayis and is considered to present an accurate representation of the potential pluvial flood risk to the proposed development site. The pluvial flood extents illustrated above are similar to the indicative pluvial flood extents illustrated on the OPW PFRA flood map (*Figure 3* above).

6.4 Assessment of Potential Groundwater Flood Risk

As discussed in *Section 3.1* above, the lower ground within the south-west corner of the site is potentially at risk from groundwater flooding. Assessment of groundwater flooding requires detailed modelling and analysis. Therefore, for the sake of simplicity, this report examines the potential worst case scenario.

For this analysis it was assumed that the bounding wall along the western and southern boundary of the site is not porous. Utilising the hydrology module of an appropriate 3D software package, the site was examined to find the maximum depth of water that may be contained in the south-west corner of the site before the bounding wall is overtopped and flood waters spill out onto the adjacent road. This analysis indicates a maximum water level of 18.53mOD (Malin). *Drawing Number IE1983-002-A, Appendix A* indicates the maximum predicted groundwater extents within the boundary of the proposed development site.

The possible depth of groundwater floodwaters is illustrated on the *Drawing Number IE1983-003-A, Appendix A* via a graphical representation and via tables of predicted floodwater depths. The floodwater depth table presents floodwater depths over 20 separate elevation ranges of the possible inundated areas within the boundary of the proposed development site.

By applying a Triangulated Irregular Network (TIN) analysis to the existing DTM surface and to the predicted maximum groundwater flood level, the volume of flood waters that may inundate the south-west corner of the proposed developed site was calculated.

The potential maximum and mean floodwater depths and flood volumes that may inundate the site are summarised in *Table 2* below.

	Maximum Groundwater Flood Event
Maximum Flood Depth (m)	**1.696**
Mean Flood Depth (m)	**0.952**
Total Flood Water Volume (m^3)	**3,740.46**

Table 2 – Flood Depth and Inundation Volumes

This analysis presented above and the extent of ground water flooding illustrated on *Drawing Number IE1983-002-A, Appendix A* illustrates a potential worse case scenario. In reality, the extent of ground water flooding that may occur at the proposed development site is expected to be less than that indicated on the above drawing.

6.5 Assessment of Secondary Flood Risk

Pluvial - Urban Drainage/Water Supply Infrastructure

Secondary or residual pluvial flood risk can also be attributed to a potential surcharge of the urban drainage network and /or damage to the water supply infrastructure in the general vicinity of the site. An urban drainage infrastructure map was obtained from Irish Water, an extract of which is illustrated in *Figure 18* below. The following infrastructure has been identified in the vicinity of the proposed development site:

- A mains water supply running through the south of the proposed development site.
- A manhole on the L1614 road, next to the southern boundary of the proposed site.

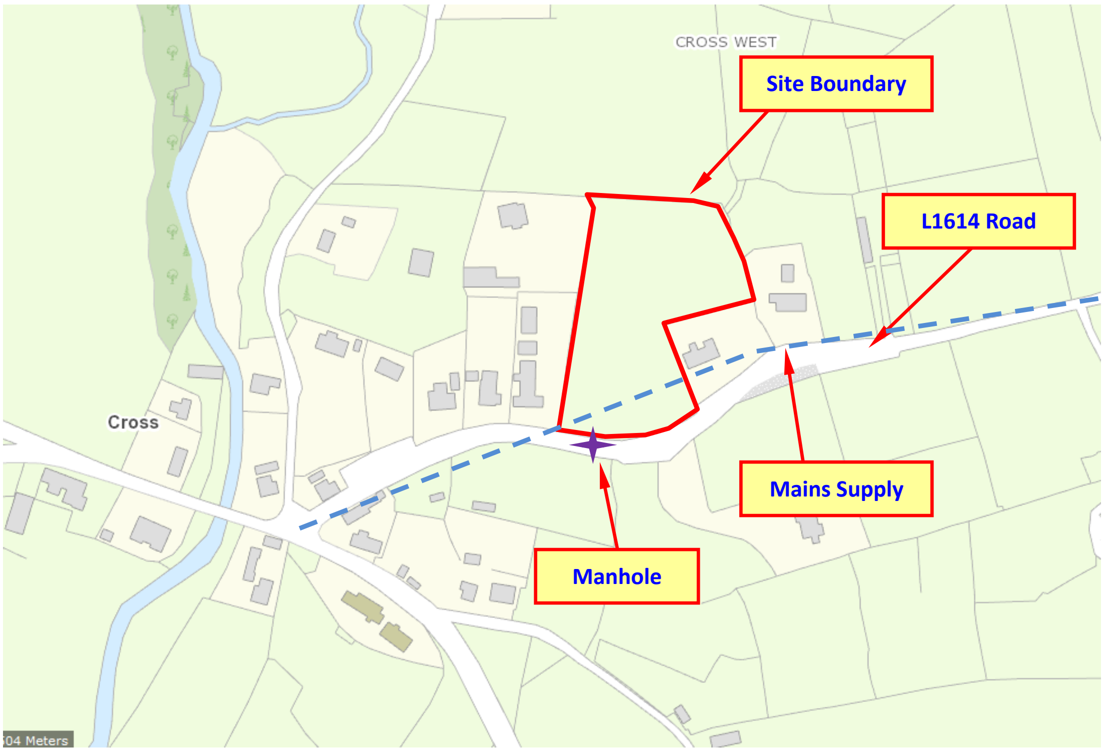

Figure 19 – Urban Drainage Records – Irish Water

It is predicted that any flooding due to a surcharge of the manholes located next to the southern boundary of the site would likely cause pluvial surcharge waters to spill out onto the L1614 Road and flow into the proposed development site, as illustrated in *Figure 20* below.

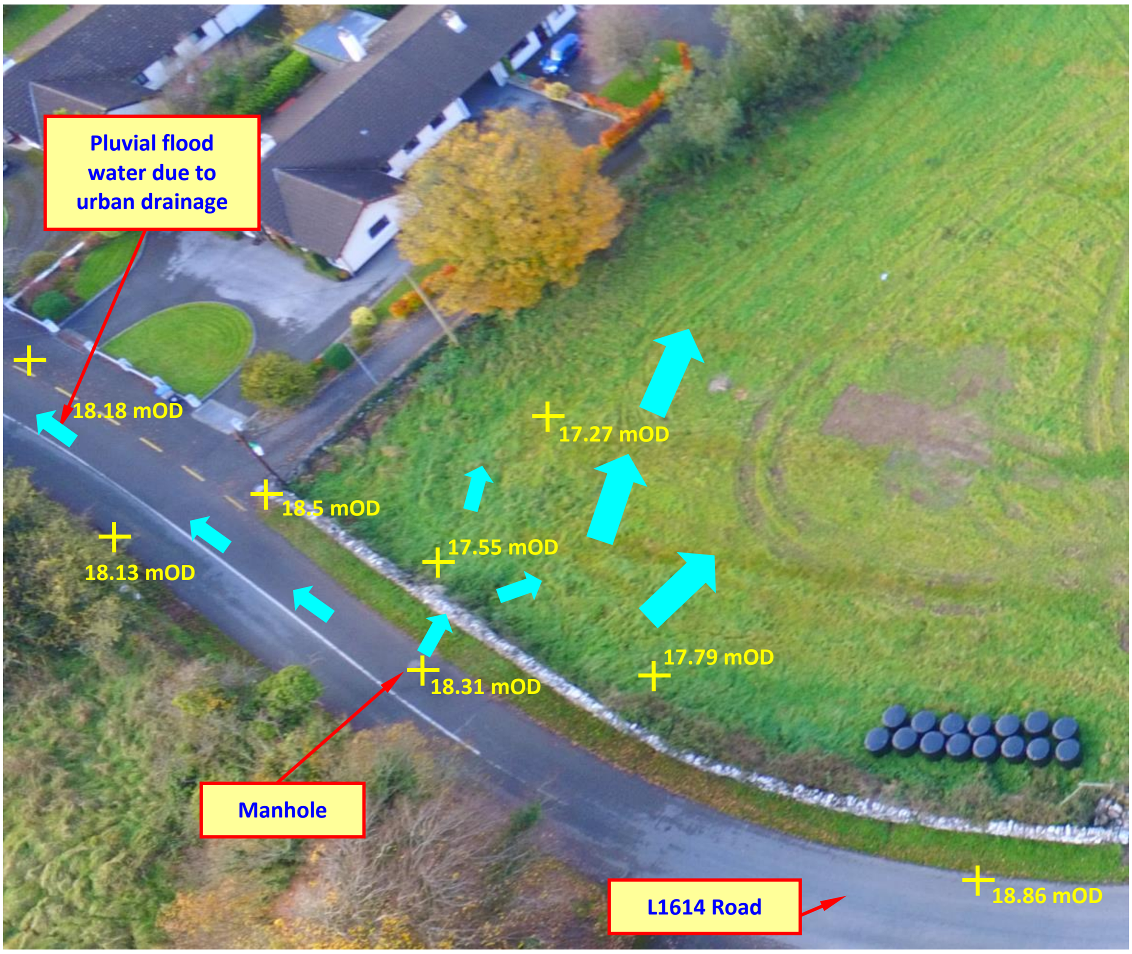

Figure 20 – Overland flow paths

Based on the topography of the site and surrounding land, secondary or residual pluvial surcharge waters are anticipated to first enter the site at the southern boundary. However, the maximum extent which could inundate the site is smaller to that of the groundwater flooding extent, as illustrated on *Drawing Number IE1983-003-A, Appendix A.* Once the surcharge waters reach the level of the L1614 road to the south (18.13m OD) any surcharge waters will be conveyed along the road on a north-westerly directly.

The probability of the sewer and/ or water main of failing or significantly surcharging is generally considered to be **Low**. However, in the unlikely event that the system does fail or surcharge the risk to the site from surcharged pluvial flood water is considered to be **Medium**.

7 Proposed Development in the Context of the Guidelines

In the context of the *'Planning System and Flood Risk Management Guidelines, DOEHLG, 2009'* three flood zones are designated in consideration of flood risk to a particular development site.

Flood Zone 'A' – where the probability of flooding from rivers and watercourses is the highest (greater than 1% or 1 in 100 year for river and watercourse flooding and 0.5% or 1 on 200 for coastal or tidal flooding).

Flood Zone 'B' – where the probability of flooding from rivers and watercourses is moderate (between 0.1% or 1 in 1000 year for river and watercourse flooding and 0.5% or 1 on 200 for coastal or tidal flooding).

Flood Zone 'C' – where the probability of flooding from rivers and watercourses is low or negligible (less than 0.1% or 1 in 1000 year for both river and watercourse and coastal flooding). *Flood Zone 'C'* covers all areas that are not in *Zones 'A'* or '*B*'.

The *'Planning System and Flood Risk Management Guidelines'* list the planning implications for each flood zone, as summarised below:-

Zone A – High Probability of Flooding. Most types of development would not be considered in this zone unless the Justification Test is satisfied. Development in this zone should be only be considered in exceptional circumstances, such as in city and town centres, or in the case of essential infrastructure that cannot be located elsewhere, and where the *'Planning System and Flood Risk Management Guidelines'* justification test has been applied. Only water-compatible development, such as docks and marinas, dockside activities that require a waterside location, amenity open space and outdoor sports and reaction would be considered appropriate in this zone.

Zone B – Moderate Probability of Flooding. Highly vulnerable development such as hospitals, residential care homes, Garda, fire and ambulance stations, dwelling houses, strategic transport and utilities infrastructure would generally be considered inappropriate in this zone, unless the requirements of the justification test can be met. Less vulnerable development such as retail, commercial and industrial uses and recreational facilities might be considered appropriate in this zone. In general however, less vulnerable development should only be considered in this zone if adequate lands or sites are not available in *Zone 'C'* and subject to a flood risk assessment to the appropriate level of detail to demonstrate that flood risk to the development can be adequately managed and that development in this zone will not adversely affect adjacent lands and properties.

Zone C – Low to Negligible Probability of Flooding. Development in this zone is appropriate from a flood risk perspective. Developments in this zone are generally not considered at risk of fluvial flooding and would not adversely affect adjacent lands and properties from a flood risk perspective.

The assessment and analysis undertaken as part of this Site Specific Flood Risk Assessment (SSFRA) indicates that an area of the site is potentially at risk of pluvial and groundwater flooding, with groundwater flooding presenting the most significant potential flood risk to the site. The maximum potential, or worst case scenario, groundwater flood extents is illustrated on *Drawing Number IE1983-002-A, Appendix*. For the purposes of this SSFRA the area of the site indicated as subject to potential ground water flooding is considered to fall within Flood Zone 'A'.

In terms of the development potential of the site it is recommended that any proposed development is limited to areas of the site beyond the maximum potential groundwater flood extent as illustrated on *Drawing Number IE1983-002-A, Appendix* – i.e. areas of the site that fall within Flood Zone 'C'.

The area of the site that falls within Flood Zone 'A' may be utilised as green open area as part of any development proposals, however it is recommended that no significant infilling or ground level raising is undertaken within this area.

In the context of the *'Planning System and Flood Risk Management Guidelines, DOEHLG, 2009'*, and in consideration that development proposals for the site will be limited to Flood Zone 'C', development as proposed is not subject to the requirements of the Justification Test.

8 Summary Conclusions and Recommendations

In consideration of the findings of this site specific flood risk assessment and analysis the following conclusions are made in respect of the proposed development site:-

- *A Site Specific Flood Risk (SSFRA) assessment, appropriate to the type and scale of development proposed, and in accordance with 'The Planning System and Flood Risk Management Guidelines – DoEHLG-2009' has been undertaken.*
- *The proposed development site has been screened, scoped and assessed for flood risk in accordance with the above guidelines.*
- *The primary potential flood risk to the development site can be attributed to a pluvial flood event from overland flow and groundwater flooding.*
- *2-D surface water modelling has been undertaken in consideration of an extreme 1 in 100 year rainfall event of duration 6 hours including climate change. The surface water modelling undertaken as part of this flood risk assessment examined the pluvial flood risk to the site in consideration of the ground levels in the site.*
- *A detailed Digital Terrain Model (DTM) has been developed for the site. Utilizing the DTM, an appropriate 2D software package and OPW pluvial analysis methodology, the pluvial flood extents within the site were delineated.*
- *The model results of the 2D surface water modelling indicates that a portion of the south western are of the site may be susceptible to pluvial flood inundation, as illustrated in Figure 17.*
- *Primary flood risk to the site can also be attributed to groundwater flooding within the site. Assessment of groundwater flooding requires detailed modelling and analysis. Therefore, for the sake of simplicity, this report examined the potential worst case scenario.*
- *As illustrated on Drawing Number IE1983-002-A, Appendix A, on a worst case scenario an area of the site is potentially at risk of groundwater flooding.*
- *In terms of the development potential of the site it is recommended that any proposed development is limited to areas of the site beyond the maximum potential groundwater flood extent as illustrated on Drawing Number IE1983-002-A, Appendix – i.e. areas of the site that fall within Flood Zone 'C'.*

- *It is recommended that any development of the site includes an appropriate stormwater management system that shall limited stormwater discharge from the site to existing greenfield runoff rates and.*
- *It is recommended that any proposed finished road levels and finished floor levels be constructed to a minimum level of 0.15m and 0.30m respectively above the maximum worst case scenario groundwater flood level of 18.53m OD.*
- *In consideration that any development proposals for the site will be limited to Flood Zone 'C', development of the site is not expected to result in an adverse impact to the existing hydrological or groundwater regime of the area and is therefore considered to be appropriate from a flood risk perspective.*

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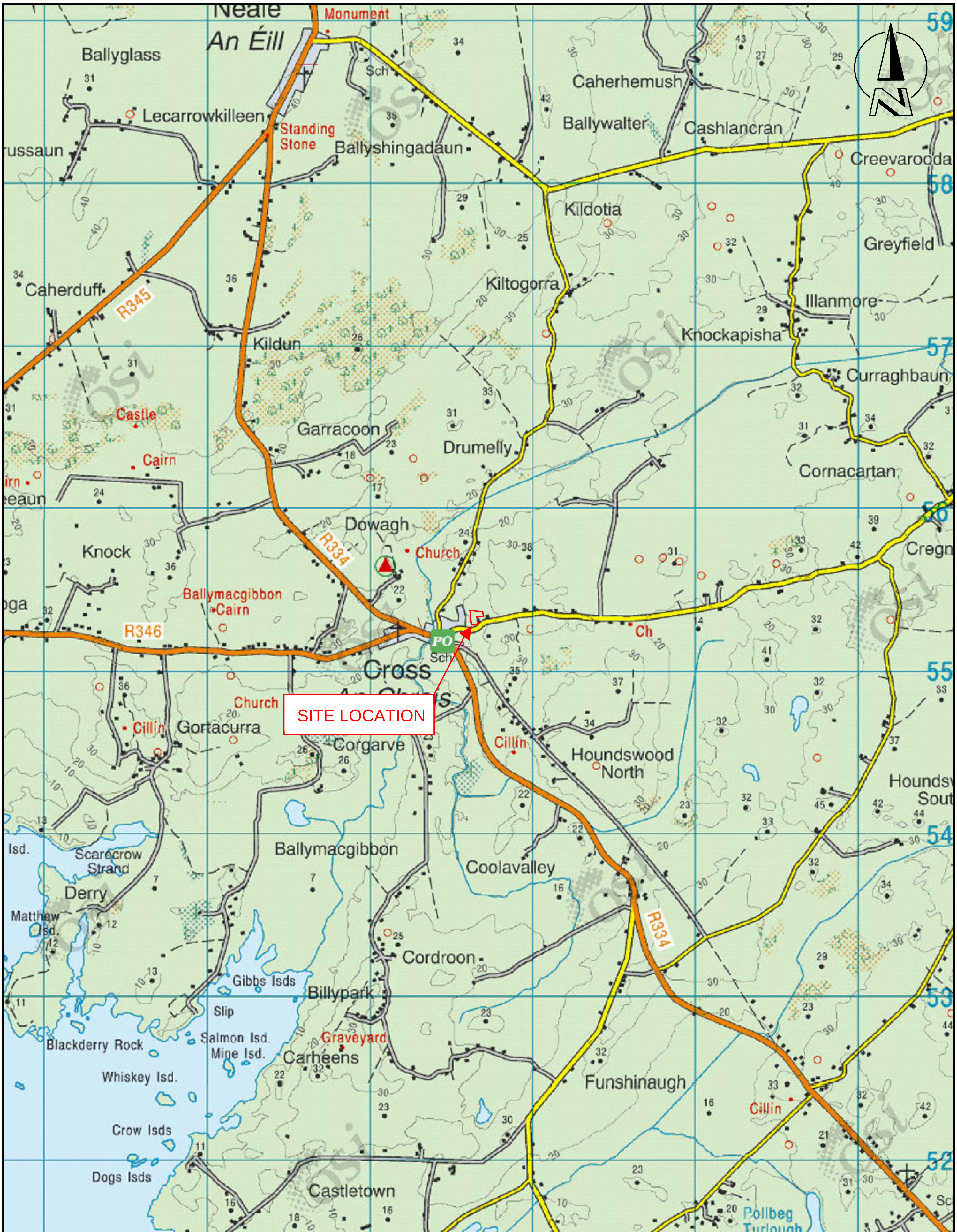
APPENDIX A

Drawing Number IE1983-001-A

Drawing Number IE1983-002-A

Drawing Number IE1983-003-A



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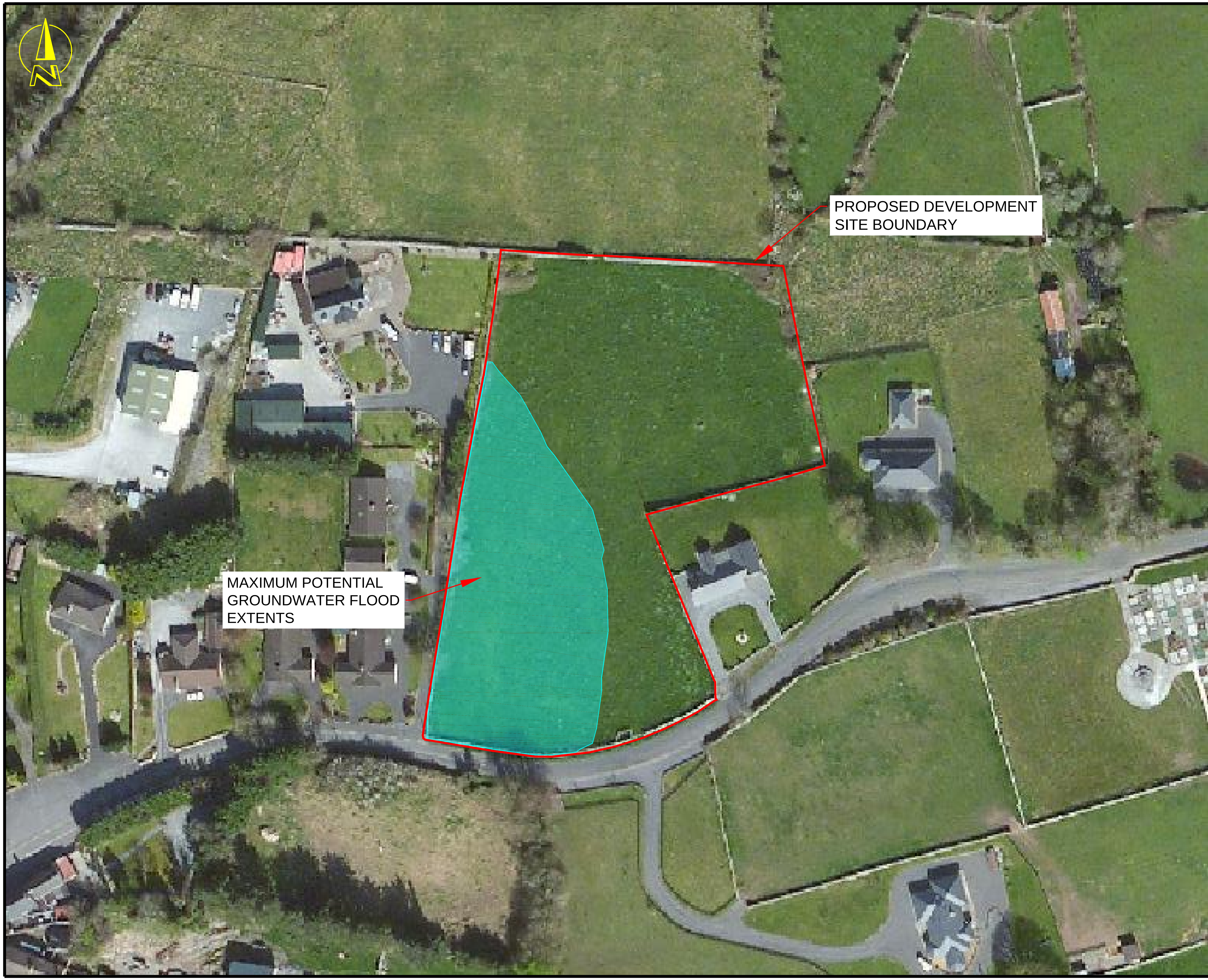
Project Title:	SITE SPECIFIC FLOOD RISK ASSESSMENT
Project Address:	CROSS WEST, CO. MAYO
Client:	PRIORITY GEOTECHNICAL LTD.
Drg. Title:	SITE LOCATION MAP

Dwg.Scale:	Date:	Dwg.No:	Job No:	Revision:	Dwg.By:
1:50,000	14-11-19	IE1983-001	IE1983	A	MOF



LEGEND

- SITE BOUNDARY
- MAXIMUM POTENTIAL GROUNDWATER FLOOD EXTENTS

rev.	date	amendment	drn	ckd
A	13.11.19	PLANNING	LMc	PMS

PROPOSED DEVELOPMENT AT
CROSS WEST,
CO. MAYO

SITE SPECIFIC FLOOD RISK ASSESSMENT

MAXIMUM POTENTIAL GROUNDWATER FLOOD EXTENTS

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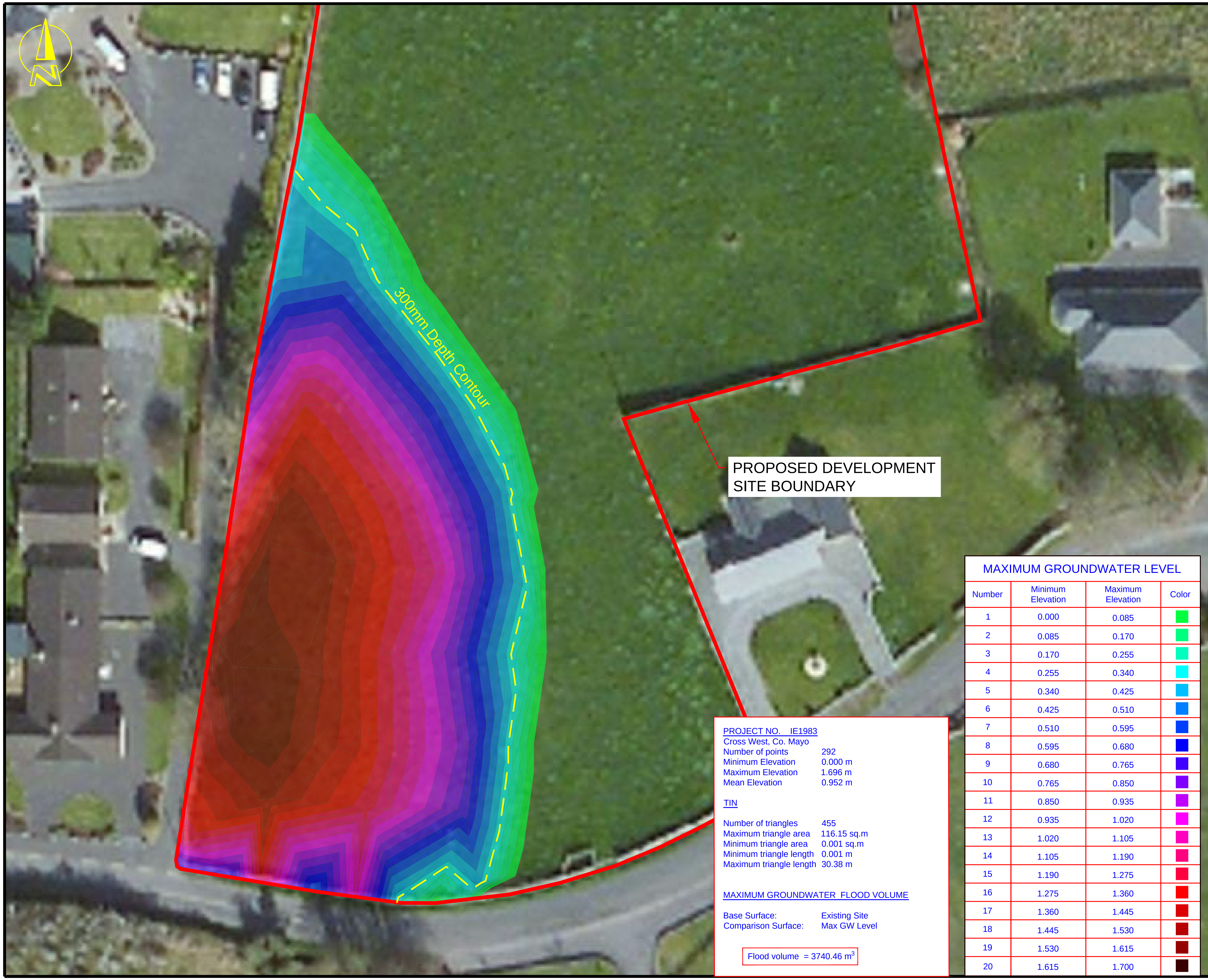
file location: N:\IE1983\DRAWINGS		scale:	1:1,000 @ A3
drawing status: PLANNING		datum:	MALIN
		drawn:	LMC
drawing no. IE1983-002	rev A	checked:	PMS
		approved:	PMS
		date:	13.11.2019



PROJECT NO. IE1983
Cross West, Co. Mayo

Number of points	292
Minimum Elevation	0.000 m
Maximum Elevation	1.696 m
Mean Elevation	0.952 m

TIN

Number of triangles	455
Maximum triangle area	116.15 sq.m
Minimum triangle area	0.001 sq.m
Minimum triangle length	0.001 m
Maximum triangle length	30.38 m

MAXIMUM GROUNDWATER FLOOD VOLUME

Base Surface:	Existing Site
Comparison Surface:	Max GW Level

Flood volume = 3740.46 m^3

MAXIMUM GROUNDWATER LEVEL

Number	Minimum Elevation	Maximum Elevation	Color
1	0.000	0.085	
2	0.085	0.170	
3	0.170	0.255	
4	0.255	0.340	
5	0.340	0.425	
6	0.425	0.510	
7	0.510	0.595	
8	0.595	0.680	
9	0.680	0.765	
10	0.765	0.850	
11	0.850	0.935	
12	0.935	1.020	
13	1.020	1.105	
14	1.105	1.190	
15	1.190	1.275	
16	1.275	1.360	
17	1.360	1.445	
18	1.445	1.530	
19	1.530	1.615	
20	1.615	1.700	

LEGEND

SITE BOUNDARY

rev.	date	amendment	drn	ckd
A	13.11.19	PLANNING	LMc	PMS

PROPOSED DEVELOPMENT AT
CROSS WEST,
CO. MAYO

SITE SPECIFIC FLOOD
RISK ASSESSMENT

MAXIMUM POTENTIAL GROUNDWATER
FLOOD VOLUME & DEPTH ANALYSIS

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

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file location:	N:\IE1983\DRAWINGS	scale:	1:500 @ A3
drawing status:	PLANNING	datum:	MALIN
		drawn:	LMC
drawing no.	IE1983-003	checked:	PMS
rev	A	approved:	PMS
		date:	13.11.2019

APPENDIX B

MET ÉIREANN D-D-F TABLES

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 119628, Northing: 255328,

	Interval		Years													
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.8,	3.9,	4.5,	5.3,	5.9,	6.4,	7.9,	9.6,	10.7,	12.2,	13.6,	14.7,	16.3,	17.6,	18.6,	N/A ,
10 mins	3.9,	5.4,	6.2,	7.4,	8.3,	8.9,	11.0,	13.3,	14.9,	17.0,	18.9,	20.4,	22.7,	24.5,	25.9,	N/A ,
15 mins	4.5,	6.3,	7.3,	8.7,	9.7,	10.5,	12.9,	15.7,	17.5,	20.0,	22.3,	24.0,	26.7,	28.8,	30.5,	N/A ,
30 mins	6.1,	8.3,	9.5,	11.2,	12.4,	13.3,	16.2,	19.4,	21.5,	24.4,	27.0,	29.0,	32.0,	34.3,	36.2,	N/A ,
1 hours	8.1,	10.9,	12.3,	14.4,	15.8,	16.8,	20.2,	24.0,	26.4,	29.7,	32.7,	34.9,	38.3,	40.9,	43.0,	N/A ,
2 hours	10.8,	14.2,	15.9,	18.4,	20.1,	21.4,	25.3,	29.7,	32.5,	36.3,	39.6,	42.1,	45.9,	48.8,	51.1,	N/A ,
3 hours	12.8,	16.6,	18.5,	21.3,	23.2,	24.5,	28.9,	33.6,	36.6,	40.7,	44.2,	46.9,	51.0,	54.0,	56.5,	N/A ,
4 hours	14.4,	18.6,	20.7,	23.7,	25.6,	27.1,	31.7,	36.7,	39.9,	44.2,	47.9,	50.7,	54.9,	58.1,	60.7,	N/A ,
6 hours	17.1,	21.7,	24.1,	27.4,	29.5,	31.1,	36.2,	41.6,	45.0,	49.6,	53.6,	56.6,	61.0,	64.4,	67.1,	N/A ,
9 hours	20.3,	25.4,	28.0,	31.7,	34.0,	35.8,	41.3,	47.1,	50.8,	55.7,	59.9,	63.1,	67.8,	71.4,	74.2,	N/A ,
12 hours	22.8,	28.4,	31.2,	35.1,	37.6,	39.5,	45.3,	51.5,	55.3,	60.5,	64.9,	68.2,	73.1,	76.8,	79.7,	N/A ,
18 hours	27.1,	33.3,	36.3,	40.6,	43.3,	45.4,	51.7,	58.3,	62.4,	67.9,	72.5,	76.0,	81.2,	85.1,	88.2,	N/A ,
24 hours	30.5,	37.2,	40.5,	45.0,	47.9,	50.1,	56.8,	63.7,	68.0,	73.7,	78.5,	82.1,	87.5,	91.5,	94.7,	105.4,
2 days	38.9,	46.6,	50.3,	55.4,	58.7,	61.1,	68.5,	76.0,	80.7,	86.8,	92.0,	95.8,	101.5,	105.7,	109.1,	120.2,
3 days	46.2,	54.7,	58.8,	64.5,	68.0,	70.6,	78.6,	86.8,	91.8,	98.4,	103.9,	108.0,	114.0,	118.4,	122.0,	133.7,
4 days	52.8,	62.2,	66.6,	72.7,	76.5,	79.3,	87.9,	96.6,	101.9,	108.9,	114.7,	119.0,	125.4,	130.0,	133.8,	146.0,
6 days	65.0,	75.7,	80.8,	87.7,	92.0,	95.2,	104.8,	114.4,	120.3,	128.0,	134.4,	139.1,	146.0,	151.1,	155.2,	168.5,
8 days	76.4,	88.3,	93.9,	101.5,	106.2,	109.7,	120.2,	130.7,	137.1,	145.5,	152.4,	157.4,	164.8,	170.3,	174.7,	188.9,
10 days	87.1,	100.2,	106.2,	114.5,	119.6,	123.4,	134.7,	146.0,	152.9,	161.8,	169.2,	174.6,	182.5,	188.3,	192.9,	207.9,
12 days	97.5,	111.6,	118.1,	127.0,	132.5,	136.5,	148.6,	160.6,	167.9,	177.4,	185.2,	190.9,	199.2,	205.3,	210.2,	226.0,
16 days	117.6,	133.5,	140.9,	150.8,	157.0,	161.5,	175.0,	188.4,	196.4,	206.8,	215.4,	221.7,	230.8,	237.5,	242.8,	260.1,
20 days	136.9,	154.5,	162.7,	173.7,	180.4,	185.4,	200.1,	214.7,	223.4,	234.8,	244.1,	250.8,	260.7,	267.9,	273.6,	292.1,
25 days	160.4,	180.1,	189.1,	201.3,	208.7,	214.2,	230.4,	246.3,	255.9,	268.2,	278.3,	285.7,	296.4,	304.2,	310.3,	330.3,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf