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Drawings

IE-DUBZZ-ZZZZ-ZZ-ARP-DR-C-00011-01

IE-DUBZZ-ZZZZ-ZZ-ARP-DR-C-00011-02

IE-DUBZZ-ZZZZ-ZZ-ARP-DR-C-00011-03

IE-DUBZZ-ZZZZ-ZZ-ARP-DR-C-00011-04

Appendices

Geotechnical Desk Study

Site Walkover

GI factual report

Geological Cross Section

1 Introduction

1.1 Description of the Project

The planning application proposes two data centres, energy generation and all other associate works on a site of 6.181ha at Profile Park, Nangor Road, Clondalkin, Dublin 22.

The application proposes two data centres, one to the south west of the site and the other to the south east of the site.

The proposed development will consist of:

10 year permission for the following development: Removal of an existing unused waste water treatment facility on site and the erection of two data centre buildings, gas powered energy generation compound, and all other associated ancillary buildings and works. The two data centre buildings, DUB 15 and DUB 16, will comprise a total floor area of c. 33,577m² over two storeys. The first 2 storey data centre building (DUB15), located to the south west of the site, will comprise 16,865m² data storage use, ancillary office use and associated electrical and mechanical plant rooms, loading bays, maintenance and storage space. A second 2 storey data centre building (DUB16), located to the south east of the site, will comprise 16,712m² data storage areas, ancillary office use and associated electrical and mechanical plant rooms, loading bays, maintenance and storage space. Both data centre buildings will reach a height of 20m.

Emergency generators and associated emission flues and plant are proposed in compounds adjacent to each data centre building. Gas powered energy generation is proposed to the north east corner of the site to provide electricity for the proposed development.

The application proposes to re-route and widen an existing watercourse constructed following an earlier planning permission. It is proposed to reroute this watercourse along the eastern and southern boundary of the site. Landscaping is proposed to the south of the site to screen the buildings. Fencing and security gates are proposed around the site.

New access roads within the site are proposed along with 71 car parking spaces and 26 cycle spaces, bin stores, site lighting, and all associated works including underground foul and storm water drainage attenuation and utility cables and all other ancillary works.

A Natura Impact Statement will be submitted to the planning authority with the application.

1.2 Geotechnical Category of the Project

The project has been identified as being a Geotechnical Category 2 in accordance with IS EN 1997-1:2005 Geotechnical Category 2 is defined as a project which includes 'conventional types of geotechnical structures, earthworks and activities, with no exceptional geotechnical risks, unusual or difficult ground conditions or loading conditions'.

2 Desktop Study

A desk study was carried out as a preliminary assessment of the ground conditions of the site.

The sources used for geological, geotechnical, historical, and other general information relevant to the area are listed in **Table 1: Sources of information**.

Table 1: Sources of information.

Source	Description
OSi Geohive [1]	Aerial photos
Google Earth	Aerial Photography
OSi Geohive	Historical Mapping
GSI Geotechnical Public Data Viewer [2]	Geology maps
Arup (2011) Profile Park Development Ground Investigation report [3]	Ground Investigation completed for a proposed motorway alignment.

Available historical mapping and aerial photographs of the location have been reviewed to provide an overview of the site history and are contained in Appendix A Geotechnical Desk Study.

2.1 Site Location and Description

The site is located to the north of Casement Aerodrome Baldonnell and to the west of the R136 road. The proposed future development includes two additional data halls, associated site infrastructure and an electricity substation.

2.2 Topography

The site is generally flat, with a gentle downward slope from south to north. During the site walkover carried out on the 22nd of March 2021 the topography of the site was noticed to be gently undulating.

2.3 Historic Land-use

Available historical mapping and aerial photographs of the location have been reviewed to provide an overview of the site history. Historically the site was used for agricultural purposes and it had a river/drainage channel running through the centre of the site from south to north. The key site feature is the sewage plant which was constructed sometime between 1913 and the 1930s, likely at the same time as the Aerodrome was developed.

Between 2006 and 2014 on site development was initiated and completed to its current state which included the diversion of the river/drainage channel, development of the data halls, the stockpiling of construction and the demolition materials and road installation.

2.4 Regional Soils, Geology and Hydrogeology

The relevant geological information of the site is summarized in **Table 2:** Geological information review (refer to Appendix A Geotechnical Desk Study) and the relevant figures detailed in the table and contained in Appendix A Geotechnical Desk Study.

Table 2: Geological information review (refer to Appendix A Geotechnical Desk Study)

Figure No.	Mapping	Comments
5.1	GSI Teagasc Subsoils	Site on deep well drained mineral soil (basic) and poorly drained mineral soil (basic)
5.2	Quaternary geomorphology	Nothing to note.
5.3	GSI Quaternary Sediments	Till derived from limestone.
5.4	GSI Bedrock 100k Geology	Lucan formation Limestone
5.5	GSI Depth to Bedrock	1 m to 3 m depth to bedrock shown.
5.6	GSI Groundwater Bedrock Aquifer	Locally important aquifer, moderately productive
5.7	GSI Groundwater Vulnerability	High groundwater vulnerability
5.8	Groundwater recharge	51-100 mm/year shown
5.9	Sensitive features	River shown, but this is the old drainage channel since replaced
6.1	Pits and Quarries	No historic pits and quarries in the vicinity
7.1	GSI Historic Ground Investigation	2 km to the north west GI showing bedrock at 3.3 m BGL, 4 km to the east showing bedrock between 1.5 m and 3.6 mBGL

2.5 Regional Soils

The superficial geology of the area generally consists of Made Ground overlying glacial drift material with limestone bedrock beneath.

According to the Teagasc subsoils map (publicly available on the GSI database), the shallow overburden beneath the site is comprised of Made Ground. The most recent Made Ground deposits are assumed to be associated with the most recent construction works at the site.

The glacial drift comprises of Brown and Black Boulder Clays. This glacial till material is generally described as intermittent layers of stiff to hard brown/black sandy gravelly clay with many cobbles and boulders and dense to very dense sandy gravel with cobbles and boulders. The Brown Boulder Clay is generally found to overlay the black and is therefore considered to be the result of weathering of the Black Boulder Clay.

Brown Boulder Clay is usually a firm to stiff sandy gravelly clay, while Black Boulder Clay is generally stiffer than the brown. Both clays are of low plasticity, and water bearing sand and gravel deposits are often encountered within this material.

2.6 Regional Bedrock Geology

The bedrock geology underlying the site comprises of the Lucan Formation, which is a dark limestone and shale, and is often referred to as Calp Limestone.

Calp Limestone generally consists of dark grey to black, fine grained, impure limestone with interbedded shales and veins of white calcareous spar. The variation in bed thickness, grain size, colour and proportion of shale are a feature of the depositional environment.

The Calp Limestone is generally quite a 'muddy' limestone and is less susceptible to karstification than other limestones. The GSI indicates that the formation ranges from 300m to 800m in thickness.

2.7 Hydrogeology

According to the GSI online maps, the aquifer below the site is a locally important aquifer and is moderately productive. The groundwater vulnerability is defined as high by the same source and the groundwater recharge is shown as 51-100 mm/year.

2.8 Radon

According to the EPA's Radon Map (<https://www.epa.ie/radiation/radonmap/>), the site is located in an area with 5%-10% of homes estimated to be above the national reference levels of 200Bq/m³ for radon gas. This area is considered a low radon risk area. A high radon area is anywhere where it is predicated that 10 % or more of the houses will exceed the national reference level.

2.9 Seismicity of the Area

Ireland lies in an area of very low tectonic activity with few seismic events in the last 41 years. From the data collected by the Irish National Seismic Network (INSN) the following number of seismic events have been registered since 1980 in Ireland and nearby areas in the UK up to the 29th January 2021:

- 70 No. Negligible ($ML \leq 1.0$);
- 58 No. Micro ($1.0 < ML \leq 1.9$);
- 28 No. Minor ($2.0 < ML \leq 3.9$);
- 2 No. Light ($4.0 < ML \leq 4.9$);
- 1 No. Moderate ($5.0 < ML \leq 5.9$) – $ML=5.4$ in Llyn Peninsula, Wales, 1984.

Where ML is the Richter local magnitude scale of the earthquake.

Based on the information above it is considered that the area presents a low risk for seismic events affecting the planned development and therefore there is no further assessment required regarding seismicity of the Site.

2.10 Site Walkover

A site walkover was undertaken on the 22nd of March 2021, the site walkover record is contained in Appendix B Site Walkover. The topography of the site was gently undulating.

During the site walkover the following observations were noted:

- There are onsite services present including drain covers and temporary foul services;
- Construction and demolition waste material stockpiles are present to the west of the site associated with the construction of the Dub 13 Dub 14 data centres;
- A diverted stream drainage channel was observed on site which contained a reinforced earth channel with associated gabions and culverts at bridges (with some of the vegetation and shrubbery and potentially soft ground of the original ditch evident on site);
- A Drainage ditch was present at the boundary of the site and the golf course; and
- A disused sewage treatment plant degrading but intact with tanks infilled with clinker ash was observed to the east of the site. While it has been decommissioned, no site clearance was undertaken and as such underground utilities etc are likely to remain in place.

There were also subtle changes in the colouration of the vegetation on site. There were areas where the vegetation was discoloured possibly as a result of the presence of underlying made ground.

3 Ground Investigations and Studies

Ground investigations have been carried out at the site in 2011 and 2021. The content of these investigations is presented in the following sections.

3.1 Site specific Ground Investigation 2011

A site specific ground investigation was completed by IGSL in 2011.

This ground investigation consisted of 16 trial pits with geotechnical and geo-environmental sampling and laboratory testing. Table 3 summarises the in-situ and laboratory testing for the 2011 ground investigation.

Table 3: Summary of in-situ and laboratory testing carried out for the 2011 ground investigation

Laboratory Testing	Quantity
Moisture Content	17 no.
Particle Size Distribution	9 no.
Atterberg Limits	11 no.
Suite E*	8 no
Suite F*	1 no
Compaction Test	3 no.
Moisture Condition Value (MCV)	5 no.
California Bearing Ratio (CBR)	7 no.

* Laboratory Testing Suites as presented in Appendix C

3.2 Project Specific Ground Investigations

The intrusive ground investigation was undertaken by Site Investigations Limited (SIL) from April to May 2021. The SIL (2021) factual report is presented in Appendix C.

Table 4 to

Table 6 summarise the exploratory holes, in situ testing and laboratory testing for the 2021 ground investigations. A specific assessment of the results will be presented in further sections. These investigation locations are shown in Figure I.

Table 4: Summary of exploratory holes carried out for the recent ground investigation

Exploratory Hole Type	Quantity
Cable Percussive Borehole	5 no. (maximum depth of 3.6 m BGL) BH101 – BH105

Exploratory Hole Type	Quantity
Rotary Core Borehole	5 no (maximum depth of 8.4 m BGL) BH101 – BH105
Trial pits	17 no (maximum depth of 4.5 mBGL) TP101 – TP117
Foundation Inspection Pit	3 no. FP102, FP103 & TP104
<i>m BGL represent Meter Below Ground Level</i>	

Table 5: Summary of in situ testing carried out for the recent ground investigation

In situ Testing & Monitoring	Quantity
Standard Penetration Test	18 no.
Soakway Test SA101, SA102	2 no.
Plate Load Test	4 no.
Standpipe Monitoring Installation	3 no.

Table 6: Summary of laboratory testing carried out for the recent ground investigation

Laboratory Testing	Quantity
Moisture Content	53 no.
Particle Size Distribution	25 no.
Atterberg Limits	48 no.
pH	20 no.
Water soluble Sulfate	20 no.
Chloride content tests	20 no.
Unconfined compressive strength tests	3 no.
Point Loads	6 no.
Suite E and Suite E.1 analysis*	66 no.
Acid soluble Sulfate	20 no.
Total Sulfur tests	20 no.
Magnesium tests	20 no.
Nitrate content	20 no.
Suite F analysis*	2 no.

* Laboratory Testing Suites as presented in Appendix C

Figure I: As built site plan of INXN Dub 15/16 ground investigation



4 Geotechnical Interpretation

This section provides an interpretation of the ground conditions at the site. It contains details and descriptions of the various materials encountered.

The site geology has been determined from ground investigations, i.e. cable percussive boreholes, rotary core holes, trial pits, and foundation inspection pits.

4.1 Geological Units

4.1.1 Topsoil

Topsoil was encountered at four boreholes (BH101, 102, 103 and 104) and six trial pits (TP102, 105, 106, 107, 110, 117) across the site. Topsoil was encountered from 79.0 to 76.0mOD.

4.1.2 Made ground

Made ground was encountered throughout the site at ground level as stockpiled material to the west of the site and underlying the topsoil in the eastern portion of the site. The made ground was described as a brown to grey silty slightly sandy to sandy, slightly gravelly to gravelly clay with anthropogenic material, and as a brown to grey silty slightly sandy to sandy gravel with anthropogenic material.

Anthropogenic material observed includes timber fragments, plastic, lean mix concrete, electric cable, red brick, steel, and concrete fragments. The made ground was noted to have a low to medium cobble content and low boulder content. The made ground was encountered at 0 - 0.2mBGL (79.8 – 77.0mOD) to a maximum depth of 3.5mBGL (75.3mOD).

4.1.3 Brown Boulder Clay

Brown Boulder Clay (Glacial Till) was encountered throughout the site underlying Topsoil and/or Made Ground. The Brown Boulder Clay has been described as firm brown slightly sandy slightly gravelly to gravelly silty CLAY with low cobble content. The Brown Boulder Clay was encountered at 0.2 to 1.4 mBGL (77.9 – 75.0mOD) to a maximum depth of 1.8mBGL (74.6mOD).

4.1.4 Black Boulder Clay

Black Boulder Clay (Glacial Till) was encountered throughout the site underlying made ground and/or the Brown Boulder Clay. The Black Boulder Clay has been described as firm to very stiff dark grey to black slightly sandy, slightly gravelly to very gravelly, silty Clay with medium cobble and low boulder content. The Black Boulder Clay was encountered from 0.7 to 3.5mBGL (78.2 to 76.3mOD) to a maximum depth of 5.4mBGL (71mOD).

4.1.5 Bedrock

The underlying Carboniferous bedrock known locally as Calp is comprised of interbedded Limestone and Mudstone bedrock which was encountered in all five boreholes with the depth to the top of rock ranging from 3.6 to 5.4mBGL (71.0 to 74.3mOD).

The bedrock is described as a strong to very strong light grey fine-grained muddy Limestone interbedded with a moderately strong to strong dark grey calcareous Mudstone and occasional calcite veins (<20mm) and pyrite crystals. The rock is largely described as fresh to slightly weathered. There were discontinuities noted in all rock cores which were predominantly clean, occasionally stained grey with some clay infill and occasionally filled with pyrite crystal veins.

The core logs reveal that there is interbedded limestone and mudstone within the bedrock from the Lucan formation. Where mudstone is present within this rock formation it is prudent to check for the presence of pyrite. The presence of pyrite in the rock will impact the reusability of the material as engineering fill.

4.2 Ground Model

The ground conditions encountered during the recent ground investigation are summarised in **Table 7** for the whole site area.

Table 7: Summarised ground model

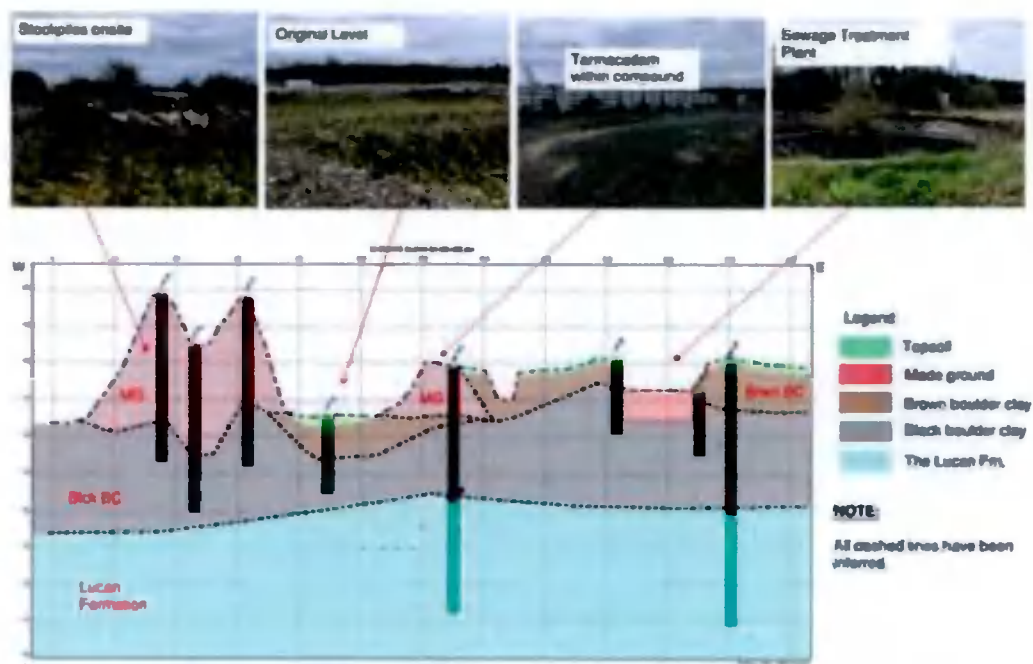
Strata	Top of strata (mBGL)	Top of strata (mOD)	Thickness (m)
Topsoil	0	79.0 - 7.0	0.1 - 0.3
Made Ground	0 - 0.2	79.8 - 73.8	0.7 - 3.6
Brown Boulder Clay	0.2- 1.4	77.9 - 75.0	0.3 - 1.2
Black Boulder Clay	0.7 - 5.4	78.6 - 71.0	0.7 - 4.0
Limestone	3.6 - 5.4	74.3 - 73.9	Unproven

Two cross sections were completed across the site.

Figure II provides a summary of the ground conditions encountered West to East. The section includes information on the existing ground conditions at locations around the site.

Further information on the geological cross sections across the site is included in Appendix D of this report.

Figure II: Ground conditions West to East on site



4.3 Groundwater

4.3.1 Groundwater Monitoring

Groundwater monitoring standpipes were installed in BH102, BH103 and BH104 with response zones within the made ground (BH102) and in bedrock (BH103 and BH104). The groundwater readings from the 18/05/2021 to the 10/06/2021 ranged from 2.25mBGL to 3.24mBGL. The groundwater readings are described below in **Table 8**.

Groundwater strikes were noted in the trial pit logs (TP102 and TP112) ranging from 3.3 to 3.6mBGL in the Black Boulder Clay. Water ingress was reported as slow.

Table 8: Summary of static groundwater levels.

Borehole no.	Slotted Standpipe (mBGL)	Response Zone	18/-5/21 (mBGL)	18/05/21 (mOD)	03/06/21 (mBGL)	03/06/21 (mOD)	10/06/21 (mBGL)	10/06/21 (mOD)
BH102	1 to 3.5	Made ground and Black Boulder Clay	Dry	Below 75.8 (Dry)	3.1	73.68	3.24	73.54
BH103	4.1 to 7.1	Bedrock	2.79	75.22	2.25	75.76	2.54	75.47
BH104	4.7 to 7.7	Bedrock	2.71	73.98	2.65	74.04	2.78	73.91

4.3.2 Groundwater Quality

Groundwater samples were recovered from BH102 at 2.8mBGL and BH103 at 2.7mBGL. The results of the were screened against the Threshold Values listed in the following documents:

- Column 4 of Schedule 5 of the EU Groundwater Regulations 2016;
- Column 4 of Schedule 5 of the EU Groundwater Regulations 2010; and
- Petroleum Hydrocarbons in Groundwater Guidance - CL:AIRE

There have been no recorded exceedances but there has been a high concentration of Iron recorded above the detection limit with a concentration range of 1800 to 1100ug/l.

4.3.3 Gas Monitoring

4.3.3.1 Results

Gas monitoring standpipes were installed in BH102, BH103 and BH104. Ground gas monitoring was completed on the 03/06/2021 when the barometric pressure was 1006mB. The results gathered onsite are described below:

There was no methane recorded across the site. Carbon dioxide levels of 0.1% were recorded in all standpipes. The oxygen levels across the site range from 20.3% (BH102) to 20.8% (BH103) with an average reading of 20.5%. Carbon monoxide levels of 1 to 2 ppm were recorded across the site, with an average reading of 1.66ppm. There was no hydrogen sulphide recorded across the site. Peak methane levels recorded across the site was 0.1 to 0.2%. The typical flow rate across site was 0.1 l/hr with an exception in BH104 where it was recorded as 0.4. The ground gas readings from the 03/06/2021 are summarised in **Table 9**.

Table 9: Summary of static groundwater levels.

Date	03/06/2021	Standpipe		
Parameter	Unit	BH102	BH103	BH104
		CH4	%	0
CO2	%	0.1	0.1	0.1
O2	%	20.3	20.8	20.4
CO	ppm	2	2	1
H2S	ppm	0	0	0
Balance	%	79.6	79.1	79.5
Peak CH4	%	0.1	0.1	0.2
Barometric Pressure	mB	1006	1006	1006
Flow	l/hr	0.1	0.1	0.4

4.3.3.2 Discussion

Gas Screening Values (GSV) have been calculated for Carbon dioxide and Methane readings across the site. This has been calculated using the guidance provided in the CIRIA guidance (C665) on assessing risks posed by hazardous ground gases to buildings with the following formula:

- Gas screening value (litres of gas per hour) = max borehole flow rate (l/hr) × max gas concentration (%).

The results are summarised in Table 10 below.

Table 10: Gas Screening Values across the site

Parameter	Unit	Standpipe		
		BH102	BH103	BH104
CO2	GSV	0.01	0.01	0.04
CH4	GSV	0.01	0.01	0.08

The results can be classified as very low risk to low risk when compared to the Gas Screening Values (GSV) in the CIRIA guidance (C665) on Assessing Risks posed by hazardous ground gases to buildings.

Using table 2 from the BS 8485:2015 - Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings (+A1:2019) the GSV for Carbon dioxide and Methane across site has been calculated as CS1 with one exception for BH104 where the GSV for CH4 reflects a CS2.

The results suggest it is unlikely that there will be a requirement for mitigation of ground gas for the proposed works.

4.4 Surface water infiltration

Two soakaway tests were performed (SA101 and SA102) within the glacial till.

- The soakaway test at location SA101 in Brown Boulder Clay stratum revealed an infiltration rate of (f) 0.00106m/min.
- The soakaway test at location SA102 in made ground revealed an infiltration rate of (f) 0.00362m/min.

5 Geo-Environmental Test Results

5.1 Assessment Methodology

In accordance with sustainable earthworks best practice, excavated natural and uncontaminated soils where suitable can be reused within the overall development site. Excess excavated material will be assessed for potential reuse under the EPA determination guidance for by-products (Article 27) or processing into end-of-waste status (Article 28), where appropriate. All remaining materials requiring disposal off-site are classified as wastes. The steps in the waste classification process are as follows:

1. Classify the material according to the EPA document “Waste Classification, List of Waste & Determining if Waste is Hazardous or Non-hazardous, Valid from July 2018”. The HazWasteOnline cloud-based software is used to perform this classification.
2. If the material is classified as ‘17 05 03*’ as defined in the EPA 2018 guidance referenced above, the material is hazardous and requires specialist treatment or export to a hazardous licenced landfill.
3. If the material is classified as ‘17 05 04 – Soil and Stones excluding those included in 17 05 03*’ as defined in the EPA 2018 guidance the material must then be classified according to the limits defined in the Landfill Directive (2002) referred to as the Waste Acceptance Criteria (WAC).

5.2 HazWasteOnline

HazWasteOnline is a cloud-based software package and is used for the classification of waste. It is used to assess the samples following the latest UK Environment Agency's technical guidance WM3 and current EU Regulations (<https://www.hazwasteonline.com>, accessed 28/05/2020) as recommended by the Irish EPA.

5.3 Waste Acceptance Criteria

The WAC are defined in the Landfill Directive (2002). According to the WAC a material with the waste code 17 05 04 is defined as one of the following:

- Soils suitable for disposal to an inert licenced landfill;
- Soils suitable for disposal to a non-hazardous licenced landfill;

Should the soil have a LoW code 17 05 03*, or hold the LoW code 17 05 04 but exceed the acceptance criteria for a non-hazardous licenced landfill, it is classed as the following:

- Soils suitable for disposal to a hazardous licenced landfill.

5.4 Waste Disposal Categories

The soils beneath the site are described using the document “Waste Classification; List of Waste & Determining if Waste is Hazardous or Non-hazardous” applicable from 5th July 2018, published by the EPA. Using this document a List of Waste code has been applied to the soils as provided below:

- 17 05 04 – Soil and Stones excluding those included in 17 05 03*

Based on the outcomes of the screening exercises described in Section 7.3, the soils are described by the categories below:

- Soils suitable for disposal to an inert licenced landfill; and
- Soils suitable for disposal to a non-hazardous licenced landfill.
- Soils requiring disposal to a hazardous licenced landfill.

As part of the GI, 66 no. samples were geo-environmentally tested. The following is the split of performed tests in terms of stratigraphy:

- 38 no. samples from Made Ground;
- 27 no. samples from the Glacial Till; and
- One sample of Gravel.

Error! Reference source not found. Table 11 provides the breakdown of the geo-environmental test results into the following WAC categories: suitable for disposal to an inert, non-hazardous, or hazardous licenced landfill.

Table 11: Tested sample categorisation

Soil Type	No. of samples	No. of Inert samples	No. of Non-Haz samples	No. of Haz samples
Made Ground	38	28	9	1
Glacial Till	27	23	2	2
Gravel	1	1	0	0

Given the isolated detection of potentially hazardous samples, further investigation will be undertaken as part of detailed design in order to determine the presence and extent of any such materials. All excavated materials determined as waste will be removed and deposited at suitably permitted or licenced facilities in accordance with current waste legislation.

6 Conclusions

6.1 Earthworks

The proposed earthworks are indicated on the following drawings included in the planning application:

- IE-DUBZZ-ZZZZ-ZZ-ARP-DR-C-00011-01;
- IE-DUBZZ-ZZZZ-ZZ-ARP-DR-C-00011-02;
- IE-DUBZZ-ZZZZ-ZZ-ARP-DR-C-00011-03; and
- IE-DUBZZ-ZZZZ-ZZ-ARP-DR-C-00011-04.

The proposed earthworks plan for the site was designed using a sustainability approach and as such earthworks were minimised where possible and site levels are generally close to the existing levels on site for much of the site.

The development of DUB13 and DUB14 and Profile Park has involved bulk excavation and the remaining earthworks and made ground associated with the development remain on site in the form of stockpiles and deposited made ground.

Enabling works will include the removal of these existing stockpiles on the site for recovery or disposal to a suitably licensed facility offsite. It will also include for the excavation and removal of the decommissioned sewage treatment works (unused waste water treatment facility) and associated buried structures and foundations.

It is envisaged that the area around the sewage treatment works will be excavated to a depth of approximately 2m BGL and replaced with suitable engineering fill to allow for the construction of Dub16, the proposed new water course at this location and associated site security fencing.

Additional site clearance and preparation works will include service diversions and works associated with the diversion of the existing site water course and associated infrastructure.

During permanent works unsuitable material or made ground encountered on the site will be excavated under all structures and associated infrastructure for removal from site to a suitably licensed facility and replaced with suitable engineering fill.

The suitability of excavated materials for re-use as acceptable earthworks fill will be assessed in accordance with the requirements of the TII Specification for Roadworks.

6.2 Foundations

The proposed finished floor levels (FFL) for DU15 and DUB16 are as follows:

- DUB 15 – FFL = 76.85mOD

- DUB 16 – FFL = 77.84mOD

Based on the expected ground conditions on the site all structures will be founded on shallow foundations. The stiff black boulder clay will provide an adequate bearing capacity for low rise buildings as those proposed for the development. It is prudent that foundations span over a uniform stratum in both consistency and strength to control differential settlement.

Any made ground or soft spots within the founding soil stratum will be excavated and replaced with suitable material.

The depth to bedrock is shallowest in the southern part of the site and localised rock excavation may be required in deeper excavations associated with the proposed attenuation tanks in this location.

Temporary dewatering of excavations may be required particularly where bedrock is encountered.

6.3 Construction Considerations

Good construction management practices shall be employed to minimise the risk of transmission of hazardous materials as well as pollution of adjacent watercourses and groundwater.

The construction management of the site will take account of the recommendations of the CIRIA guidance Control of Water Pollution from Construction Sites – Guidance for consultants and contractors (Masters-Williams et al., 2001) to minimise as far as possible the risk of soil, groundwater and surface water contamination.

Measures to be implemented to minimise the risk of spills and contamination of soils and waters should include:

- Employing only competent and experienced workforce, and site specific training of site managers, foremen and workforce, including all subcontractors, in pollution risks and preventative measures;
- Ensure that all areas where liquids (including fuel) are stored, or cleaning is carried out, are in designated impermeable areas that are isolated from the surrounding area and within a secondary containment system, e.g. by a roll-over bund, raised kerb, ramps or stepped access;
- The location of any fuel storage facilities shall be considered in the design of all construction compounds. These are to be designed in accordance with relevant guidelines and codes of best practice and will be fully bunded;
- Good housekeeping at the site (daily site clean-ups, use of disposal bins, etc.) during the entire construction phase;
- All concrete mixing and batching activities will be located in areas away from watercourses and drains;
- Potential pollutants to be adequately secured against vandalism;

- Provision of proper containment of potential pollutants according to codes of best practice;
- Thorough control during the entire construction stage to ensure that any spillage is identified at early stage and subsequently effectively contained and managed; and
- Spill kit to be provided and to be kept close to the storage area. Staff to be trained on how to use spill kits correctly.

A contingency plan for pollution emergencies should also be developed by the appointed contractor prior to the commencement of works and regularly updated, which would identify the actions to be taken in the event of a pollution incident. It shall address, between others, containment measures, emergency discharge routes, a list of appropriate equipment and clean-up materials and notification procedures to inform the relevant environmental protection authority.

References

Arup (2021). Dub 15 Dub 16 Due Diligence Report

CIRIA C665 guidance Assessing Risks Posed by Hazardous Ground Gases to Buildings

CIRIA guidance Control of Water Pollution from Construction Sites – Guidance for consultants and contractors (Masters-Williams et al., 2001)

European Union Environmental Objectives (Groundwater) (Amendment) Regulations 2016.

European Union Environmental Objectives (Groundwater) (Amendment) Regulations 2010.

Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies.

The Landfill Regulations, EPA 2002

Waste Classification, List of Waste & Determining if Waste is Hazardous or Non-hazardous, EPA 2018



Appendix A

Geotechnical Desk Study



DUB15DUB16 DUE DILIGENCE - GEOTECHNICAL DESK STUDY

CONFIDENTIAL

280503

04/03/2021 11:41:33

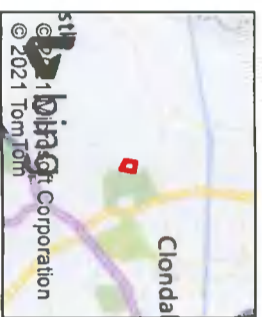
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Legend
 Site Boundary



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Project Title
DUB15 DUB16

Drawing Title
Site Location

Client
Confidential

Scale at A3
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Job No
280503

Drawing Status
Draft

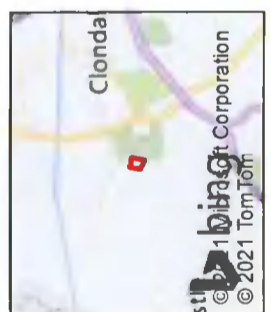
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Legend
 Site Boundary



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Drawing Title
 Site Location and Landuse

Client
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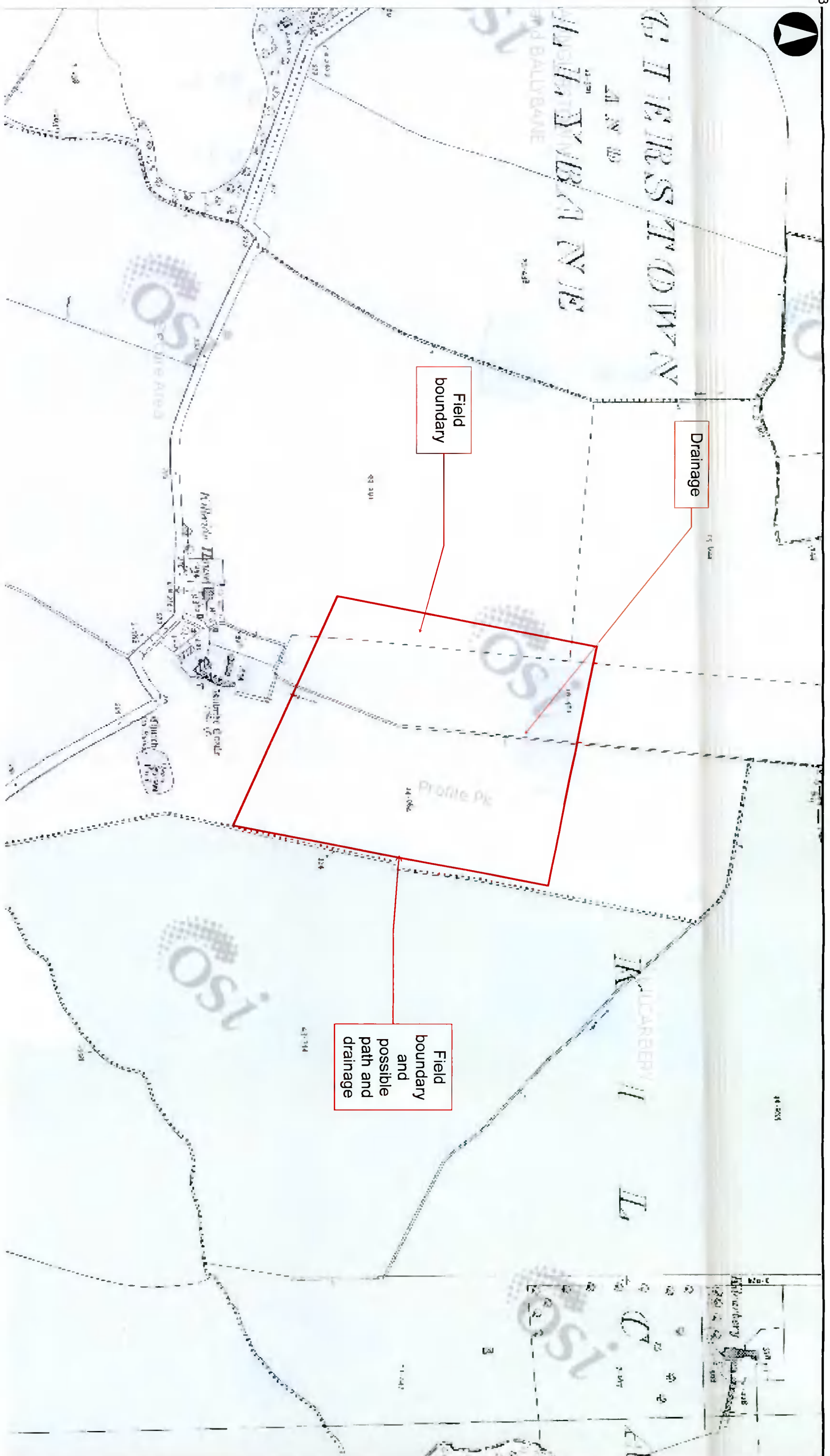
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Job No.
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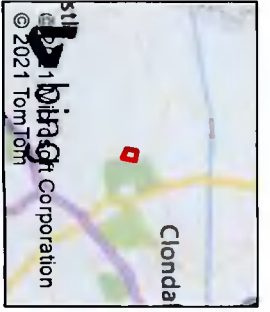
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Legend
 Site Boundary

Source: Geohive, 6 inch B&W map (1837 - 1842)
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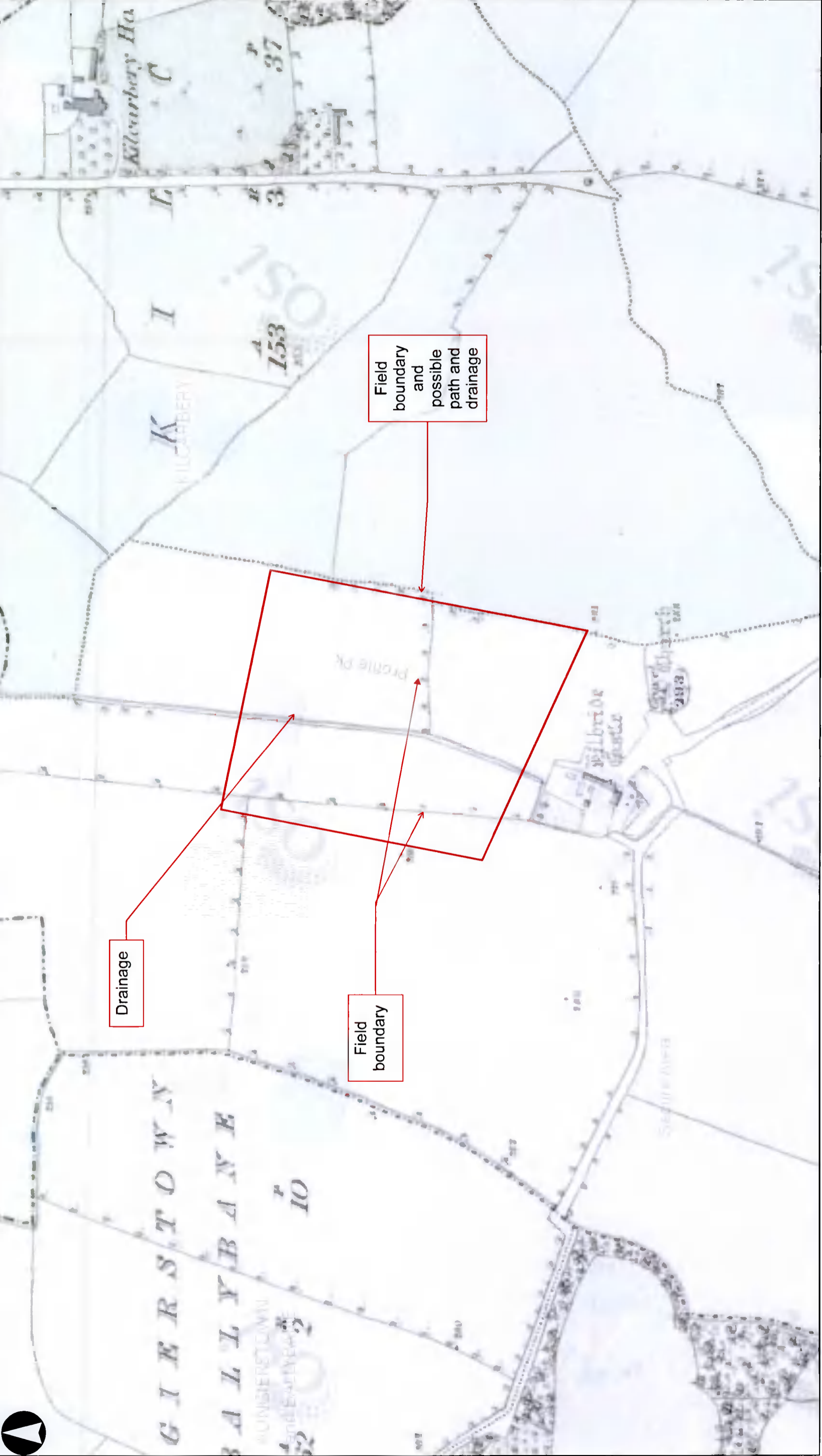
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Drawing Status
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Figure number

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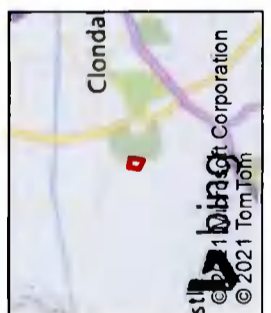
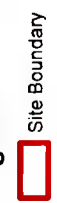


Drainage

Field boundary

Field boundary and possible path and drainage

Legend



Source: Geohive, 25 inch B&W map (1888-1913)
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Drawing Title
Historical Mapping 2

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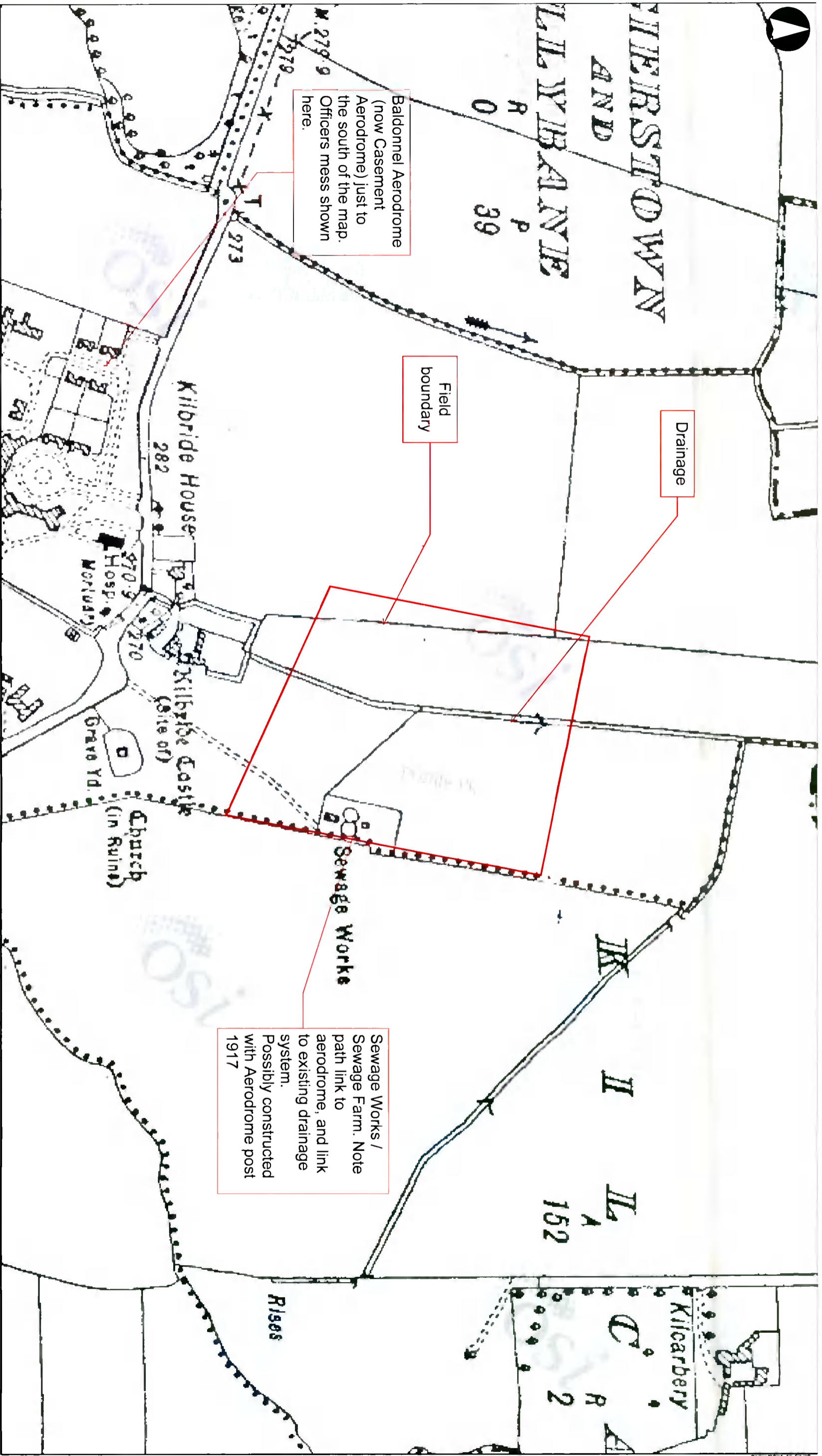
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Job No.
280503

Drawing Status
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Figure number

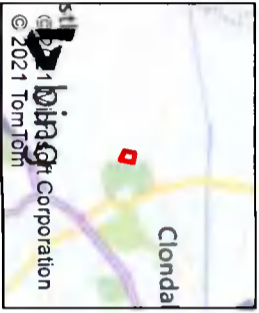
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Legend

 Site Boundary

Source: Geohive, 6 inch Cassini map (1830s - 1930s)
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Drawing Title
Historical Mapping 3

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Scale at A3
NTS

Job No
280503

Drawing Status
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Figure number

2.3



705145_361_729554_529 © 2017 Ordnance Survey Ireland Digital Globe

Legend
 Site Boundary

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Project Title
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Drawing Title
Aerial Photography 1995

Client
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Scale at A3
NTS

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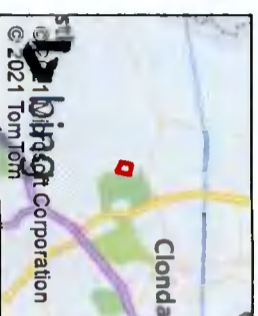
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Legend
 Site Boundary

Source: Geohive, 2000 Aerial Photography
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Drawing Title
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Confidential

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1:3,500
 Job No
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 Drawing Status
Preliminary
 Figure number

3.2



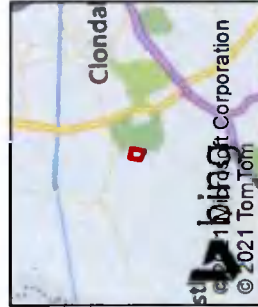
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Drawing Title
Aerial Photography 2005

Client
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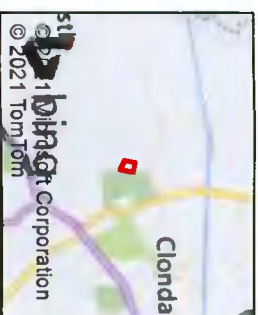
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280503
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 Figure number

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Legend
 Site Boundary

Source: Geohive, 2005-2012 Aerial Photography
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Drawing Title
 Aerial Photography 2005-2012

Client
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Job No
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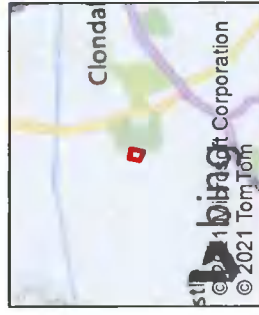
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Figure number
3.4



Legend

Site Boundary



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Drawing Title
Google Earth 2009

Client
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Scale at A3
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Job No.
280503
Drawing Status
Preliminary
Figure number

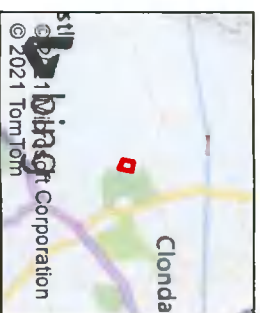
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Google Earth

Legend

 Site Boundary



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Drawing Title
Google Earth 2012 - March

Client
Confidential

Scale at A3
NTS

Job No
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Drawing Status
Preliminary

Figure number

3.6



Construction compound and parking.
Risk of contamination from refuelling if not well controlled.

Existing drainage channel intercepted. Also connection to sewage farm if it still existed.

Dub 13 and Dub 14 site clearance

Material stockpiled potential.
Review of Dub 13 and 14 construction records to inform material placed here.

Google Earth

Legend

Site Boundary



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Drawing Title
Google Earth 2012 - June

Client
Confidential

Scale at A3
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Job No.
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Drawing Status
Preliminary

Figure number

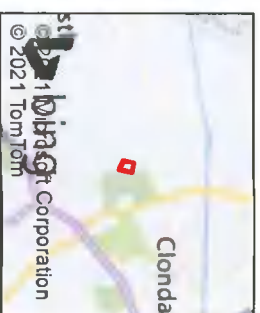
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Google Earth

Legend

Site Boundary

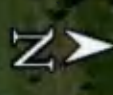


Construction stockpiles

Construction stockpiles

Drainage fully re-routed.

100 m



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Drawing Title
Google Earth 2013 - July

Client
Confidential

Scale at A3

NTS

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Drawing Status
Preliminary

Figure number

3.8

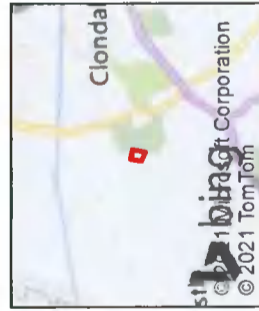


Google Earth

Legend



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Drawing Title
Google Earth 2014 - June

Client
Confidential

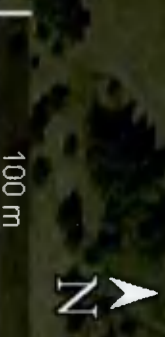
Scale at A3
NTS
 Job No
280503
 Drawing Status
Preliminary
 Figure number

3.9



Construction stockpiles changed. Risk of inclusion of construction waste in the made ground.

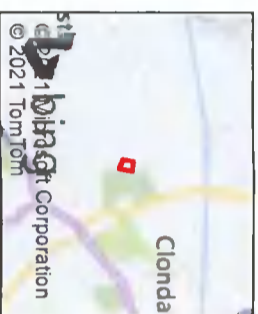
Return to agricultural land with hay bales.



Google Earth

Legend

Site Boundary



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Drawing Title
Google Earth 2018 - June

Client
Confidential

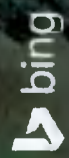
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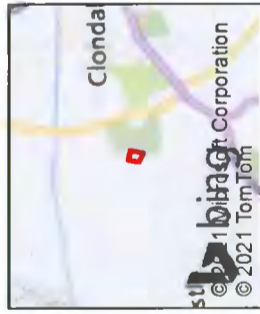
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Legend

- Site Boundary
- EPA Contours



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Project Title
DUB15 DUB16

Drawing Title
Topography

Client
Confidential

Scale at A3
1:3,500

Job No
280503

Drawing Status
Preliminary

Figure number

4.1



Legend

Site Boundary

Soil Type

BminDW - Deep well drained mineral soil (basic)

BminPD - Poorly drained mineral soil(basic)

Made



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Project Title
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Drawing Title
Soils

Client
Confidential

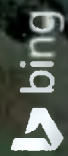
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Drawing Status
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Figure number

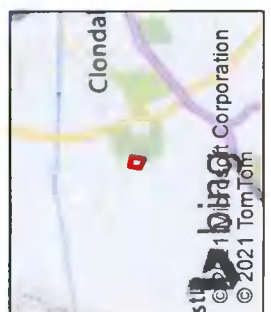
5.1



Legend

 Site Boundary

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Project Title
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Drawing Title
Quaternary Geomorphology

Client
Confidential

Scale at A3
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Job No
280503

Drawing Status
Preliminary

Figure number

5.2

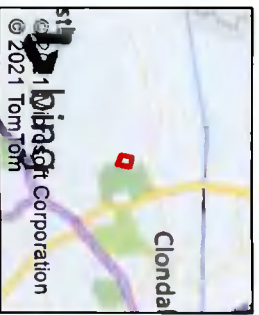
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Legend

- Site Boundary
- A. Alluvium
- T1s, T1t1 derived from limestones



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Project Title
DUB15 DUB16

Drawing Title
Quaternary Sediments

Client
Confidential

Scale at A3
1:3,500

Job No
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Drawing Status
Preliminary




Figure number

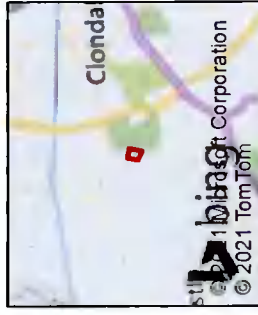
5.3



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Legend

-  Site Boundary
-  Outcrop
- Bedrock 1:100,000**
-  Lucan Formation



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Project Title
DUB15 DUB16

Drawing Title
Bedrock Geology

Client
Confidential

Scale at A3
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Job No
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Drawing Status
Preliminary

Figure number

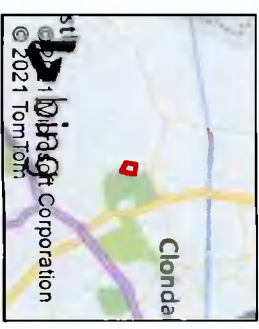
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Legend

- Site Boundary
- 0 to 1m
- 1 to 3m
- 3 to 5m
- 5 to 10m
- 10 to 15m
- 15 to 20m
- 20 to 25m
- 25 to 30m
- 30 to 45m



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Project Title
DUB15 DUB16

Drawing Title
Depth to Bedrock

Client
Confidential

Scale 1:1A3
1:3,500

Job No
280503

Drawing Status
Preliminary

Figure number

5.5



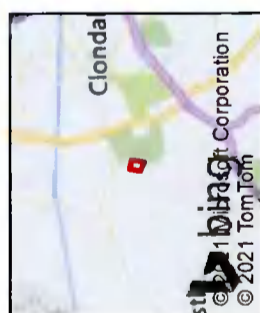
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Legend

Site Boundary

Bedrock Aquifer

L1- Bedrock which is moderately productive only in local zones



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Project Title
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Drawing Title
Bedrock Aquifer

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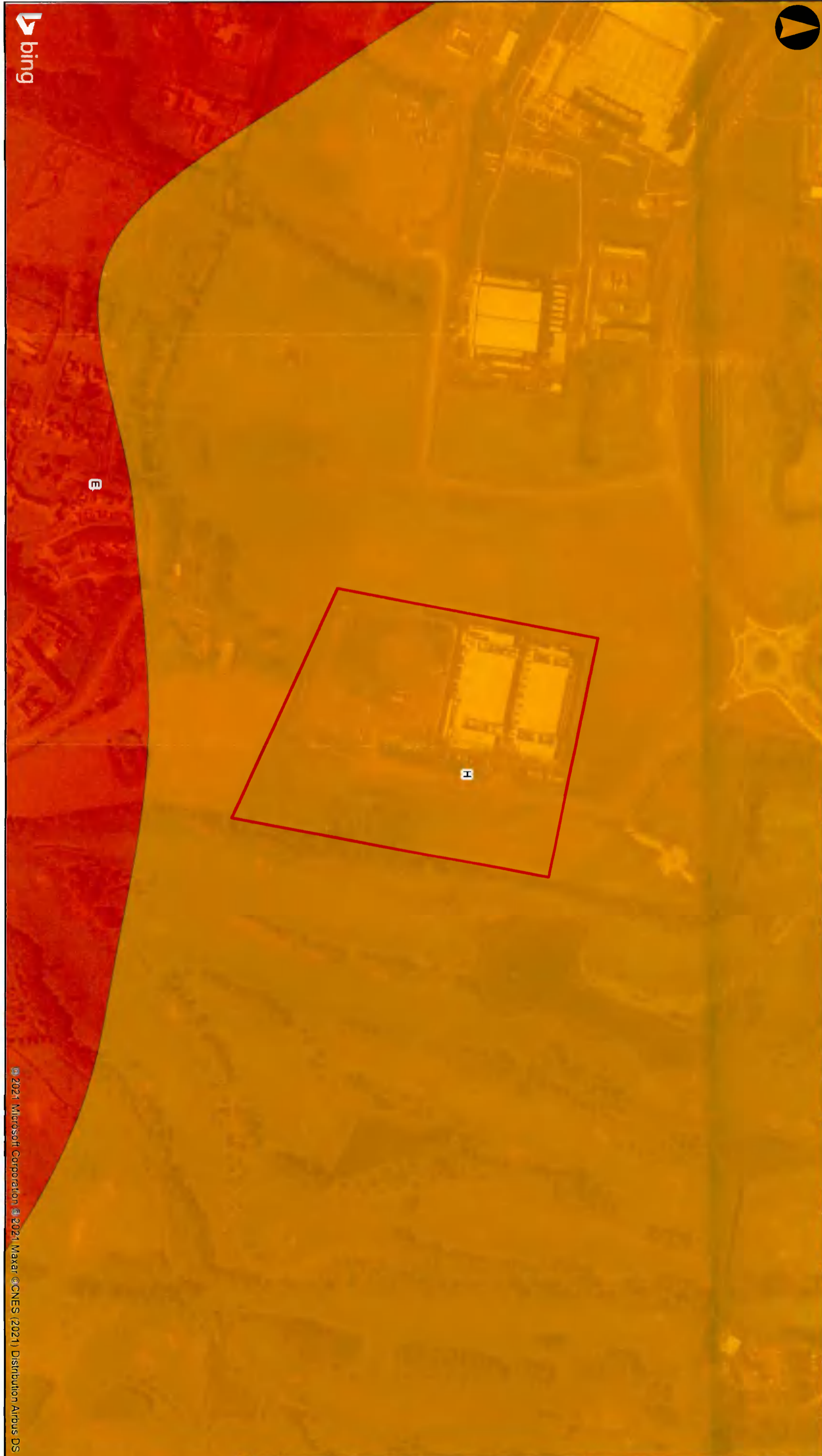
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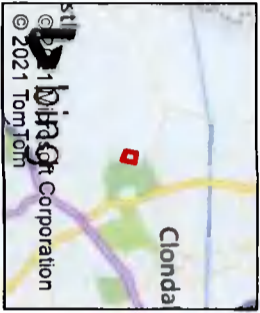
Figure number

5.6



Legend

- Site Boundary
- Extreme
- High



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Drawing Title
Groundwater Vulnerability

Client
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Scale at A3
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Drawing Status
Preliminary

Figure number

5.7



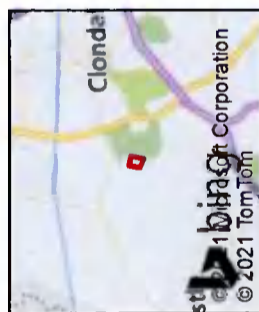
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Legend

- Site Boundary
- Recharge mm/yr
 - 51 - 100
 - 101 - 150
 - 151 - 200



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0 1,800 3,600 7,200 Metres

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	2021-03-04	AH	MF	MF

Project Title
Dub15

Client
Groundwater Recharge

Drawing Title
Confidential

Scale at A3
1:3,500

Job No
280503

Drawing Status
Preliminary

Figure number
5.8

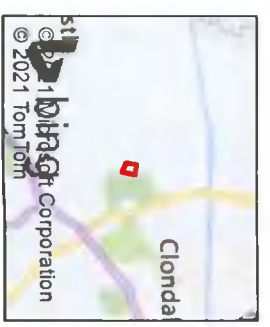


Line shown is historic river/drainage channel and no longer present on the alignment shown within the site boundary.

Revised drainage run following Dub 13 Dub 14 construction.

Legend

- Site Boundary
- Groundwater Wells and Springs
- River Network and River Flow Direction Arrows
- Lake Segments
- proposed National Heritage Areas
- Current drainage on site



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Dub15

Drawing Title
Sensitive Features

Client
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1:3,500

Job No
280503

Drawing Status
Preliminary

Figure number

5.9

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- Legend**
- Site Boundary
 - Active Quarries
 - Historic Pits and Quarries



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Project Title
Dub15

Drawing Title
Pits and Quarries

Client
Confidential

Scale at A3
1:3,500

Job No.
280503

Drawing Status
Preliminary

Figure number

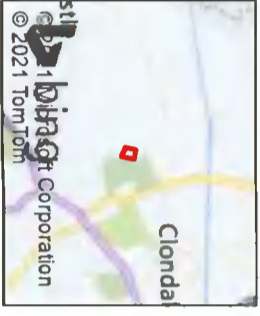
6.1



Report: 7538
Boreholes showing bedrock met at 3.3 m below ground

Report: 7035
Corkagh Grange Housing, IGSL
Cable percussive boreholes encountered firm to stiff clay, but all terminated on obstructions between 1.5 and 3.6 m, corresponding with the depth to weathered rock. Rotary core boreholes recovered laminated or thinly bedded limestone.

- Legend**
- Site Boundary
 - External Geotechnical Boreholes
 - ▲ 0-5m Bedrock Not Met
 - 5-10m Bedrock Not Met
 - ▲ 10-20m Bedrock Not Met
 - ◆ 20-30m Bedrock Not Met
 - ★ 30-1000m Bedrock Not Met
 - Hole Depth (metres)
 - ▲ 0-5m Bedrock Met
 - ◆ 5-10m Bedrock Met
 - 10-20m Bedrock Met
 - ★ 20-30m Bedrock Met
 - 30-1000m Bedrock Met
 - External Geotechnical Sites
 - 0-5m Bedrock Not Met
 - 5-10m Bedrock Not Met
 - 10-20m Bedrock Not Met
 - 20-30m Bedrock Not Met
 - 30-1000m Bedrock Not Met



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Project Title
Dub15

Drawing Title
GSI Ground Investigations

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Scale at A3
1:10,000

Job No
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Drawing Status
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Figure Number

7.1

A3



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No.	Date	By	Description	Out By
DRAFT				

Job Title: **Profile Point Development**

Drawing Title: **Indicative Trial Pit Locations**

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 Drawing No: 20-001 Rev: A

Site specific GI

Completed 2011

Covered Western part of site, no GI on the majority of the area to the east of the access road.

Scoped prepared by Arup and investigation completed by IGSL. GI consisted only of Trial Pits, with geotechnical and geoenvironmental samples.

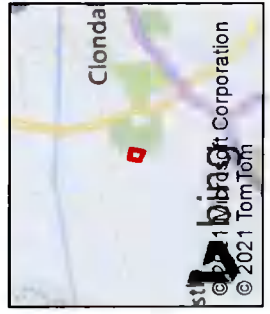
Ground conditions

The summary of the ground conditions from the draft report is shown below. Rock was not confirmed by coring, but was assumed to have been observed at the base of the trial pits.

Soil Stratum	Typical Depth (m BGL)
Topsoil	0 - 0.40
Made Ground	0 - 3.00
Soft - Firm Clay	0.15 - 3.80
Firm - Stiff Clay	0.35 - 3.80
Sand/Gravel	3.10 - 3.70
Possible Bedrock	1.20 - 3.60

Table 1: Summary of soils encountered and typical depths

Legend



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Project Title
Dub15

Drawing Title
Previous Ground Investigation

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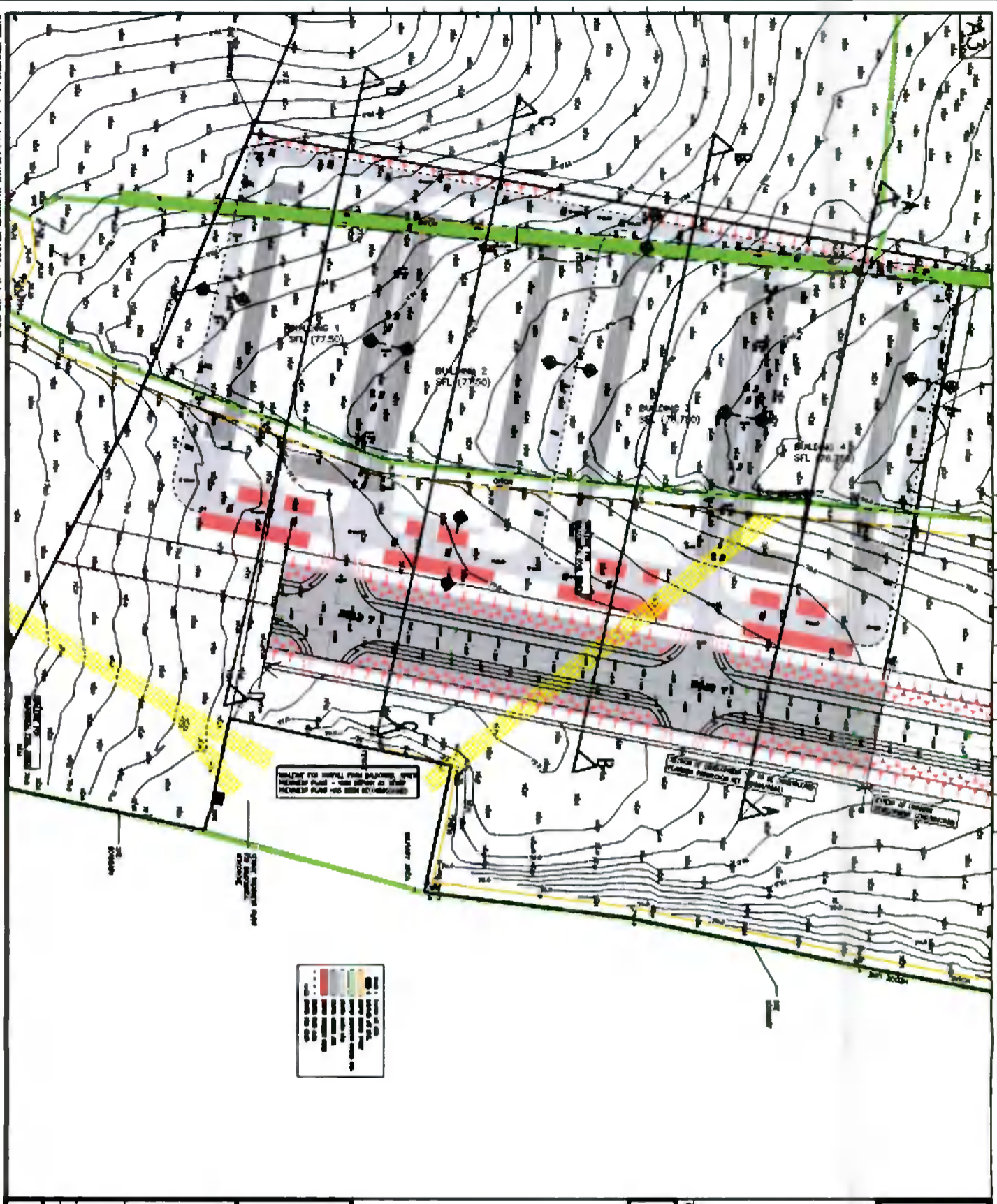
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Job No.
280503

Drawing Status
Preliminary

Figure number

7.2



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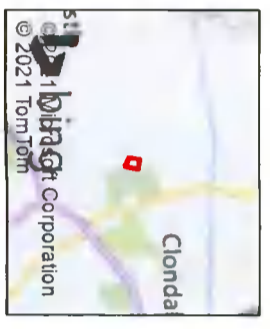
**Previous Topography
 2011 Site Investigation**

Yellow outlines show wayleaves from the sewage treatment plant to the drain that cut through the site.

Any extent of this will need to be confirmed.

The topography shows a steep change in level on the eastern edge of the site. This should be confirmed as current with a site walkover.

Legend



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Project Title
Dub15

Drawing Title
Previous Ground Investigation 2

Client
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Scale of A3
1:10,000

Job No
280503

Drawing Status
Preliminary

Figure number

7.3



Sewage Farm / Sewage Treatment Plant

Constructed post 1920.

Likely related to the aerodrome. No date for decommissioning provided.

Requirements for moving forward:

- Confirm status of tanks (empty / full)
- Specialist contractor to drain tanks.
- Specialist contractor to remove existing tanks.
- Sampling and testing of ground beneath and around the facility to confirm if any contamination has occurred.

The extent of any buried services connecting the sewage farm to the previous river / drainage ditch through the site will need to be confirmed.

The recommended geoenvironmental testing is highlighted in the table below. This is generally captured as part of the typical suite of testing, with the addition of testing for pathogens, asbestos and organic compounds.

Department of the Environment (1995) Sewage Works and sewage farms, industry profile

Table 1 Main groups of contaminants and their probable locations

Sewage works and sewage farms

Main group of contaminants	Process areas			Location				
	Sewage works	Sewage farms	Sludge treatment/ storage	Debris storage/ disposal	Pipework channels	Electricity transformer areas	Chemical storage	
Metals, metalloids and their compounds	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	
Inorganic compounds	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	
Acids/alkalis	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	
Asbestos	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	
Organic compounds	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	
Polychlorinated biphenyls (PCBs) and other transformer oils	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	
Micro-organisms (pathogens)	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	
Methane carbon dioxide hydrogen sulphide	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	

Shaded boxes indicate areas where contamination is most likely to occur

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Project Title
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Drawing Title
Geotechnical Risk Register

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Scale at A3
1:10,000

Job No.
280503

Drawing Status
Preliminary

Figure number

8.1

GEOTECHNICAL RISK REGISTER

Please refer to notes for more information

Rev. **JOB TITLE: DUB 15 DUB 16**
JOB NO: 280503

Particular Definitions

Hazard: Ground conditions and geotechnical related elements which have the potential to adversely impact on the project.
Risk: The consequence if a particular hazard was to occur or was left untreated.

Ref. Sub Ref.	Created By	Phase of Works and/or Source	Hazard	Observation / Cause	Location of Hazard	Risk Exposure	Risk / Opportunity	Pre-Mitigation Risk Analysis	Mitigation Measures	Risk Control Mitigation Measures	Phase of Application	Required by		
	Date	Initials						Likelihood L/M/H	Severity L/M/H	Risk L/M/H				
1	06/03/2021	AH	Desk Study	Contamination	Sewage Treatment plant / Sewage Farm	Services	Contaminated ground with increased cost for disposal	R	H	M	H	Engaged specialist contractor for sewage plant removal, then complete site specific GI and testing to confirm any contamination	Ground Investigation	
2	06/03/2021	AH	Desk Study	Unforeseen ground conditions	Existing site clearance	Geology	Contain construction waste from original DUB13 DUB14 works. Increased cost of disposal	R	M	L	M	Additional GI to confirm if there is any construction waste on site. Allow for costing of disposal for Made Ground rather than natural ground.	Ground Investigation	
3	06/03/2021	AH	Desk Study	Topography		Site Extent	Steep slopes at edge of site requiring additional fill / excavation to level site	R	H	L	M	Site walkover to confirm topography. Move any construction elements away from site edge.	Desk Study	
4	06/03/2021	AH	Desk Study	Unforeseen utilities / services	Sewage Treatment plant connection to old drainage.	Services	Existing drainage channel still in the ground that will require removal.	R	M	M	M	Review construction records for DUB 13 DUB 14 to confirm presence of connection. Additional GI closer to sewage tank to locate the sewer connection and possible removal if required.	Ground Investigation	
5	06/03/2021	AH	Desk Study	Unforeseen ground conditions	Depth to bedrock.	Geology	Weathered bedrock located at 2 m BGL on the south of the site (at time of GI in 2011, prior to site works). Increased excavation costs if building depth exceeds 2 m. Modified drainage channel (reinforced drainage channel)	R	M	H	M	Review of current site levels and additional GI to confirm depth to bedrock.	Conceptual Design	

GEOTECHNICAL RISK REGISTER

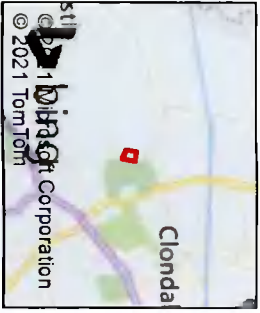
Please refer to notes for more information

Rev. **JOB TITLE: DUB 15 DUB 16**
JOB NO: 280503



Ref. Sub Ref.	Created By	Phase of Works and/or Source	Hazard	Observation / Cause	Location of Hazard	Likelihood L/M/H	Severity L/M/H	Risk L/M/H	Status
1	06/03/2021	AH	Desk Study	Contamination	Sewage Treatment plant / Sewage Farm	Services			
2	06/03/2021	AH	Desk Study	Unforeseen ground conditions	Existing site clearance	Geology			
3	06/03/2021	AH	Desk Study	Topography		Site Extent			
4	06/03/2021	AH	Desk Study	Unforeseen utilities / services	Sewage Treatment plant connection to old drainage.	Services			
5	06/03/2021	AH	Desk Study	Unforeseen ground conditions	Depth to bedrock.	Geology			

Legend



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Geotechnical Risk Register

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1:10,000

Job No
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Figure number
8.1