ARUP

Google Ireland Limited

Data Centre Development DC3

Main Environmental Impact Assessment Report

Reference: Chapter 13: Appendix

| June 2024

Job number 298479-00

Ove Arup & Partners Ireland Limited
50 Ringsend Road
Dublin 4
D04 T6X0
Ireland
arup.com

Contents

Tables

No table of figures entries found.

Figures

No table of figures entries found.

Drawings

No table of figures entries found.

Pictures

No table of figures entries found.

Photographs

No table of figures entries found.

Attachments

No table of figures entries found.

Appendices

Chapter 13: Appendix
A.1 Walkover Notes

ARUP

298479-11 –Campus Plan Refresh

Geotechnical Site Walkover

1

ARUP

JOB TITLE	Campus Plan Refresh
	298479-11
JOB NUMBER	LI
	AL,SM
MADE BY	14.12.2023
	Site Walkover
Sheet Number Prefix	01
Member/Location	
	N/A

2

ARUP

Site Walkover

Overview

Lazaros Iatropoulos

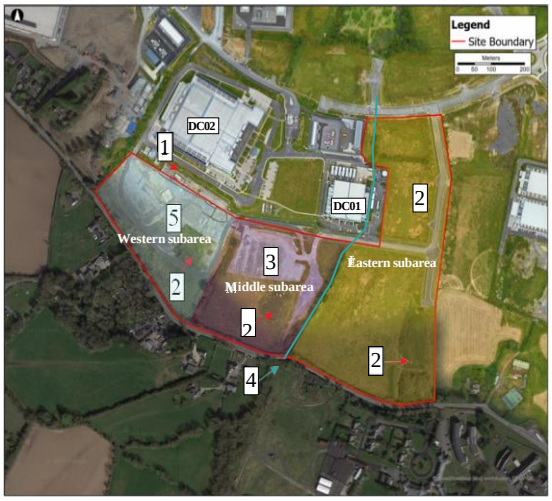
14/12/2023

3

ARUP

Site Walkover

Summary



Notes:

A geotechnical site walkover of Campus Plan Refresh site was undertaken as part of the geotechnical due diligence study.

Within the site's boundaries, three distinct subareas can be identified. The eastern part of the site is characterized by green space, the middle portion served as a temporary gravel parking lot for neighboring facilities, and the western part was previously used as a temporary contractor laydown area.

1. Notable elevation difference (~2m) between DC02 and DC03. The elevation increases from north to south.
2. Several spoil heaps were observed across the site, with at least one allocated for each subarea. Mostly believed to be related with the construction of DC01 and DC02.
3. It is believed that soil was also stripped to make way for the gravel parking in the middle subarea. Several mounds were noted.

   A stream flows through the middle of DC03 (south to north) flowing under the eastern boundary of DC01 going off the site.

5. The western subarea has also been stripped and used as construction storage. Due to the lack of vegetation and poor drainage; ponding water was noticed. Waste related with previous site activities was found and suggest that there is a potential for localized ground contamination.

4

ARUP

Site Walkover

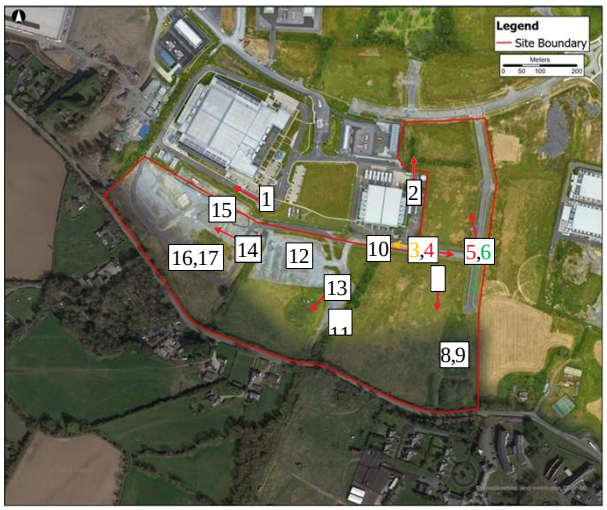
Photographs

5

ARUP

Site Walkover

Site Plan



Notes:

The figure illustrates the location from which each presented photograph was captured, along with the corresponding direction indicated by the associated arrow.

In the absence of an arrow, the photograph information pertains to a specific feature situated at the labeled point.

6

ARUP

Site Walkover

Photograph Site 1

Notes:

- This photograph was taken along the local road outside the DC02 facilities looking in a northwestern direction.
- It displays the elevation difference between DC03 and DC02.

7

ARUP

Site Walkover

Photograph Site 2

Notes:

- This photograph was captured from the northwestern extreme of the eastern subarea, facing north. It depicts the surface flow of the channel, which extends off the site and passes beneath the road.
- There is a decrease in the elevation moving from the pre-existing facilities into the DC03 site. However, the elevation increases moving southwards.

8

Site Walkover

ARUP

Photograph Site 3,4

Notes: The two photographs were taken along the local road that divides DC01 and DC02 from DC03. The one on the left (3) looks towards the western portion of the site and the one on the right (4) is looks towards the eastern portion.

9

Site Walkover

ARUP

Photograph Sites 5,6

Notes:

- The photograph on the right (6) was taken along the same local road; from the eastern extremity of the site looking towards the north. The photograph displays the green fields of the eastern subarea and small elevation anomalies are also noticeable.
- Photograph 5 on the left was taken from the same point but looking towards the south.
- Additionally, construction works can be seen outside the site boundary to the north and east.

10

Site Walkover

ARUP

Photograph Site 7

Notes:

- This portion of the site is also displaying green fields.
- The biggest spoil heap related with stockpiled soil stripped for the construction of DC01 is sitting on the southeastern corner of the site and can be seen (7).

11

Site Walkover

ARUP

Photograph Site 8,9

Notes:

- These photos were captured at the eastern spoil heap showcasing the material that it consists of. It's believed, based on-site observations, that the spoil is a mix of topsoil, brown and grey glacial till.
- No evidence of environmental contamination was noticed, only roots of the growing vegetation were found in the material.

12

ARUP

Site Walkover

Photograph Site 10,11

Notes:

- The photo on the right (11) displays the stream that is the natural border between the eastern and middle subareas of the site.
- The photo on the left (10) shows the stream that flows underground right before the local road in front of DC01.

13

ARUP

Site Walkover

Photograph Site 12,13

Notes:

- Both photos were taken from the middle subarea.
- The one on the left (12) depicts the gravel parking lot along with the light poles.
- The one on the right (13) displays the stockpiled stripped soil found in the middle subarea.

14

ARUP

Site Walkover

Photograph Site 14, 15

Notes:

- The photos were taken from the western subarea of the site. The photo on the left (14) shows the asphalt and gravel roads, a few surficial concrete platforms and the lack of vegetation in this subarea. It was evident that this area was used for construction storage purposes.
- On the right it's a standpipe from previous ground investigation that could still be used for groundwater level monitoring.

15

ARUP

Site Walkover

Photograph Site 16, 17

Notes:

- Taken from the spoil heap found at the western subarea.
- The presented photographs indicate the risk of potential soil and water contamination.

16

A.2 Ground Investigation Factual Reports

Please refer to EIAR Appendices Part 5

A.3 Hydrogeological Assessments

Technical Note

Project title	DC03 EIAR Hydrogeology Chapter
Job number	298479
File reference	CH13-TN-001
cc	
Prepared by	Gerry Baker
Date	16 May 2024
Subject	Dewatering Calculations

50 Ringsend Road Dublin 4 D04 T6X0 Ireland
t +353 1 233 4455 d +353 1 233 4441
arup.com

1. Introduction

This document provides a dewatering assessment for the excavations associated with the DC03 project. The resulting calculations are used to support the Hydrogeology elements of the Environmental Impact Assessment Report (EIAR).

The assessment is completed by Gerry Baker (PGeo. EurGeol., MSc. BA) an Associate Arup Hydrogeologist with 23 years of experience working in hydrogeology consultancy in Ireland.

The assessment is based on the best available information at this time and the nature of the proposed development.

2. Methodology

The methodology adopted for the assessment uses the UK Environment Agency Tier 1 Analytical Tools excel model. The model was developed as part of a UKEA science project (Sc040020) to develop a methodology for assessing the hydrogeological impact of dewatering abstractions. The Tier 1 assessments are appropriate as initial calculations to determine the potential level of impact and where this is low or negligible no further assessment is required. Tier 2 or 3 modelling can be progressed where more significant impacts are identified.

The tools implemented for the purposes of this assessment include:

- No. 21 Radius of Influence (Sichardt) – to determine the likely radius of influence of the dewatering.
- No. 12 Wellpoints – Partial Penetration by a double row of wells points – to determine the inflows to excavations on the site.

The input parameters to these assessments include:

- Permeability of the formation – which is based on GSI Aquifer Parameters Handbook[1] typical range of value for the host formation and experience of similar projects in this area in the past.

[1] Kelly, C., Hunter Williams, T., Misstear, B.M., Motherway, K. 2015. Irish Aquifer Properties – A reference manual and guide. Prepared on behalf of the Geological Survey of Ireland and the Environmental Protection Agency

- Scale of excavation and depth of dewatering – based on the proposed design.

3. Parameter Values

3.1 Conceptual Site Model

The site is underlain the Lucan formation which is overlain by a thin layer of Dublin Boulder Clay (1-3m) which is in turn variably overlain by topsoil or made ground.

Groundwater monitoring on site has found the water-table to generally be positioned at the top of bedrock and broadly aligned with topography and hydraulically linked to local streams (Baldonnell Stream).

The excavation for the proposed development will extend below the water-table in some locations which will require localised dewatering.

3.2 Aquifer Parameters

The bedrock underlying the site is the Lucan formation, which is part of the Dinantian Upper Impure Limestone (DUIL) hydro-stratigraphic rock unit group. The bedrock aquifer is classified in this area by GSI as a Locally Important Bedrock Aquifer (Ll) which is only moderately productive in local zones.

There have been no pumping test or falling head tests completed on site to provide a site specific permeability value.

Table 1 outlines the estimated mean, 95th and 5th percentile permeability values for this rock type based on the GSI Aquifer Handbook. For the purposes of the assessment it is assumed most transmissivity values in the GSI database are from borehole which are approximately 100m deep, which is fairly typical depth in Irish water well drilling.

Table 1: Estimated Permeability Values

Bedrock Formation	Lucan Formation			
Rock Unit Group	DUIL			
Aquifer Classification	Ll	Average	95th Percentile	5th Percentile
Transmissivity	m^2/d	8	100	0.9
Thickness	m	100	100	100
Permeability	m/d	0.08	1.0	0.0
Permeability	m/s	$9.3x10^{-7}$	$1.2x10^{-5}$	$1.0x10^{-7}$

3.3 Excavation / Dewatering Areas

The site has been considered within the main 5 development areas to determine the likely range of drawdown in the water-table based on the proposed excavation levels and observed range in groundwater, as shown in Table 2. This highlights that drawdown ranges from nil in places to a maximum of 2.5m in the Southern Site Area.

Table 2: Estimated Drawdown Required

Site area	Ground level (mOD) (approx.)	Excavation levels (m OD)	Groundwater levels (approx.)	Drawdown Range (m)
Southern site area – attenuation pond	80 – 78	76.3	78 – 77	0.7-1.7
Southern site area – building incl. existing stream	82 - 78	78.5	81 - 78	0.0 – 2.5
Southern site area – diverted stream	~ 80	78.5 – 77.5	78 - 79	0.0 – 1.5
Central site area - building	80 - 77	76.8	77 - 75	0.0 – 0.2

Site area	Ground level (mOD) (approx.)	Excavation levels (m OD)	Groundwater levels (approx.)	Drawdown Range (m)
Eastern site area - building	77.5 - 74	75.3	77 – 75*	0.0 – 1.7

Notes: * - no groundwater monitoring data available. Groundwater levels assumed as per central site area.

4. Calculations

4.1 Zone of Influence

The cone of depression in the water table reduces logarithmically with increasing distance from the dewatered area with the most significant drawdown occurring closest to the excavation and reduction to a point of no drawdown at some distance away – the extent of this area is the zone of influence.

The EA Toolbox provides the Sichardt empirical method to estimate the Zone of Influence. While this is an empirical method has been found to be a reasonable estimate for cases where only limited drawdown is required.

For the purposes of this assessment the maximum required drawdown of 2.5m is adopted with the range of permeability values outlined in Table 1.

The results presented in Figure 1 show the zone of influence for the 2.5m excavation is limited to 7.23m with the average permeability but may range up to 26m at the higher range of the permeability values.

21) Radius of influence (Sichardt) $R_0 = C s \sqrt{K}$

Empirical equation based on drawdown and permeability

Essential input
Optional input
Calculated

		expected	min	max	
Drawdown in well	s	2.5 m	0	3	m
Hydraulic conductivity	K	####### m/s	1E-07	0.000012	m/s
		0.08035 m/d	0.00864	1.0368	m/d
Factor	C	3000	3000 for radial flow 1500-2000 for line flow to trenches or wellpoints		
Radius of influence	R_0	7.23 m	0.00	25.98	m

The following assumptions apply to this equation
- the aquifer is unconfined
- the aquifer has infinite areal extent
- the aquifer is homogeneous, isotropic and of uniform thickness
- flat initial water table
- the aquifer is pumped at a constant discharge rate
- the pumping well is fully penetrating, therefore receiving water from the entire saturated thickness of the aquifer
- the flow to the well is in a steady state

Data sources (to complete an audit trail)

Drawdown in well	s	Drawdown Required
Hydraulic conductivity	K	GSI Aquifer Parameters Handbook for Calp
Factor	C	Radial flow to drawdown sump

Index

4.2 Dewatering Rates

The analysis method adopted for the estimate of dewatering rates is “Partial penetration by a double row of well points of an unconfined aquifer midway between two equidistant and parallal line sources”.

The aquifer is considered to be unconfined and while the dewatering contractor may not choose to use wellpoints to dewater the site the solution provides a suitable estimate of inflow rates to an excavation area. The assumed aquifer thickness for the calculations is 15m, while the Lucan formation is much thicker there is a significant reduction in permeability with depth. The height of the water-table at the well is defined to achieve a suitable drawdown (2.5m) at the centre of the excavation (i.e. h_D should be at least 12.5m, providing 2.5m of drawdown throughout the excavation).

The dimensions of the excavation are based on the southern site area which has the greatest drawdown over the largest area.

The results of the analysis indicate a best estimate dewatering rate of approximately 23m^3/d for this area.

Similar calculations for each of the areas outlined in Table 2 result in the dewatering estimates outlined in Table 3. The total dewatering for all areas combined is 42m^3/d.

This is considered a very localised reduction in groundwater resources for the Dublin Groundwater Body. Based on the likely zone of influence any drawdown associated with these shallow excavations are expected to be indiscernible within a short distance of the site. On this basis the magnitude of the potential impact is considered **negligible.**

Table 3: Dewatering Estimates By Area

Site area	Drawdown Range (m)	Estimated Dewatering Rate (m3/d)
Southern site area – attenuation pond	0.7-1.7	7.0
Southern site area –building incl. existing stream	0.0 – 2.5	23.0
Southern site area – diverted stream	0.0 – 1.5	4.0
Central site area - building	0.0 – 0.2	1.0
Eastern site area - building	0.0 – 1.7	7.0
Total		42

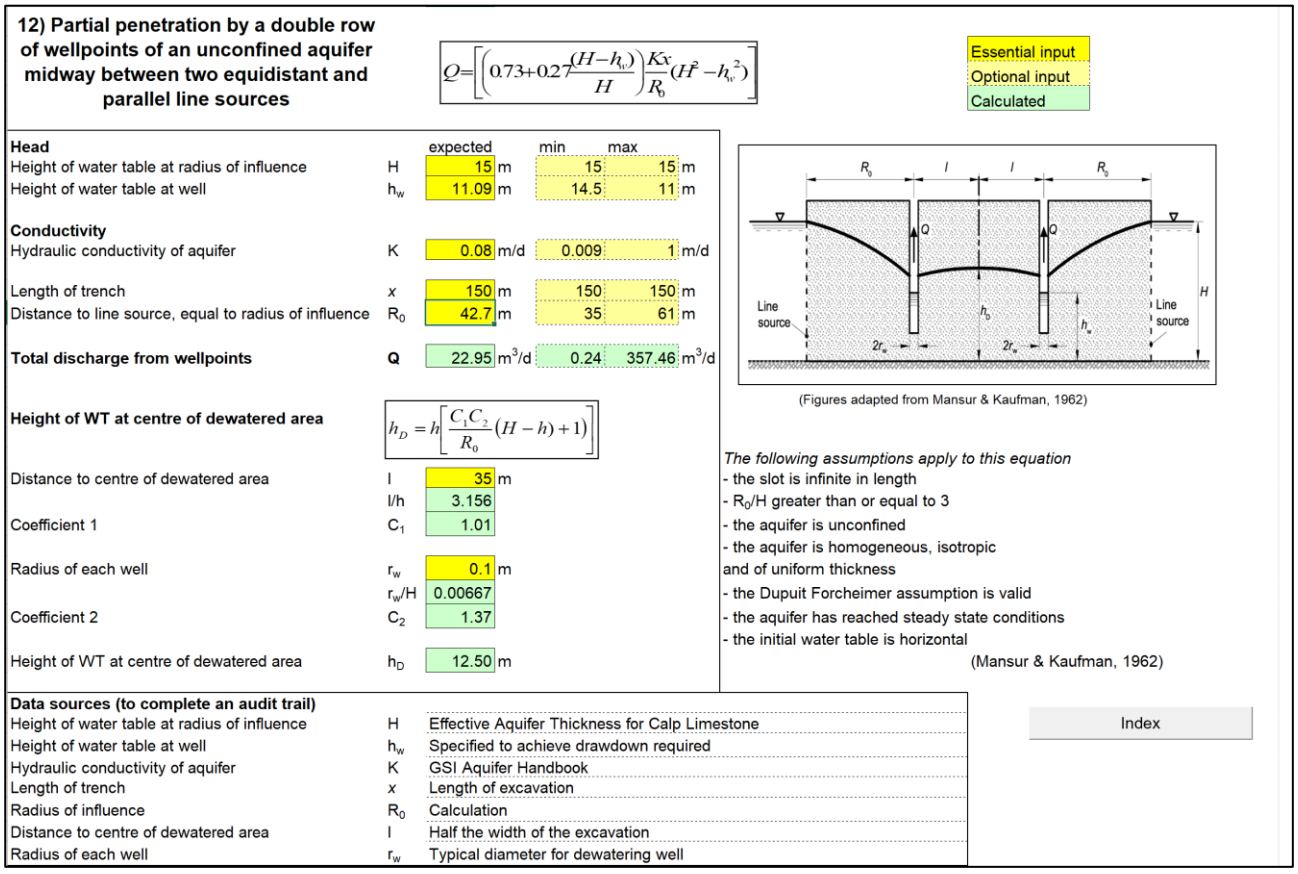


Figure 1: Dewatering Estimate for Southern area

DOCUMENT CHECKING

	Prepared by	Checked by	Approved by
Name	Gerry Baker		
Signature			

A.4 Geological Cross Sections

Attenuation Basin

Firewater Tank

DISTANCE ALONG BASELINE (m)

ELEVATION (mOD)

Surface Level 79.3m OD

Invert Level 76.3m OD

FGL at Tank 79.3m OD

Excavation level 74.5m OD

DCH FFL 80.02m OD

DCH formation level 79.72m OD (underside of slab)

DCH sub-formation level 79.42m OD (underside of sub-base material)

DCH founding level ranges between 78.42m OD and 77.67m OD (depending on depth and thickness of pad foundations)

EXISTING TOPOGRAPHY

SCALE 1:67V 1:2222H @ A3-L

RECEIVED: 28/06/

LEGEND

Hole offset is +ve to the RIGHT of the baseline

HoleID (Offset) N20*

SPT N value, * denotes N extrapolated by gINT: * from main blows ** from seating blows

Water strikes during boring / excavation

Time for reported water rise and flow rate remarks

20min. Steady flow

Level that water rose to

Level of water strike

Piezometer readings

Range of water levels recorded

Piezo response zone

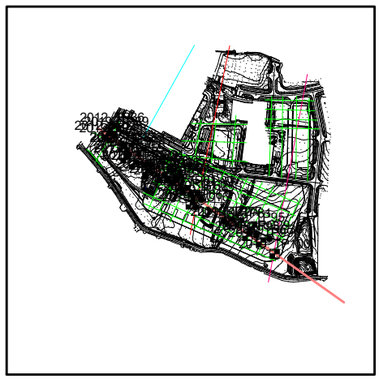
Tip depth

Type of piezometer

SPIE

Key to piezo types: SP Standpipe

PLAN



COLOUR LEGEND

- TOPSOIL [TOPSOIL]
- MADE GROUND [MG]
- DUBLIN BOULDER CLAY - SOFT TO FIRM [DBC-SOFT TO FIRM]
- DUBLIN BOLDER CLAY - FIRM TO STIFF [DBC-FIRM TO STIFF]
- WEATHERED LUCAN FORMATION [LUCAN-W]
- INTACT LUCAN FORMATION [LUCAN]
- NO RECOVERY [NR]

MATERIALS

- TOPSOIL
- Sandy gravelly CLAY
- Gravelly cobbly CLAY
- LIMESTONE
- Fill (MADE GROUND)
- NO RECOVERY

DC03
GEOLOGICAL CROSS SECTION

298479-00

FIGURE - 13.4.1

DISTANCE ALONG BASELINE (m)

600 550 500 450 400 350 300 250 200 150 100 50 0

ELEVATION (mOD)

82 81 80 79 78 77 76 75 74 73 72

DCH FFL 80.02m OD

DCH formation level 79.72m OD (underside of slab)

DCH sub-formation level 79.42m OD (underside of sub-base material)

DCH founding level ranges between 78.42m OD and 77.67m OD (depending on depth and thickness of pad foundations)

gCUB 1-5 FFL 76.8m OD

gCUB 1-5 sub-formation level 75.2m OD

2019_TP100 (-2.2)
2019_TP97 (-8.1)
2019_RC30 (-8.6)
2019_TP94 (-15.9)
2019_TP90 (-14.5)
2019_TP87 (7.0)
2019_TP85 (-9.8)
2019_TP36 (12.1)
2019_TP32 (15.4)
2019_TP33 (18.2)
2019_TP27 (8.4)
2019_TP28
2019_TP23 (1.0)

EXISTING TOPOGRAPHY

SCALE 1:56V 1:1667H @ A3-L

LEGEND

Hole offset is +ve to the RIGHT of the baseline

HoleID (Offset) N20*

SPT N value, * denotes N extrapolated by gINT:
* from main blows
** from seating blows

Water strikes during boring / excavation

Time for reported water rise and flow rate remarks

20min. Steady flow

Level that water rose to

Level of water strike

Piezometer readings

Range of water levels recorded

Piezo response zone

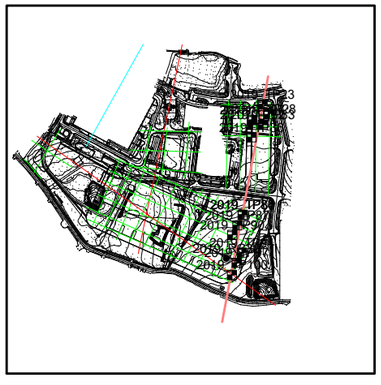
Tip depth

Type of piezometer

SPIE

Key to piezo types:

PLAN



COLOUR LEGEND

- TOPSOIL [TOPSOIL]
- DUBLIN BOULDER CLAY - SOFT TO FIRM [DBC-SOFT TO FIRM]
- DUBLIN BOLDER CLAY - FIRM TO STIFF [DBC-FIRM TO STIFF]
- INTACT LUCAN FORMATION [LUCAN]
- NO RECOVERY [NR]

MATERIALS

- NO RECOVERY
- LIMESTONE
- TOPSOIL
- Sandy gravelly CLAY

DC03
GEOLOGICAL CROSS SECTION

298479-00

FIGURE - 13.4.2

DISTANCE ALONG BASELINE (m)

ELEVATION (mOD)

DCH FFL 80.02m OD

DCH formation level 79.72m OD (underside of slab)

DCH sub-formation level 79.42m OD (underside of sub-base material)

DCH founding level ranges between 78.42m OD and 77.67m OD (depending on depth and thickness of pad foundations)

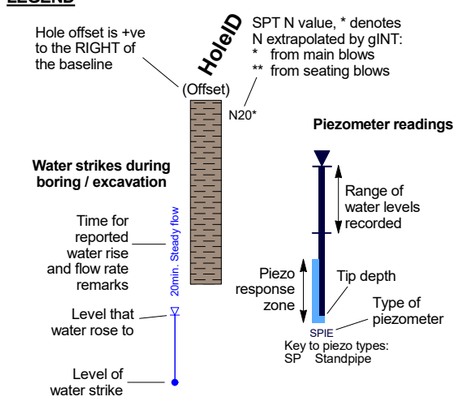
gCUB 6-8 FFL 78.1m OD

gCUB 6-8 sub-formation level 76.8m OD

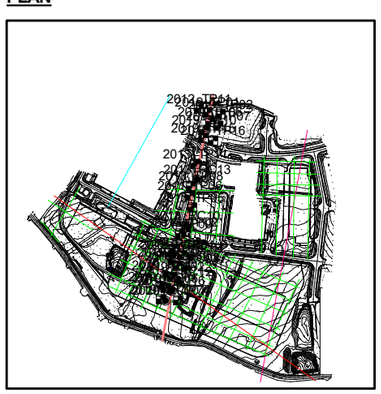
EXISTING TOPOGRAPHY

SCALE 1:78V 1:1528H @ A3-L

LEGEND



PLAN



COLOUR LEGEND

- TOPSOIL [TOPSOIL]
- MADE GROUND [MG]
- DUBLIN BOULDER CLAY - SOFT TO FIRM [DBC-SOFT TO FIRM]
- DUBLIN BOLDER CLAY - FIRM TO STIFF [DBC-FIRM TO STIFF]
- WEATHERED LUCAN FORMATION [LUCAN-W]
- INTACT LUCAN FORMATION [LUCAN]
- NO RECOVERY [NR]

MATERIALS

- TOPSOIL
- Fill (MADE GROUND)
- Sandy gravelly CLAY
- Gravelly cobbly CLAY
- LIMESTONE
- NO RECOVERY

DC03
GEOLOGICAL CROSS SECTION

298479-00

FIGURE - 13.4.3

A.5 Land Contamination Assessments

Technical Note

Project title	Data Centre Development DC3
Job number	298479
File reference	4-04-04
cc	
Prepared by	Jack Walton/Agnieszka Lopez-Parodi
Date	17 May 2024
Subject	Geoenvironmental Assessment

4 Pierhead Street Capital Waterside Cardiff CF10 4QP United Kingdom t +44 29 2047 3727

arup.com

1. Introduction

As part of the proposed data centre expansion, it is proposed to construct a new data storage facility with associated offices, infrastructure and ancillary buildings. This technical note undertakes a review of available information pertaining to the proposed development site with respect to land contamination and presents geoenvironmental assessments aiming to identify potential risks to the proposed development and provide recommendations for further action.

1.1 Proposed Development

The proposed development at the site includes the following construction activities:

- Site clearance and earthworks to construct the development platform. This will require excavation up to approximately 4m bgl across the majority of the site. There may be an opportunity to reuse excavated crushed rock and natural soils as Class 1 and 2 fill materials in the areas of structures or infrastructure.
- Removal of the majority of made ground within the proposed development site area. At this stage it is assumed that all excavated made ground as well as topsoil will require off-site disposal.
- Realignment of a watercourse currently crossing the central part of the site around southern and eastern site boundary in an open channel.
- Construction of shallow foundations comprising pads.
- Construction of an attenuation pond.
- Landscaping and planting.

2. The Site

2.1 Site Location and Description

The site is located on the outskirts of Dublin (approximately 13km southwest of the city centre) and is centred on National Grid Reference (NGR) O 03397 30297. The site is part of the Google Data Centre Campus bounded by the Baldonnel Road to the south, the Digital Realty Profile Park to the east and the existing DC1 and DC2 to the north.

The site is located within an area of mixed industrial and agricultural land. The southwest of the site is currently utilised as an area for car parking (associated with the DC1 and DC2 developments).

The east of the site is currently undeveloped greenspace.

The topography of the site falls towards the north, lying around 75mAOD and rising to 85mAOD in the south. The present DC1 and DC2 buildings have been constructed on flat platforms. Five stockpiles are located onsite, see Section 4.1.1 for more details.

A small watercourse bisects the southern site area, running downslope in a south to north direction, eventually converging with the Griffen River to the north.

2.2 Site History

The history of the site and pertinent details for the surrounding areas have been summarised in Table 1 from available historical OS mapping[1] as well as historical aerial photographs[2].

Table 1: Proposed development site history review

Date	Mapping Observations (Onsite)	Mapping Observations (Surrounding Area)
1837-1842 (1:10,500)	• The site is mapped as agricultural land.	• Very little development within the surrounding area. • Bagot castle is mapped approximately 300m to the southwest. • A quarry is located approximately 250m southwest of the site. • A further castle (Kilbride castle) is mapped 100m to the east.
1897-1913 (1:25,000)	• No significant changes.	• The quarry (250m southwest) is no longer mapped.
1937 (1:10,560)	• No significant changes.	• Baldonnel Aerodrome and Military Camp is mapped approximately 1km south of the site. • A sewage works is mapped approximately 450m to the east of the site.
1995 (Aerial Imagery)	• No significant changes.	• Noticeable residential development along Baldonnel Road, bordering the site to the south. • Industrial activity mapped 250m north of the site. • Development of the military aerodrome camp to the south (approximately 400m southeast).
2000 (Aerial Imagery)	• No significant changes.	• A golf course is mapped 500m to the east of the site. • Industrial development related to the area north of the site (250m) and aerodrome to the southeast (400m) appear to be complete.
2005 (Aerial Imagery)	• No significant changes.	• No significant changes.

[1] Government of Ireland and Tailte Eireann (GoI & TE). 2024. National Geospacial Data Hub, GeoHive Hub, [online] Available at: http://map.geohive.ie/mapviewer.html

[2] Google Maps. 2024. Google Maps. [Online] Available from http://www.google.com/maps/

Date	Mapping Observations (Onsite)	Mapping Observations (Surrounding Area)
2009 (Aerial Imagery)	• Topsoil has appeared to be stripped from parts of the site. • A temporary access construction road ran through the centre of the site in a south- north direction, connection to Baldonnel Road to the south. • A spoil heap is present in the southeastern corner of the site and appears to be related to the development of the DC1 site immediately north.	• The DC1 data centre campus directly adjacent to the site was in development, with one structure complete. • Infrastructure relating to the DC1 development had been constructed to the north, including a connecting road. • The existing golf course in the east (approximately 500m) began expansion.
2012 (Aerial Imagery)	• Several containers are pictured adjacent to the temporary access road in the centre of the site.	• A temporary parking area and storage yard is located next to the DC1 development bordering the site to the north. • Construction of the Digital Realty Profile Park began (approximately 100m to the east).
2013 (Aerial Imagery)	• No significant changes.	• The temporary parking area and storage yard to the west of DC1 has been removed.
2016 (Aerial Imagery)	• Topsoil has been stripped within the western area of the site in order to construct a compound. The site appears to be surfaced with gravel.	• The DC2 Campus to the north has been constructed and associated infrastructure developed (e.g. access road).
2019 (Aerial Imagery)	• The centre of the site has been developed into a parking lot. • The western area appears to be utilised as a storage compound with stockpiled topsoil generated during clearance depicted. • Temporary roads connect the parking lot and storage compound to the local road. • Stockpiled material (likely topsoil from previous developments) is evident in the eastern section of the site.	• The surrounding area saw significant industrial development, specifically to the north (approximately 500m). • The construction of the DC2 development (immediately north) and Digital Realty Profile Park (100m east) have been completed. • Construction of the CyrusOne Dublin I building (approximately 200m northwest) and Bennet DUB79 (approximately 370m northwest) began.
2022 (Aerial Imagery)	• No significant changes.	• The construction of the CyrusOne Dublin I building appears to be complete (approximately 200m northwest). • A substation (Castlebagot) is depicted approximately 150m to the northwest. • Construction of the Bennet DUB79 building continues (approximately 270m northwest).

3. Ground Conditions

3.1 Published Geology

3.1.1 Superficial Deposits

Teagasc soil mapping[3] has identified the soils underlying the proposed development site as till derived from Limestones, poorly drained subsoils with areas of well drained soils.

3.1.2 Bedrock

GSI bedrock mapping indicates that the proposed development as well as the wider region, is underlain by the Upper Carboniferous Limestone, known as the Lucan formation. There are no geological faults mapped within the proposed development area.

3.2 Hydrogeology

The GSI classifies the Lucan Formation bedrock as a Locally Important Aquifer. This is described as "capable of 'good' well yields 100-400m^3/d (1,000-4,000 gph). Aquifer vulnerability for the site ranges from high in the north-east of the site to extreme vulnerability in the remainder of the site.

The closest groundwater abstraction is located approximately 3km southeast of the site. It is uncertain if the wells remain in operation as the wells were drilled in 1962 and 1899.

4. Ground Investigations

A number of ground investigations were previously undertaken in the area of the proposed development between 2011 and 2019, as detailed in Table 2. The ground investigations covered the proposed development site, but also a wider area associated with the present data centres (DC1 and DC2) to the north and northwest. The locations are presented on **Figure 1**. A supplementary project specific investigation is currently ongoing. The investigation commenced on 27 March 2024. No preliminary data is currently available for inclusion within the assessments.

Table 2: Summary of completed geotechnical ground investigations

Contractor	Year	Factual Report	Scope within Proposed Development	Scope outside Proposed Development
Glover Site Investigations Ltd	2011	Report No. 11-089 Rev A	2No trial pits; 2No rotary boreholes 1No groundwater monitoring installation In-situ geotechnical testing and infiltration tests Laboratory geotechnical and geo-environmental soil testing	9No trial pits ; 1No rotary boreholes; 4No dynamic probes; In-situ geotechnical testing and infiltration tests Laboratory geotechnical and geo-environmental soil testing
IGSL Ltd	2012	Report No. 16419	17No trial pits; 4No dynamic probes; In-situ geotechnical testing and infiltration tests Laboratory geotechnical and geo-environmental soil testing	27No trial pits; 8No dynamic probes; In-situ geotechnical testing and infiltration tests Laboratory geotechnical and geo-environmental soil testing

[3] Environment Protection Agency (EPA). 2024. EPA Maps. [Online] Available from https://gis.epa.ie/EPAMaps/

Contractor	Year	Factual Report	Scope within Proposed Development	Scope outside Proposed Development
IGSL Ltd	2013	Report No. 17136	8No trial pits; 3No rotary boreholes; 5No dynamic probes 2No groundwater monitoring installations In-situ geotechnical testing Laboratory geotechnical and geo-environmental soil testing	12No trial pits; 9No rotary boreholes; 9No dynamic probes 2No groundwater monitoring installations In-situ geotechnical testing Laboratory geotechnical and geo-environmental soil testing
IGSL Ltd	2019	Report No. 22000	44No trial pits; 24No rotary boreholes; 52No dynamic probes; 8No groundwater monitoring installations In-situ geotechnical testing and infiltration tests Laboratory geotechnical and geo-environmental soil testing (including WAC)	66No trial pits; 6No rotary boreholes; 7No dynamic probes; In-situ geotechnical testing and infiltration tests Laboratory geotechnical and geo-environmental soil testing (including WAC)
Causeway Geotech Limited	2024	Ongoing	23No. trial pits 18No. Geobore-S boreholes 16No. dynamic probes 8No. groundwater monitoring installations 8No. in-situ plate load tests 8No. in-situ thermal resistivity tests 2No. in-situ infiltration tests Laboratory geotechnical testing (soil and rock) Geoenvironmental testing (soil and groundwater)	N/A

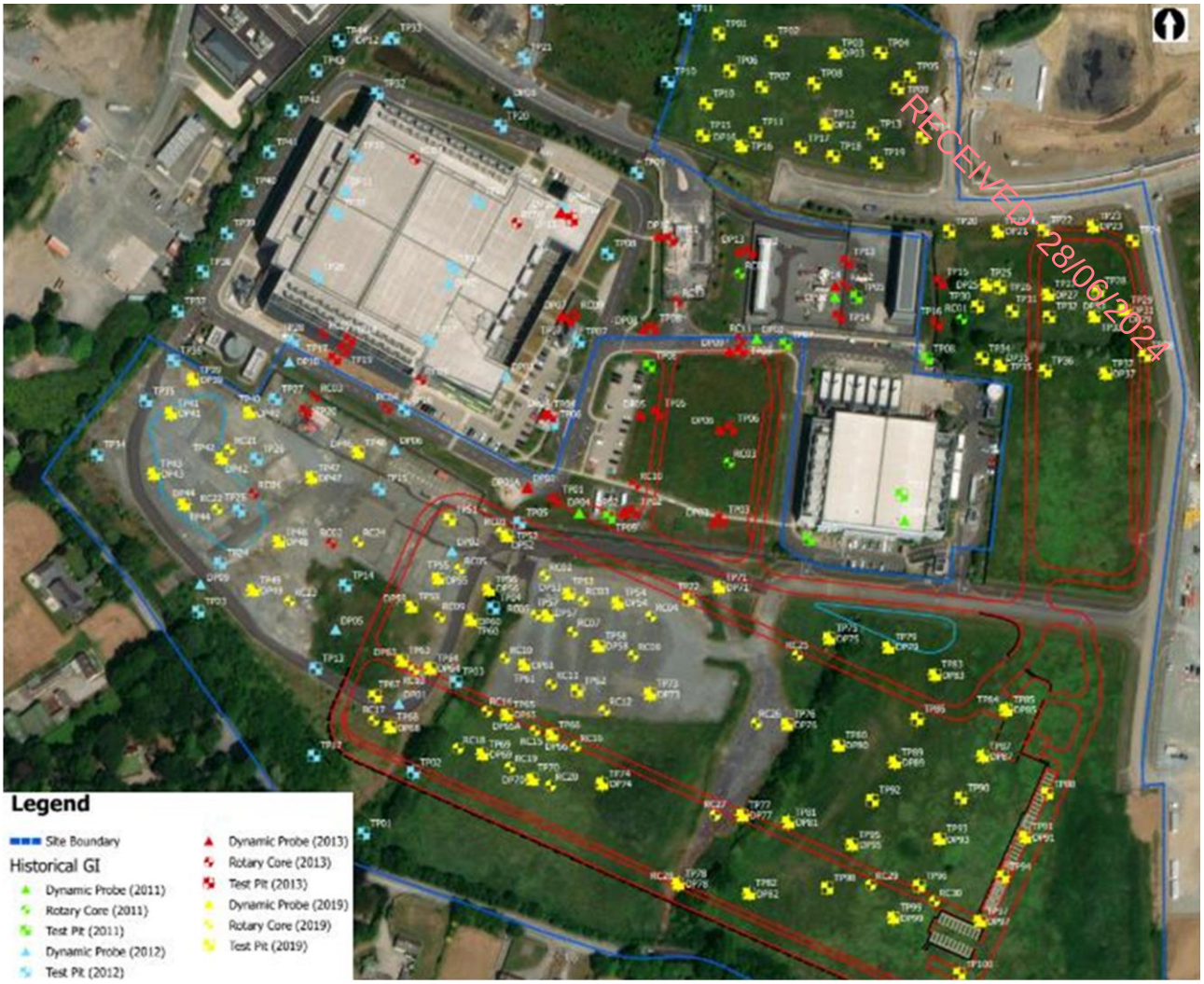


Figure 1: Completed Ground Investigations

4.1 Encountered ground Conditions

4.1.1 Superficial Deposits

The proposed development site was found to be underlain by glacial till deposits. These deposits were described as soft to firm grey and brown sandy gravelly clay and firm to stiff greyish brown slightly sandy and very gravelly clay. The thickness of the glacial till varied from 1.2m to 4.2 m (approx. 78 m OD to 81 m OD).

The investigations also encountered topsoil and made ground at surface. Made ground comprised aggregate type materials in the existing car parking areas underlain by a white geotextile separator layer in the central extent of the proposed development site and reworked glacial till with anthropogenic inclusions (including wire, wood, plastic sheeting and rebar) in the western extent of the proposed development. Up to 0.8m of made ground was encountered. The extent of encountered made ground materials is marked on Figure 2.

Five stockpiles have been identified on site with heights recorded up to 4m. Their locations are marked on Figure 2. No ground investigations have been completed within the stockpiles, however based on aerial photography review (as presented in Table 1), it is anticipated that these stockpiles contain topsoil/subsoils removed as a result of construction of the existing storage/car parking areas in the western and central site areas.

Figure 2: Areas of made ground materials based on aerial photography and completed ground investigations, identified stockpiles.

4.1.2 Bedrock

The completed ground investigations encountered medium to very strong, medium to thinly bedded grey black fine-grained argillaceous or calci-siltite Limestone with interbedded weak Mudstone with a rockhead at between 3-4m bgl (71.2 to 78.4 mOD, thickness unproven).

4.1.3 Stratigraphy

A summary of the stratigraphy encountered during the historical ground investigations is presented in Table 3 below.

Table 3: Summary of stratigraphical profile

Strata	General Extent/Location	Depth to Top of Strata, (m OD)	Thickness Range (m)	Notes/Description
Topsoil	Eastern and Central site extent	75.5 to 79.9	0.3 to 0.4	Soft brown slightly sandy slightly gravelly CLAY. Sand is fine to medium.
Made Ground	Western and Central extent	78.0 to 81.3	0.1 to 0.8	Typical description: Compact grey sandy GRAVEL with a low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse. Central Extent: Presence of a white geotextile sheeting underlying. Western Extent: Fragments of wire, wood, plastic or rebar found locally with trial pits.

Strata	General Extent/Location	Depth to Top of Strata, (m OD)	Thickness Range (m)	Notes/Description
Glacial Till (Dublin Boulder Clay)	Widespread	75.1 to 80.8	1.2 to 4.2	Soft to Firm grey, brown sandy gravelly CLAY with a low cobble content. Firm to stiff greyish brown slightly sandy very gravelly silty CLAY with a low to medium cobble content with occasional boulder content.
Lucan Formation	Widespread	71.2 to 78.4	Unproven	Medium to very strong, medium to thinly bedded grey black, fine-grained, argillaceous, or calci-siltite LIMESTONE with interbedded weak MUDSTONE.

4.2 Groundwater

During the previous ground investigations, groundwater was encountered within the Glacial Till (Dublin Boulder Clay) and Lucan Formation between 1.5mbgl to 4.8mbgl. Rapid groundwater flow was recorded within the western boundary of the site between a depth of 1.6 to 2.7mbgl (2012 – TP22, 34, 36, 39, 43 and 44). Monitored groundwater levels within the Lucan Formation ranged from 80.7m OD to 73.5m OD across the proposed development.

It is anticipated that groundwater flow will be in line with the general topography gradient towards the north. Locally, the groundwater is likely to discharge into the surface watercourses, located within the site (unnamed stream) and the tributaries to the Griffeen River, located approximately 75m to the east and 200m north away from the site boundary.

4.3 Geoenvironmental Testing

The chemical soil and groundwater testing was undertaken as part of the completed ground investigations within the site as summarised in Table 4 and Table 5 below.

Table 4: Summary of completed chemical soil testing

Contra ctor	Year	Tested materials	Number of soil samples tested (MG & Nat ground)							
			Metals	Asbestos	PAHs	VOCs	PCBs	Pesticides	TPH	WAC
Glover Site Investig ations Ltd	2011	MG	4	4	4	4	4	4	4	-
		Nat	6	6	6	6	6	6	6	_
IGSL Ltd	2012	MG	No testing							
		Nat	-	-	4	-	4	-	4	4
IGSL Ltd	2013	MG	No testing							
		Nat	2	2	2	-	2	2	2	-
IGSL Ltd	2019	MG	7	7	7	-	7	-	7	-
		Nat	4	4	4	-	4	-	4	-

Table 5: Summary of completed chemical groundwater testing

Contractor	Year	Number of groundwater samples tested					
		Metals	PAHs	General parameters	Pesticides	TPH	Major Ions
Glover Site Investigations Ltd	2011	No groundwater testing undertaken					
IGSL Ltd	2012	2	2	-	2	2	2
IGSL Ltd	2013	2	-	2	-	2	2
IGSL Ltd	2019	No groundwater testing undertaken					

5. Conceptual Site Model

The land contamination risks assessments have been undertaken in line with the EPA 'Guidance On The Management Of Contaminated Land And Groundwater At EPA Licensed Sites'[4]. Although the proposed development site is not a licenced site, the assessment framework stipulated by the EPA guidance has been broadly applied to identify potential risks to the proposed development from land contamination.

The following section details the Conceptual Site Model (CSM), which underpins the risk assessment process and aims to identify any potential pollutant linkages requiring assessment. The CSM describes the potential sources of contamination at a site, the migration pathways it may follow and the receptors it could impact upon. Potential receptors to land and groundwater contamination might include (but are not exclusive to) humans, water resources, groundwater/surface water dependent ecosystems and living organisms. If complete source– pathway–receptor scenarios exist, then there is a potential pollutant linkage that needs to be characterised and assessed.

Sources, pathways and receptors have been identified based on all available information, including information obtained during ground investigations completed within the site (as outlined in Section 4). The CSM considers construction and operational phases of the proposed development as outlined in Section 5.4.

5.1 Potential Sources of Contamination

Potential sources of contamination are summarised in Table 6.

Table 6: Potential sources of contamination

Potential sources of contamination	Potential contaminants	Information
On-site:		
S1: Made Ground	Asbestos, TPHs, PAHs, general inorganics (including metals).	Completed GI encountered Made Ground within the proposed development area. Made Ground comprised imported materials to develop the existing car parking areas or was recorded containing anthropogenic inclusions of wire, wood, plastic sheeting etc. It is anticipated that the vast majority of the made ground will be removed as a result of the earthworks. Five stockpiles are present within the site, thought to contain topsoil and subsoil tripped from the site.
	Ground gas	Made Ground is considered a potential source of ground gas. The Made Ground encountered during the completed GI was recorded to relatively shallow depths (up to 0.8m thick). Descriptions of the encountered Made Ground (Section 4) do not identify organic materials or inclusions. Therefore, Made Ground is anticipated to have a very low gas generation potential. Refer to Section 6.3 for a ground gas risk assessment.

[4] EPA, Office of Environmental Enforcement, Guidance On The Management Of Contaminated Land And Groundwater At EPA Licensed Sites, EPA, 2013

Potential sources of contamination	Potential contaminants	Information
Off-site:		
S2: IEL activities including data centres, pharmaceutical companies and an electrical substation (Grange Castle Business Park)	TPHs, PAHs, general inorganics (including metals), solvents, PCBs.	Activities associated with the operation of the existing data centres (DC1 and DC2) are regulated by the IEL and therefore unlikely to result in significant contamination. In addition, these activities are located to the north of the proposed development and therefore hydraulically downgradient. Consequently, the existing data centres are unlikely to pose a risk with respect to land contamination.
S3: Baldonnel Aerodrome (airport)	TPHs, PAHs, solvents, pesticides, herbicides,	The airport has been active since 1917. Its use (including refuelling aircraft/vehicles or extinguishing of potential fires etc.) may have resulted in contamination of groundwater with hydrocarbons and PFAS/PFOA. Completed GI indicates groundwater flows towards the north, in line with
	PCBs, PFAS and PFOA.	a general regional groundwater flow towards the Liffey River. Therefore, there is a potential for contamination migration towards the site so that groundwater beneath the site may be impacted by this contamination.
S4: EPA waste licensed activity	TPHs, PAHs.	The licence was for import of waste soils and other construction waste for the development of the golf course. Waste placement activity regulated by EPA licence and therefore unlikely to have resulted in contamination of groundwater. Therefore, it is unlikely to constitute a potential risk of contamination with respect to the proposed development.
S5: Belgard Quarry	TPHs, PAHs, Solvents.	The quarry, located 2.3km southeast away from the site, has been operational since the 1970s. Dewatering activities and substantial distance to the site, are likely to have reduced the risk of offsite migration of contamination associated with the quarrying activities. Therefore, it is unlikely to constitute a potential risk of contamination with respect to the proposed development.
S6: Trade waste discharge (water)	TPHs, PAHs, Solvents.	The discharge under the Section 4 discharge licence is likely to have been incorporated into the current IEL licence for the existing site. Consequently, unlikely to constitute a potential risk of contamination with respect to the proposed development.

5.2 Receptors

Potential human health and environmental receptors of contamination are listed below:

5.2.1 Human Health Receptors

- **R1**: Construction workers.
- **R2**: Future maintenance workers or ground workers.
- **R3**: Future site end users (e.g. data centre employees).
- **R4**: Site neighbours including residential properties to the south-west and industrial/commercial workers to the north and east.

5.2.2 Environmental Receptors

- **R5**: Surface waters including the unnamed stream (onsite) and the Griffeen River and its tributaries (the nearest located approximately 75m to the east).
- **R6**: Groundwater within the Lucan Formation (locally important aquifer).
- **R7**: Property (e.g. buildings and foundations), buried services and other below ground structures.

5.3 Pathways

Potential human health pathways present at the site that could link the sources and receptors are listed below:

5.3.1 Pathways to Human Health Receptors

- **P1**: Ingestion of contaminated soils/dusts/groundwater.
- **P2**: Inhalation of contaminated soils/dusts/fibres/groundwater.
- **P3**: Dermal contact with contaminated soils/dusts/groundwater.
- **P4**: Inhalation of ground gas.

5.3.2 Pathways to Environmental Receptors

- **P5**: Leaching of contaminants from Made Ground into the underlying groundwater.
- **P6**: Leaching of contaminants from Made Ground and subsequent lateral/vertical migration of contaminants.
- **P7**: Vertical flow along preferential pathways introduced during development (foundations, monitoring wells etc.).
- **P8**: Surface runoff into, and transportation along existing watercourses/streams.
- **P9**: Direct contact with contaminants.
- **P10**: Discharge during construction (subject to implemented groundwater control and management during earthworks)
- **P11**: Discharge during operation

5.4 Potential Pollutant Linkages

Based on all available information and identified potential sources – pathways and receptors, the following initial CSM has been produced, which identifies the potential pollutant linkages (PPL) (as presented in Table 7).

Table 7: Initial Conceptual Site Model

PPL	Potential Sources	Potential Pathways	Potential Receptors	Comments
Construction Phase				
1	S1: Made Ground identified at the site. S3: Baldonnel Aerodrome.	P1-P4: Dermal contact, ingestion and inhalation of soils, dusts/fibres and groundwater, and inhalation of ground gas.	R1: Construction workers.	Construction workers are likely to have a direct contact with made ground materials and groundwater during construction. Construction of the proposed development is unlikely to result in creation of confined spaces where ground gas could potentially accumulate and the made ground is anticipated to have a limited gas generation potential, with majority of the made ground removed off site.
2	S1: Made Ground identified at the site.	P2: Inhalation of dusts/fibres.	R4: Site neighbours.	The proposed earthworks may result in dust generation, which may migrate off-site. Site neighbours may be exposed to contaminants and fibres. Risk to site neighbours could be managed through good practice dust control during construction.
3	Groundwater impacted by S1: Made Ground identified at the site. S3: Baldonnel Aerodrome.	P10: Discharge to ground or surface water	R5: Surface waters R6: Groundwater	The proposed earthworks may require groundwater control.

PPL	Potential Sources	Potential Pathways	Potential Receptors	Comments
Operational Phase				
4	S1: Made Ground identified at the site.	P1-P4: Dermal contact, ingestion and inhalation of soils, dusts/fibres and groundwater, and inhalation of ground gas.	R2: Future maintenance workers.	Majority of the Made Ground will be removed during construction and thus removing the primary potential source of contamination post development. Limited areas of Made Ground may remain in-situ within the footprint of the proposed building and in the proposed landscaped area between the proposed building and the proposed attenuation pond. The encountered Made Ground is unlikely to constitute a growing medium and therefore would either need to be removed or covered by suitable materials in the areas of landscaping. This could practically remove the potential source/pathway.
5	S1: Made Ground identified at the site.	P1-P4: Dermal contact, ingestion and inhalation of soils, dusts/fibres, and inhalation of ground gas.	R3: Site end users.	There is a potential for end site users to be exposed to soils in areas of landscaping. Ground gas may migrate into buildings and accumulate in unventilated spaces. Majority of the Made Ground will be removed during construction and thus practically removing the primary potential source of contamination post development. Limited areas of Made Ground may remain in-situ within the footprint of the proposed building and in the proposed landscaped area between the proposed building and the proposed attenuation pond. The encountered Made Ground is unlikely to constitute a growing medium and therefore would either need to be removed or covered by suitable materials in the areas of landscaping. This could practically remove the potential pathway. In accordance with the waste management regulations only natural or uncontaminated materials are considered suitable for reuse within the scheme. Should the contractor take an opportunity to reuse made ground materials, the reuse would be subject to an environmental permit. Limited area of Made Ground may remain in-situ near the existing stream, which is within the footprint of the proposed building with the potential for ground gas generation. The completed investigations encountered up to 0.35m of Made Ground in that site area, which is unlikely to constitute a significant gas generation source. Therefore, no further assessments are required.

PPL	Potential Sources	Potential Pathways	Potential Receptors	Comments
6	S1: Made Ground identified at the site.	P6 & P8: Leaching of contaminants from Made Ground and subsequent lateral/vertical migration and surface runoff.	R5: Surface waters	Majority of the Made Ground will be removed during construction and thus practically removing the primary potential source of contamination post development. Limited areas of Made Ground may remain in-situ within the proposed landscaped area, located between the proposed building and the proposed attenuation pond. The encountered Made Ground is unlikely to constitute a growing medium and therefore would either need to be removed or covered by suitable materials in the areas of landscaping. The underlying glacial till materials have been found to comprise cohesive materials of relatively low permeability (1.7x 10^{-5}m/s to 1.7 x 10^{-6}m/s[5]), which is likely to limit infiltration of potential contaminated soil leachate into the underlying aquifer or lateral flows into the surface water. Evapotranspiration processes within the vegetated zone would further limit rainwater infiltration and consequently potential leachate generation. In accordance with the waste management regulations only natural or uncontaminated materials are considered suitable for reuse within the scheme. Should the contractor take an opportunity to reuse made ground materials, the reuse would be subject to an environmental permit. It is proposed to divert the stream running through the centre of the site in an open channel around the southern and eastern periphery of the proposed development site. There is unlikely to be a pathway to surface waters post development. No Made Ground was encountered in that part of the site and the stockpiles will be removed, thus there are no identified sources within the proposed stream vicinity.
7	S1: Made Ground identified at the site.	P5 & P7: Leaching of contaminants from Made Ground into the underlying groundwater or vertical flow along preferential pathways	R6: Groundwater	As discussed above, the potential for contaminants leaching and migration towards the aquifer is low.
8	S1: Made Ground identified at the site.	P9: Direct contact with contaminants.	R7: Property	There is a risk of chemical attack on buried concrete from both made and natural ground.
9	Groundwater impacted by S1: Made Ground identified at the site. S3: Baldonnel Aerodrome.	P11: Discharge to surface water	R5: Surface waters	The proposed development may require permanent groundwater control measures beneath the buildings. The drainage proposals are likely to include a drainage blanket discharging into the infilled stream channel with collected groundwater discharging into the diverted stream, essentially maintaining the current hydrogeological regime on site.

[5] IGSL Lts, PPK3a Profile Park, Geotechnical Interpretive Report, Project No 22000, November 2019.

6. Preliminary Risk Assessment

The purpose of this section is to determine whether the risk associated with the proposed works are acceptable and if any mitigation measures need to be employed during construction works.

The following method of risk assessment is a qualitative method of interpreting the potential pollutant linkages (PPLs) identified in the CSM (Section 5), based on the UK guidance on contaminated land risk assessment[6]. Table 8 provides the preliminary risk assessment PRA for the site, in line with the risk assessment process set out by the EPA guidance[7].

[6]Construction Industry Research and Information Association (CIRIA), Contaminated land risk assessment A guide to good practice Ciria 552, January 2001

[7] EPA, Office of Environmental Enforcement, Guidance On The Management Of Contaminated Land And Groundwater At EPA Licensed Sites, EPA, 2013

Table 8: Preliminary risk assessment

PPL	Potential Source	Potential Pathway	Potential Receptor	Probability	Consequence	Pre-Mitigation Risk	Proposed Mitigation / Commentary	Further Assessment?
Construction works								
1	S1: Made Ground identified at the site. S3: Baldonnel Aerodrome.	P1-P4: Dermal contact, ingestion and inhalation of soils, dusts/fibres and groundwater, and inhalation of ground gas.	R1: Construction workers.	Likely	Medium	**Moderate**	Assessment of soil quality is needed to confirm the risks particularly with respect to the presence of asbestos in the soils. Risks to construction workers will be managed through health and safety legislation. Construction contractor to receive and review available information and undertake their own risk assessments.	Yes
2	S1: Made Ground identified at the site.	P2: Inhalation of dusts/fibres.	R4: Site neighbours.	Likely	Medium	**Moderate**	Assessment of soil quality needed to inform the level of measures required for the works particularly with respect to the presence of asbestos in the soils.	Yes
3	Groundwater impacted by S1: Made Ground identified at the site. S3: Baldonnel Aerodrome.	P9: Discharge to surface water	R5: Surface waters	Likely	Mild	**Moderate/ Low**	The removed water will require discharge/disposal, which will be subject to pollution control measures set out in the Construction Environmental Management Plan. If groundwater is found to be contaminated, treatment may be required prior to discharge. This will be managed by the contractor during construction. Discharge to ground is unlikely to be feasible due to high groundwater levels. Assessment of groundwater quality is needed to confirm the risks and selection of discharge options.	Yes

PPL	Potential Source	Potential Pathway	Potential Receptor	Probability	Consequence	Pre-Mitigation Risk	Proposed Mitigation / Commentary	Further Assessment?
Operational phase								
4	S1: Made Ground identified at the site.	P1-P4: Dermal contact, ingestion and inhalation of soils, dusts/fibres and groundwater, and inhalation of ground gas.	R2: Future maintenance workers.	Low likelihood	Medium	**Moderate/ Low**	Risks to maintenance workers will be managed through health and safety legislation. Site management to receive and review available information and undertake their own risk assessments. Assessment of soil quality is needed to confirm the risks particularly with respect to the presence of asbestos in the soils.	Yes
5	S1: Made Ground identified at the site.	P1-P4: Dermal contact, ingestion and inhalation of soils, dusts/fibres, and inhalation of ground gas.	R3: Site end users.	Low likelihood	Medium	**Moderate/ Low**	Assessment of soil quality is needed to confirm the risks particularly with respect to the presence of asbestos in the soils. Ground gas generation potential on site is considered to be low and therefore risk associated with ground gas is considered to be very low. Therefore, no further assessments are required.	Yes
6	S1: Made Ground identified at the site.	P5 & P7: Leaching of contaminants from Made Ground and subsequent lateral/vertical migration and surface runoff.	R5: Surface waters	Unlikely	Medium	**Low**	It is proposed to divert the stream running through the centre of the site in an open channel around the southern and eastern periphery of the proposed development site. There is unlikely to be a pathway to surface waters post development. No Made Ground was encountered in that part of the site and the stockpiles will be removed, thus there are no identified sources within the proposed stream vicinity.	No

PPL	Potential Source	Potential Pathway	Potential Receptor	Probability	Consequence	Pre-Mitigation Risk	Proposed Mitigation / Commentary	Further Assessment?
7	S1: Made Ground identified at the site.	P4 & P6: Leaching of contaminants from Made Ground into the underlying groundwater or vertical flow along preferential pathways	R6: Groundwater	Unlikely	Medium	**Low**	On account of removal of majority of made ground and due to the presence of cohesive subsoils where made ground would remain, the potential for contaminants leaching and migration towards the aquifer is low. The groundwater installations no longer needed for monitoring will require appropriate decommissioning prior to construction works.	No
8	S1: Made Ground identified at the site.	P8: Direct contact with contaminants.	R7: Property	Likely	Mild	**Moderate/ Low**	Sulphate testing is required to assess the potential for chemical attack to the proposed development post construction. The assessment of chemical attack on buried concrete will be undertaken as part of the geotechnical design.	Yes
9	Groundwater impacted by S1: Made Ground identified at the site. S3: Baldonnel Aerodrome.	P9: Discharge to surface water	R5: Surface waters	Likely	Medium	**Moderate**	The removed water will be collected through a new drainage system and discharged into the diverted stream. This will be incorporated into the current licence. Assessment of groundwater quality is needed to confirm the risks.	Yes

7. Land contamination risk assessments

7.1 Human Health Risk Assessment

The PRA has identified the following PPL requiring further assessment:

- PPL 1 – risk to construction workers from soils, dust and fibres generated during earthworks
- PPL 2 – risk to site neighbours from dust and fibres generated during earthworks
- PPL 4 – risk to future maintenance workers from soils, dust and fibres generated during intrusive maintenance works
- PPL 5 – risk to site end users from made ground potentially remaining within the proposed development (not removed through earthworks)

The identified potential linkages are associated with potential risks to human health. The initial risk assessment considers available soil testing results obtained during completed ground investigations, as listed in Table 2.

The identified human health receptors include:

- Construction workers during construction.
- Site neighbours during construction. Site neighbours include primarily commercial premises, but some residential properties are present directly to the south of the proposed development.
- Site end users (data centre employees) during operation.
- Maintenance workers during operation.

7.1.1 Methodology

To assess ground contamination risk to the users of the proposed development site, UK derived Generic Assessment Criteria (GAC) for the initial screening of contamination testing results with respect to human health have been utilised (in the absence of Ireland or EU assessment criteria). Based on the proposed development, the most appropriate soil screening criteria for the protection of human health are considered to be current published GAC for a residential end use (site neighbours, commercial workers and maintenance workers) and commercial end use (site neighbours and end users):

- The Category 4 Screening Levels (C4SLs).
- The Land Quality Management Suitable for Use Levels (S4ULs) , where C4SLs have not been derived for particular contaminant species.
- Arup has developed GAC for various land use scenarios which cover a broad range of development scenarios, where both of these guideline values do not exist (e.g. cyanide).

Contaminants, which are below the assessment criteria do not require further assessment as these represent acceptable or minimal risk with respect to human health.

There are no published assessment criteria for assessing the risks from asbestos in soils. Asbestos has been assessed under the precautionary principle whereby the presence of asbestos detected at

<0.001% is not considered further.

No soil organic matter (SOM) testing was undertaken, and therefore the most conservative assessment criteria results (based on % organic matter) have been selected for the initial assessment.

7.1.2 Results

The identified exceedances of the applied assessment criteria are presented in the Table 9. The chemical screening tables are presented in Annex A.

Table 9: Human health risk assessment summary of assessment

Material	Number of Samples	Description	Commercial GAC	Residential GAC	Asbestos Identified (Y/N)
Topsoil	None	Soft brown slightly sandy slightly gravelly CLAY. Sand is fine to medium.	No testing data is available-		
Made Ground	11	Site Wide: Compact grey sandy GRAVEL with a low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse. Central Extent: Presence of a white geotextile sheeting underlying. Western Extent: Fragments of wire, wood, plastic or rebar found locally with trial pits.	No exceedances recorded.	Arsenic: TP55 at 0.5m (2019) at 110mg/kg TP04 at 0.7m (2011) at 46 mg/kg Cyanide: TP93 at 0.5m (2019) at 8.8 mg/kg	N
	None	Stockpiles	No testing data is available		
Glacial Till (Dublin Boulder Clay)	12	Soft to Firm grey, brown sandy gravelly CLAY with a low cobble content. Firm to stiff greyish brown slightly sandy very gravelly silty CLAY with a low to medium cobble content with occasional boulder content.	No exceedances recorded.	Arsenic: TP54 at 0.8m (2019) at 48mg/kg TP09 at 0.2m (2011) at 42 mg/kg TP10 at 0.2m (2011) at 54 mg/kg	N

The assessment identified elevated concentrations of arsenic and cyanides above the applied GAC values for a residential end use scenario with respect to the site neighbours and construction and maintenance workers. Although the applied scenario is for a chronic exposure scenario it represents an indication of a potential risk that requires further consideration when deriving an environmental pollution management and control plan.

No asbestos was identified within the tested samples. However, due to the nature of made ground, the presence of asbestos cannot be ruled out and needs to be considered by the contractor as part of their RAMS, albeit the likelihood of asbestos presence is considered to be low.

No exceedances of the applied commercial GAC were recorded within the Made Ground or Glacial Till encountered during the previous GI (2011-2019). Asbestos was not identified in either of the deposits. The assessment indicates that for the proposed development the encountered soils pose acceptable or minimal risk with respect to human health.

No topsoil or stockpiled materials samples were collected as part of previous investigations for chemical analysis. The currently ongoing ground investigations included excavation of trial pits and obtaining soil samples for testing.

The assessment will be revised on receipt of results of currently ongoing ground investigation.

7.2 Water Environment Quality Assessment

The PRA has identified the following PPL requiring further assessment:

- PPL 3 – risk to surface water from discharge of removed groundwater during earthworks
- PPL 9 – risk to surface water from discharge of drainage water during operation.

The identified potential linkage is associated with potential risks to surface water due to the discharge of groundwater removed during construction and operation. The discharge activity during construction will be managed by pollution control measures set out by the CEMP. This will include diverting on-site generated surface water (including removed groundwater) to on-site attenuation facilities.

The outfall from these to be in agreement with the Office of Public Works (OPW). If evidence of contamination is present, additional treatment prior to discharge will be required.

During operation drainage discharges will be managed by the amended existing water discharge licence.

The identified water environment receptors include:

- Surface water course within the site area, to be diverted as part of the proposed development.

Groundwater samples were obtained during previous investigations, as listed in Table 2. A screening assessment of groundwater chemical analysis results has been undertaken to assess the quality of the underlying groundwater.

7.2.1 Methodology

Four groundwater samples were obtained during completed investigations. Two samples were obtained from trial pits and two from bedrock. It is however unclear if the samples were obtained from installations or during drilling, which may impact the quality of the water.

Based on the identified water environment receptors within the area of the proposed development, the results have been screened against the Environmental Quality Standards (EQS) for freshwater environments published by the EQS Directive 2008/105/EC.

7.2.2 Results

The screening against the EQS values did not identify exceedances. The CSM identifies the presence of Aerodrome to the south of the site, which may be a source of PFAS/PFAO. No testing for PFAS/PFAO has been undertaken. Therefore, the risk of these contaminants being present in groundwater beneath the site remains and requires confirmation prior to construction to inform groundwater management during the earthworks or drainage options. The currently ongoing ground investigations included obtaining groundwater samples for testing including testing for PFAS/PFAO compounds.

8. Material Re-use

During the ground investigation, Made Ground was encountered across the site overlying natural glacial till deposits (see Section 4.1.1). Current earthworks proposal will result in the majority of Made Ground being excavated to achieve the design ground levels.

The Made Ground recorded anthropogenic material in the form of wire, rebar, plastic and geotextile sheeting. Due to these inclusions, there is a potential that the soils are contaminated and therefore conservatively it is assumed that they are not suitable for reuse within the scheme. However, the earthworks contractor will have an opportunity to reuse these materials subject to regulatory waste management requirements.

The currently ongoing ground investigations target the stockpiles. The assessments will be undertaken when information is available.

In line with current waste management regulations, it is currently proposed to reuse only natural materials. Offsite disposal requirements for the encountered materials are provided in Section 9.

9. Waste Characterisation

In order to inform soils management including potential off-site recycling, disposal or recovery, the available soil geo-environmental testing results have been compared against the EPA Soil Recovery Facility (SRF) values[8] , as well as entered for classification via HazWasteOnline[9]. HazWasteOnline is a UK based system that classifies soil in accordance with the European Union Waste Framework Directive.

The results of the initial waste characterisation assessment are summarised in Table 10. The output is presented in Annex B.

The EPA Guidance on waste acceptance criteria at authorised soil recovery facilities guidance defines geochemical domains across Ireland. The proposed development site is located within "*Domain 2 - Carboniferous limestone and related rocks*". The available soil testing results have been compared to the acceptance criteria (EPA SRF values) Domain 2, as presented in Annex A. This indicated that majority of the made ground and natural ground would be accepted at the SRF, however a proportion of these materials would require disposal at a landfill facility. The results of the ongoing ground investigation will provide a greater resolution of data and facilitate better delineation of materials acceptable at the SRF.

Further testing may be required, particularly focusing on the Dublin Boulder Clay to maximise the recycling of soils and divert soils from landfills.

It should be noted that the completed to date GI results allow for indicative waste classification of the materials and a full classification of the soil to be encountered during construction will be required. Based on the current guidance for frequency of testing (EPA SRF guidance), one sample per 2,000 tonnes is required to assess the potential for soil recycling. The ongoing ground investigation will aim to address the requirements in the aforementioned guidance.

Table 10 Initial waste characterisation assessment

Material	EPA Soil Recovery (Domain 2) Exceedances[1]	Information
Topsoil	N/A	No geoenvironmental testing of topsoil was undertaken during the previous GI. Testing will be required to classify the soils. This is being undertaken as part of the ongoing ground investigation.
Made Ground	1No. exceedances of Arsenic (2019 TP55, 0.5m – 110mg/kg).	A single EPA Soil Recovery Facility value exceedance of arsenic was recorded within the Made Ground encountered inside of the site boundary. A further exceedance of arsenic was recorded outside of the site boundary (2011 – TP04), as well as an exceedance of chromium (2011 – TP03).
Dublin Boulder Clay (DBC)	2No. exceedances of Arsenic (2019 TP54, 0.8m – 48mg/kg and 2011 TP09, 0.2m – 42mg/kg).	Two EPA Soil Recovery Facility value exceedances of arsenic were recorded within the Dublin Boulder Clay encountered inside of the site boundary. A further exceedance of arsenic was recorded outside of the site boundary (2011 – TP10).

Note 1: The maximum concentrations stated in the EPA guidance have been utilised (1.5x the Domain 2 criteria for metals).

Additionally, the values were entered into HazWasteOnline to determine if the materials may be deemed Non-Hazardous or Hazardous. Waste Acceptance Criteria (WAC) testing results obtained during the 2019 investigation were then used to determine if the materials may be suitable for disposal at an Inert, Non Hazardous or Hazardous landfill.

HazWasteOnline has classified both the Made Ground and Dublin Boulder Clay as Non-Hazardous waste.

WAC analysis conducted during the previous GI (2019) has revealed both the Made Ground and Dublin Boulder Clay are suitable for disposal at a Non-Hazardous landfill. 57% (4 out of 7) of Made Ground samples were recorded as suitable for disposal at waste inert facilities. As for the Dublin Boulder Clay, 34% (2 out of 6) of samples were recorded as suitable for inert disposal.

The results of the Waste Classification, WAC analysis and eventual landfill disposal options are summarised below:

- Topsoil: Analysis is required to confirm waste classification.
- Made Ground: Likely to comprise Non-Hazardous waste and suitable disposal at either an Inert licenced landfill or a Non-Hazardous licenced landfill.
- Dublin Boulder Clay: Likely to comprise Non-Hazardous waste and suitable disposal at either an Inert licenced landfill or a Non-Hazardous licenced landfill.

8 EPA. 2020. Guidance on waste acceptance criteria at authorised soil recovery facilities, EPA, Wexford, Ireland

9 HazWasteOnline™. 2024. Hazardous Waste Classification Software and Training for both the UK & EU regulatory environments. [Online] Available from https://www.hazwasteonline.com/

10. Conclusions and Recommendations

The initial geo-environmental risk assessment identified the following risks and data gaps requiring further action:

1. The risks with respect to exposure to soils during construction or maintenance works will be managed by the contractor in accordance with health and safety legislation. Construction contractor or land management contractor to receive and review available information and undertake their own risk assessments. Further assessment of soil quality, particularly with respect to the presence of asbestos will be undertaken on receipt of results from the currently ongoing investigations.
2. Groundwater control is likely to be required during the earthworks. The removed water will require discharge/disposal, which will be subject to a relevant licence. The licence will require obtaining information on groundwater quality and receptors quality. If groundwater is found to be contaminated, treatment may be required prior to discharge. This will be managed by the contractor during construction.
3. There is a risk of PFAS/PFAO contaminants being present in groundwater beneath the site and this requires confirmation prior to construction to inform groundwater management during the earthworks or drainage options during operation. The ongoing ground investigation includes post fields monitoring and obtaining groundwater samples from bedrock and testing for PFAS/PFAO substances.
4. The risk assessment with respect to site neighbours identified elevated concentrations of arsenic and cyanides. This is indicative of a potential risk to human health of the residents in the vicinity of the site. This will require appropriate dust control measures during construction. The assessment needs to be reviewed on receipt of results from the currently ongoing investigations.
5. The initial risk assessment with respect to end site users did not identify unacceptable risks. The assessment needs to be reviewed on receipt of results from the currently ongoing investigations.
6. The groundwater installations no longer needed for monitoring will require appropriate decommissioning prior to construction works.
7. The assessment of chemical attack on buried concrete will need to be reviewed on receipt of the results from the currently ongoing investigations to inform the geotechnical design.
8. The initial waste characterisation indicated that majority of the soils would be acceptable at the soil recovery facilities. Where landfill disposal is necessary, all soils would be suitable for disposal at a non-hazardous landfill with some materials meeting Inert WAC and therefore suitable for disposal at an inert facility. The initial waste characterisation will be reviewed on receipt of the results from the ongoing ground investigation including the testing completed on stockpiles.

DOCUMENT CHECKING

	Prepared by	Checked by	Approved by
Name	Jack Walton	Agnieszka Lopez-Parodi	Charlie Martin
Signature			

Annex A

Summary of soil chemical testing

Summary of Chemical Analysis Soil Samples

IGSL Ltd, 2019, Report No. 22000

Test	Method	LOD	Units	Lab No	.Sample ID	Depth	Other ID	Sample Type	Sampling Date	Sampling Time	Commercial Assessment Criteria	Residential without plant uptake Assessment Criteria	EPA Maximum Concentrations and/or Soil Trigger Levels (Domain 2) (1.5 x allowable derrogation)
				898657	TP39	0.40		SOIL		INERT			
				898658	TP41	0.30		SOIL		INERT			
				898659	TP42	0.30		SOIL		NON-HAZ			
				898660	TP47	0.70		SOIL		INERT			
				900765	TP48	0.50		SOIL		INERT			
				898662	TP55	0.50		SOIL		NON-HAZ			
				898663	TP67	0.20		SOIL		NON-HAZ			
				898661	TP54	0.80		SOIL		INERT			
				898664	TP76	0.65		SOIL		NON-HAZ			
				898665	TP82	0.60		SOIL		NON-HAZ			
				898666	TP93	0.50		SOIL		NON-HAZ			
				898655	TP6	0.50		SOIL		INERT			
				898656	TP17	0.50		SOIL		NON-HAZ			
				MG	MG	MG	MG	MG	MG	MG	DBC	DBC	DBC	DBC	DBC	DBC			
Column4	Column1	Column2	Column3	Column9	Column10	Column11	Column12	Column19	Column14	Column15	Column13	Column16	Column17	Column18	Column7	Column8	Column5	Column52	Column6
ACM Type		N/A		-	-	-	-	-	-	-	-	-	-	-	-	-	-		-
Asbestos Identification		0.001	%	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	-		-
ACM Detection Stage		N/A		-	-	-	-	-	-	-	-	-	-	-	-	-	-		-
Moisture		0.020	%	12	12	13	14	8.9	6.8	11	5.0	21	13	15	19	17	-		-
Boron (Hot Water Soluble)		0.40	mg/kg	0.50	0.51	0.57	0.50	0.41	< 0.40	0.48	< 0.40	0.44	< 0.40	0.42	0.40	0.44	240000	10300	-
Sulphur (Elemental)		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] 4.6	[A] 1.3	[A] < 1.0	[A] 3.0	[A] 1.3	[A] 2.9	[A] 2.0	[A] 2.5	[A] < 1.0	[A] 1.9			-
Cyanide (Total)		0.50	mg/kg	[A] < 0.50	[A] < 0.50	[A] < 0.50	[A] < 0.50	[A] < 0.50	[A] < 0.50	[A] < 0.50	[A] < 0.50	[A] < 0.50	[A] < 0.50	[A] 8.8	[A] < 0.50	[A] < 0.50	78	5.5	-
Sulphide (Easily Liberatable)		0.50	mg/kg	[A] 4.4	[A] 4.8	[A] 6.2	[A] 5.9	[A] 12	[A] 4.9	[A] 23	[A] 3.3	[A] 18	[A] 4.8	[A] 1.7	[A] 1.1	[A] 10	-		-
Sulphate (Acid Soluble)		0.010	%	[A] 0.45	[A] 0.39	[A] 0.39	[A] 0.037	[A] 0.11	[A] 0.010	[A] 0.071	[A] 0.017	[A] 0.094	[A] 0.018	[A] 0.044	[A] 0.035	[A] 0.18	-		-
Metals																			
Arsenic		1.0	mg/kg	33	24	25	14	35	110	24	48	23	28	23	13	22	640	40	24.9 (37.35)
Barium		10	mg/kg	79	69	67	37	100	79	100	120	100	43	41	78	53	22000	1300	
Cadmium		0.10	mg/kg	0.70	0.60	0.76	0.37	0.56	0.12	0.73	0.24	2.1	0.85	1.7	2.2	2.1	410	150	3.28
Chromium		1.0	mg/kg	19	23	21	17	23	29	29	39	26	14	14	25	17	8600	910	50.3
Molybdenum		2.0	mg/kg	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	3.0	< 2.0	3.4	2.8	4.8	17000	670	
Antimony		2.0	mg/kg	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	7500	550	
Copper		0.50	mg/kg	18	18	15	24	22	24	23	33	34	22	28	17	29	68000	7100	63.5
Mercury		0.10	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.18	< 0.10	< 0.10	< 0.10	0.13	1100	56	0.360
Nickel		0.50	mg/kg	25	30	23	36	33	39	39	47	49	44	43	46	59	980	180	61.9
Lead		0.50	mg/kg	34	34	35	17	19	17	27	43	59	19	25	26	27	2300	200	86.1
Selenium		0.20	mg/kg	< 0.20	< 0.20	< 0.20	0.42	< 0.20	< 0.20	< 0.20	< 0.20	1.6	< 0.20	0.35	0.45	1.3	12000	430	
Zinc		0.50	mg/kg	46	53	62	26	60	64	70	77	110	41	59	75	65	730000	40000	197
Chromium (Trivalent)		1.0	mg/kg	19	23	21	17	23	29	29	39	26	14	14	25	17	8600	910	50.3
Chromium (Hexavalent)		0.50	mg/kg	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	Below Detection Limit	Below Detection Limit	Below Detection Limit
Inorganics																			
Total Organic Carbon		0.20	%	[A] 0.45	[A] 0.44	[A] 0.61	[A] 0.46	[A] 0.37	[A] 0.34	[A] 1.3	[A] 0.68	[A] 1.8	[A] 0.57	[A] 0.93	[A] 0.62	[A] 0.89	-		3%
Mineral Oil		10	mg/kg	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Petroleum Hydrocarbons																			
Aliphatic TPH >C5-C6		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aliphatic TPH >C6-C8		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aliphatic TPH >C8-C10		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aliphatic TPH >C10-C12		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aliphatic TPH >C12-C16		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aliphatic TPH >C16-C21		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aliphatic TPH >C21-C35		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aliphatic TPH >C35-C44		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Total Aliphatic Hydrocarbons		5.0	mg/kg	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aromatic TPH >C5-C7		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aromatic TPH >C7-C8		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aromatic TPH >C8-C10		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aromatic TPH >C10-C12		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aromatic TPH >C12-C16		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aromatic TPH >C16-C21		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aromatic TPH >C21-C35		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aromatic TPH >C35-C44		1.0	mg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Total Aromatic Hydrocarbons		5.0	mg/kg	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Total Petroleum Hydrocarbons		10.0	mg/kg	[A] < 10	[A] < 10	[A] < 10	[A] < 10	[A] < 10	[A] < 10	[A] < 10	[A] < 10	[A] < 10	[A] < 10	[A] < 10	[A] < 10	[A] < 10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzene		1.0	µg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Toluene		1.0	µg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Ethylbenzene		1.0	µg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
m & p-Xylene		1.0	µg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
o-Xylene		1.0	µg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Methyl Tert-Butyl Ether		1.0	µg/kg	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
PAH MS																			
Naphthalene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Acenaphthylene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Acenaphthene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Fluorene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Phenanthrene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo[j]fluoranthene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Anthracene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Fluoranthene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Pyrene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo[a]anthracene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Chrysene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo[b]fluoranthene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo[k]fluoranthene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo[a]pyrene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Indeno(1,2,3-c,d)Pyrene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Dibenz(a,h)Anthracene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo[g,h,i]perylene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Coronene		0.10	mg/kg	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Total Of 17 PAH's		2.0	mg/kg	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
PCBs																			
PCB 28		0.010	mg/kg	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	Below Detection Limit	Below Detection Limit	Below Detection Limit
PCB 52		0.010	mg/kg	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	Below Detection Limit	Below Detection Limit	Below Detection Limit
PCB 90+101		0.010	mg/kg	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	Below Detection Limit	Below Detection Limit	Below Detection Limit
PCB 118		0.010	mg/kg	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	Below Detection Limit	Below Detection Limit	Below Detection Limit
PCB 153		0.010	mg/kg	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	Below Detection Limit	Below Detection Limit	Below Detection Limit
PCB 138		0.010	mg/kg	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	Below Detection Limit	Below Detection Limit	Below Detection Limit
PCB 180		0.010	mg/kg	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	[A] < 0.010	Below Detection Limit	Below Detection Limit	Below Detection Limit
Total PCBs (7 Congeners)		0.10	mg/kg	[A] < 0.10	[A] < 0.10	[A] < 0.10	[A] < 0.10	[A] < 0.10	[A] < 0.10	[A] < 0.10	[A] < 0.10	[A] < 0.10	[A] < 0.10	[A] < 0.10	[A] < 0.10	[A] < 0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Total Phenols		0.30	mg/kg	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	Below Detection Limit	Below Detection Limit	Below Detection Limit

Summary of Chemical Analysis
Soil Samples

				IGSL Ltd, 2013 , Report No. 17136														IGSL Ltd, 2012, Report No. 16419								Commercial Assessment Criteria	Residential without plant uptake Assessment Criteria	EPA Maximum Concentrations and/or Soil Trigger Levels (Domain 2) (1.5 x allowable derrogation)
Lab No				1	2	3	4	5	6	7	8	9	10	11	12	13	1-3	4-6	1	2	3	4	5 - 6	7 - 8	9 - 10	11 - 12			
				BH1	BH2	BH3	BH4	BH5	BH8	BH10	BH11	TP2	TP5	TP6	TP9	TP11	TP10	TP12	TP1	TP11	TP25	TP44	TP5	TP18	TP31	TP43			
Sample ID				1.0	1.0	2.0	1.0	1.0	1.0	1.0	2.0	0.4	0.35	0.45	0.5	0.4	0.6-0.7	0.7-0.8	2	1.9	0.7	1.6	0.8	0.2	0.7	0.7			
Depth				SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL			
Other ID				14/11/2013	14/11/2013	14/11/2013	14/11/2013	14/11/2013	14/11/2013	14/11/2013	14/11/2013	14/11/2013	14/11/2013	19/11/2013	19/11/2013	19/11/2013	28/10/2013	28/10/2013	14/08/2012	14/08/2012	14/08/2012	14/08/2012	14/08/2012	14/08/2012	14/08/2012	14/08/2012			
Sample Type																												
Sampling Date																												
Sampling Time																												
Test	Method	LOD	Units																									
Metals				DBC	DBC	DBC	DBC	DBC	DBC	DBC	DBC	MG/DBC	MG/DBC	MG/DBC	DBC	DBC	DBC	DBC	DBC	DBC	DBC	DBC	DBC	TS	DBC	DBC			
Aluminium	TM30/PM15	<50	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	8154	5482	-	-	-	-	-	-	-	-	-	-	-
Arsenic	TM30/PM15	1.0	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	8.3	8.6	-	-	-	-	-	-	-	-	640	40	24.9
Cadmium	TM30/PM15	0.10	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9	2.4	-	-	-	-	-	-	-	-	410	150	3.28
Chromium	TM30/PM15	1.0	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	10.7	9.3	-	-	-	-	-	-	-	-	8600	910	50.3
Molybdenum	TM30/PM15	2.0	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	25	28	-	-	-	-	-	-	-	-	17000	670	-
Copper	TM30/PM15	0.50	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	25	28	-	-	-	-	-	-	-	-	68000	7100	63.5
Mercury	TM30/PM15	0.10	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Nickel	TM30/PM15	0.50	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	39.4	36.0	-	-	-	-	-	-	-	-	980	180	61.9
Lead	TM30/PM15	0.50	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	12	13	-	-	-	-	-	-	-	-	2300	200	86.1
Selenium	TM30/PM15	0.20	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Zinc	TM30/PM15	0.50	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	36	83	-	-	-	-	-	-	-	-	730000	430	197
Sulphate as SO4 (2:1 Ext) #	TM38/PM20	<0.0015	g/l	0.0140	0.0095	0.0124	0.0098	0.0126	0.0088	0.0264	0.0084	0.0152	0.0375	0.0819	0.0167	0.0111	-	-	0.0059	0.008	0.0053	0.004	-	-	-	-	-	-	-
Sulphur	TM30/PM15	<0.01	%	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02	0.02	-	-	-	-	-	-	-	-	-	-	-
Total Sulphate #	TM50/PM15	<50	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	344	409	-	-	-	-	-	-	-	-	-	-	-
Water Soluble Boron #	TM74/PM32	<0.1	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	0.2	-	-	-	-	-	-	-	-	-	-	-
PAH MS																													
Naphthalene #	TM4/PM8	<0.04	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.04	<0.04	-	-	-	-	<0.04	<0.04	<0.04	<0.04	Below Detection Limit	Below Detection Limit	Below Detection Limit
Acenaphthylene	TM4/PM8	<0.03	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.03	<0.03	-	-	-	-	<0.03	<0.03	<0.03	<0.03	Below Detection Limit	Below Detection Limit	Below Detection Limit
Acenaphthene #	TM4/PM8	<0.05	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05	-	-	-	-	<0.05	<0.05	<0.05	<0.05	Below Detection Limit	Below Detection Limit	Below Detection Limit
Fluorene #	TM4/PM8	<0.04	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.04	<0.04	-	-	-	-	<0.04	<0.04	<0.04	<0.04	Below Detection Limit	Below Detection Limit	Below Detection Limit
Phenanthrene #	TM4/PM8	<0.03	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.03	<0.03	-	-	-	-	<0.03	<0.03	<0.03	<0.03	Below Detection Limit	Below Detection Limit	Below Detection Limit
Anthracene #	TM4/PM8	<0.04	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.04	<0.04	-	-	-	-	<0.04	<0.04	<0.04	<0.04	Below Detection Limit	Below Detection Limit	Below Detection Limit
Fluoranthene #	TM4/PM8	<0.03	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.03	<0.03	-	-	-	-	<0.03	<0.03	<0.03	<0.03	Below Detection Limit	Below Detection Limit	Below Detection Limit
Pyrene #	TM4/PM8	<0.03	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.03	<0.03	-	-	-	-	<0.03	<0.03	<0.03	<0.03	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo(a)anthracene #	TM4/PM8	<0.06	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.06	<0.06	-	-	-	-	<0.06	<0.06	<0.06	<0.06	Below Detection Limit	Below Detection Limit	Below Detection Limit
Chrysene #	TM4/PM8	<0.02	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.02	<0.02	-	-	-	-	<0.02	<0.02	<0.02	<0.02	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo(bk)fluoranthene #	TM4/PM8	<0.07	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.07	<0.07	-	-	-	-	<0.07	<0.07	<0.07	<0.07	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo(a)pyrene #	TM4/PM8	<0.04	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.04	<0.04	-	-	-	-	<0.04	<0.04	<0.04	<0.04	Below Detection Limit	Below Detection Limit	Below Detection Limit
Indeno(123cd)pyrene #	TM4/PM8	<0.04	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.04	<0.04	-	-	-	-	<0.04	<0.04	<0.04	<0.04	Below Detection Limit	Below Detection Limit	Below Detection Limit
Dibenzo(ah)anthracene #	TM4/PM8	<0.04	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.04	<0.04	-	-	-	-	<0.04	<0.04	<0.04	<0.04	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo(ghi)perylene #	TM4/PM8	<0.04	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.04	<0.04	-	-	-	-	<0.04	<0.04	<0.04	<0.04	Below Detection Limit	Below Detection Limit	Below Detection Limit
Coronene	TM4/PM8	<0.04	mg/kg																				<0.04	<0.04	<0.04	<0.04	Below Detection Limit	Below Detection Limit	Below Detection Limit
PAH 6 Total	TM4/PM8	<0.22	mg/kg																				<0.22	<0.22	<0.22	<0.22	Below Detection Limit	Below Detection Limit	Below Detection Limit
PAH 16 Total	TM4/PM8	<0.6	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.6	<0.6	-	-	-	-					Below Detection Limit	Below Detection Limit	Below Detection Limit
PAH 17 Total	TM4/PM8	<0.64	mg/kg																				<0.64	<0.64	<0.64	<0.64	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo(b)fluoranthene	TM4/PM8	<0.05	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05	-	-	-	-	<0.05	<0.05	<0.05	<0.05	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo(k)fluoranthene	TM4/PM8	<0.02	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.02	<0.02	-	-	-	-	<0.02	<0.02	<0.02	<0.02	Below Detection Limit	Below Detection Limit	Below Detection Limit
PAH Surrogate % Recovery	TM4/PM8		%	-	-	-	-	-	-	-	-	-	-	-	-	-	100	100	-	-	-	-	96	103	93	98	-	-	-
Organochlorine Pesticides																													
Aldrin	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Alpha-BHC	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Beta-BHC	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Dieldrin	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Endosulphan I	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Endosulphan II	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Endosulphan sulphate	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Endrin	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Gamma-BHC	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Heptachlor	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Heptachlor Epoxide	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
p,p'-DDE	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
p,p'-DDT	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
p,p'-TDE	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Total Methoxychlor	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Organophosphorus Pesticides																													
Azinphos methyl	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Diazinon	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Dichlorvos	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Disulfoton	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Ethion	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Ethyl Parathion (Parathion)	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Fenitrothion	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Malathion	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Methyl Parathion	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Mevinphos	TM42/PM8	<1	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
EPH (C8-C40) #	TM5/PM8	<30	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<30	<30	-	-	-	-	<30	<30	<30	<30	Below Detection Limit	Below Detection Limit	Below Detection Limit
C8-C40 Mineral Oil (Calculation)	TM5/PM8	<30	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<30	<30	-	-	-	-	<30	<30	<30	<30	Below Detection Limit	Below Detection Limit	Below Detection Limit
GRO (>C4-C8) #	TM36/PM12	<100	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<100	<100	-	-	-	-					Below Detection Limit	Below Detection Limit	Below Detection Limit
GRO (>C8-C12) #	TM36/PM12	<100	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<100	<100	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
GRO (>C4-12) #	TM36/PM12	<100	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<100	<100	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
MTBE #	TM31/PM12	<5	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-	<5	<5	<5	<5	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzene #	TM31/PM12	<5	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-	<5	<5	<5	<5	Below Detection Limit	Below Detection Limit	Below Detection Limit
Toluene #	TM31/PM12	<5	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-	<5	<5	<5	<5	Below Detection Limit	Below Detection Limit	Below Detection Limit
Ethylbenzene #	TM31/PM12	<5	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-	<5	<5	<5	<5	Below Detection Limit	Below Detection Limit	Below Detection Limit
m/p-Xylene #	TM31/PM12	<5	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-	<5	<5	<5	<5	Below Detection Limit	Below Detection Limit	Below Detection Limit
o-Xylene #	TM31/PM12	<5	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-	<5	<5	<5	<5	Below Detection Limit	Below Detection Limit	Below Detection Limit
PCBs																													
PCB 28 #	TM17/PM8	<5	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-	<5	<5	<5	<5	Below Detection Limit	Below Detection Limit	Below Detection Limit
PCB 52 #	TM17/PM8	<5	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-	<5	<5	<5	<5	Below Detection Limit	Below Detection Limit	Below Detection Limit
PCB 101 #	TM17/PM8	<5	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-	<5	<5	<5	<5	Below Detection Limit	Below Detection Limit	Below Detection Limit
PCB 118 #	TM17/PM8	<5	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-	<5	<5	<5	<5	Below Detection Limit	Below Detection Limit	Below Detection Limit
PCB 138 #	TM17/PM8	<5	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-	<5	<5	<5	<5	Below Detection Limit	Below Detection Limit	Below Detection Limit
PCB 153 #	TM17/PM8	<5	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-	<5	<5	<5	<5	Below Detection Limit	Below Detection Limit	Below Detection Limit
PCB 180 #	TM17/PM8	<5	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	-	-	-	-	<5	<5	<5	<5	Below Detection Limit	Below Detection Limit	Below Detection Limit
Total 7 PCBs #	TM17/PM8	<35	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<35	<35	-	-	-	-	<35	<35	<35	<35	Below Detection Limit	Below Detection Limit	Below Detection Limit
Total Phenols HPLC	TM26/PM21	<0.15	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.15	<0.15	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Natural Moisture Content	PM4/PM0	<0.1	%														16.4	17.0	-	-	-	-	-	-	-	-	-	-	-
Chloride #	TM38/PM20	<2	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	5	23	-	-	-	-	-	-	-	-	-		-
Hexavalent Chromium	TM38/PM20	<0.3	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	0.6	<0.3	-	-	-	-	-	-	-	-	49	21	50.3
Free Cyanide	TM89/PM45	<0.5	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Total Cyanide #	TM89/PM45	<0.5	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	<0.5	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Sulphide	TM106/PM45	<10	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	<10	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Thiocyanate	TM107/PM45	<0.6	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.6	<0.6	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Asbestos																	NAD	NAD											
pH #	TM73/PM11	<0.01	pH units	-	-	-	-	-	-	-	-	-	-	-	-	-	8.43	8.42	8.51	8.04	8.4	8.46	-	-	-	-	-	-	-
Mass of raw test portion	NONE/PM17		kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.113	0.1088	0.1039	0.1027	-	-	-	-	-	-	-
Mass of dried test portion	NONE/PM17		kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.09	0.09	0.09	0.09	-	-	-	-	-	-	-
% Dry Matter 105°C	NONE/PM4	<0.01	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	79.5	82.6	86.2	88.1	-	-	-
Total Organic Carbon	TM21/PM24	<0.2	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.6	0.3	0.3	<0.2	-	-	3%

Summary of Chemical A Soil Samples

Glover Site Investigations Ltd, 2011, Report No. 11-089 Rev A

Test	Units	AP90148	AP90149	AP90150	AP90151	AP90152	AP90153	AP90154	AP90155	AP90156	AP90157	AP90158	AP90159	AP90160	Commercial Assessment Criteria	Residential without plant uptake Assessment Criteria	EPA Maximum Concentrations and/or Soil Trigger Levels (Domain 2) (1.5 x allowable derrogation)
Lab No																	
Sample ID		TP01	TP02	TP03	TP03	TP04	TP05	TP06	TP07	TP08	TP08	TP09	TP09	TP10			
Depth		0.6	0.6	0.3	0.8	0.7	0.2	0.2	0.2	0.2	0.5	0.2	0.8	0.2			
Other		E	E	B	E	E	E	E	E	E	B	E	B	E			
ID		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL			
Sample Type																	
Sampling Date																	
Sampling Time																	
		MG	MG	MG	MG	MG	DBC	DBC	DBC	DBC	DBC	DBC	DBC	DBC			
Metals																	
Arsenic	mg kg-1	12	8	-	17	46	12	11	16	19		42		54	640	40	24.9 (37.35)
Cadmium	mg kg-1	0.51	0.28	-	0.12	2.1	1.5	2.2	2.4	2.1		1.2		1.4	410	150	3.28
Chromium	mg kg-1	5.7	7.7	-	83	23	13	16	22	27		27		27	6800	910	50.3 (75.45)
Copper	mg kg-1	12	8.7	-	35	20	17	27	39	29		16		24	68000	7100	63.5
Mercury	mg kg-1	<0.10	<0.10	-	<0.10	<0.10	<0.10	<0.10	<0.10	0.1		<0.10		<0.10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Nickel	mg kg-1	30	21	-	55	57	31	50	69	50		60		52	980	190	61.9 (92.85)
Lead	mg kg-1	7.5	5.7	-	23	18	20	35	25	39		23		32	2300	200	86.1
Zinc	mg kg-1	20	<10	-	100	86	52	89	100	110		83		60	730000	430	197
Chromium (hexavalent)	mg kg-1	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5		<0.5	Below Detection Limit	Below Detection Limit	Below Detection Limit
PAH MS																	
Acenaphthene	mg kg-1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	Below Detection Limit	Below Detection Limit	Below Detection Limit
Acenaphthylene	mg kg-1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	Below Detection Limit	Below Detection Limit	Below Detection Limit
Anthracene	mg kg-1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo[a]anthracene	mg kg-1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo[a]pyrene	mg kg-1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo[b]fluoranthene	mg kg-1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo[g,h,i]perylene	mg kg-1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzo[k]fluoranthene	mg kg-1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	Below Detection Limit	Below Detection Limit	Below Detection Limit
Chrysene	mg kg-1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	Below Detection Limit	Below Detection Limit	Below Detection Limit
Dibenzo[a,h]anthracene	mg kg-1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	Below Detection Limit	Below Detection Limit	Below Detection Limit
Fluoranthene	mg kg-1	0.14	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	23000	1500	Below 1mg/kg Total PAHs
Fluorene	mg kg-1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	Below Detection Limit	Below Detection Limit	Below Detection Limit
Indeno[1,2,3-cd]pyrene	mg kg-1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	Below Detection Limit	Below Detection Limit	Below Detection Limit
Naphthalene	mg kg-1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	Below Detection Limit	Below Detection Limit	Below Detection Limit
Phenanthrene	mg kg-1	0.19	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	22000	1300	Below 1mg/kg Total PAHs
Pyrene	mg kg-1	0.13	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1		< 0.1	54000	3700	Below 1mg/kg Total PAHs
Total (of 16) PAHs	mg kg-1	< 2	< 2	-	< 2	< 2	< 2	< 2	< 2	< 2		< 2		< 2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Methyl tert-butyl ether	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Dichlorodifluoromethane	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Chloromethane	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Vinyl chloride	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Bromomethane	µg kg-1	<20	<20	-	<20	<20	<20	<20	<20	<20	-	<20	-	<20	Below Detection Limit	Below Detection Limit	Below Detection Limit
Chloroethane	µg kg-1	<2.0	<2.0	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-	<2.0	-	<2.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Trichlorofluoromethane	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,1-Dichloroethene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Dichloromethane	µg kg-1	ne	ne	-	ne	ne	ne	ne	ne	ne	-	ne	-	ne	Below Detection Limit	Below Detection Limit	Below Detection Limit
trans-1,2-Dichloroethene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,1-Dichloroethane	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
cis-1,2-Dichloroethene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Bromochloromethane	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Trichloromethane	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,1,1-Trichloroethane	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Tetrachloromethane	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,1-Dichloropropene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Benzene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,2-Dichloroethane	µg kg-1	<2.0	<2.0	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-	<2.0	-	<2.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Trichloroethene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,2-Dichloropropane	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Dibromomethane	µg kg-1	<10	<10	-	<10	<10	<10	<10	<10	<10	-	<10	-	<10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Bromodichloromethane	µg kg-1	<5.0	<5.0	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	-	<5.0	-	<5.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
cis-1,3-Dichloropropene	µg kg-1	<10	<10	-	<10	<10	<10	<10	<10	<10	-	<10	-	<10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Toluene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
trans-1,3-Dichloropropene	µg kg-1	<10	<10	-	<10	<10	<10	<10	<10	<10	-	<10	-	<10	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,1,2-Trichloroethane	µg kg-1	<10	<10	-	<10	<10	<10	<10	<10	<10	-	<10	-	<10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Tetrachloroethene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,3-Dichloropropane	µg kg-1	<2.0	<2.0	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-	<2.0	-	<2.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Dibromochloromethane	µg kg-1	<10	<10	-	<10	<10	<10	<10	<10	<10	-	<10	-	<10	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,2-Dibromoethane	µg kg-1	<5.0	<5.0	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	-	<5.0	-	<5.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Chlorobenzene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,1,1,2-Tetrachloroethane	µg kg-1	<2.0	<2.0	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-	<2.0	-	<2.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Ethylbenzene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
m- & p-Xylene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
o-Xylene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Styrene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Tribromomethane	µg kg-1	<10	<10	-	<10	<10	<10	<10	<10	<10	-	<10	-	<10	Below Detection Limit	Below Detection Limit	Below Detection Limit
Isopropylbenzene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Bromobenzene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,2,3-Trichloropropane	µg kg-1	<50	<50	-	<50	<50	<50	<50	<50	<50	-	<50	-	<50	Below Detection Limit	Below Detection Limit	Below Detection Limit
n-Propylbenzene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
2-Chlorotoluene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,2,4-Trimethylbenzene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
4-Chlorotoluene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
tert-Butylbenzene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,3,5-Trimethylbenzene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
sec-Butylbenzene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,3-Dichlorobenzene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
4-Isopropyltoluene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,4-Dichlorobenzene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
n-Butylbenzene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,2-Dichlorobenzene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,2-Dibromo-3-chloropropane	µg kg-1	<50	<50	-	<50	<50	<50	<50	<50	<50	-	<50	-	<50	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,2,4-Trichlorobenzene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Hexachlorobutadiene	µg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
1,2,3-Trichlorobenzene	µg kg-1	<2.0	<2.0	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-	<2.0	-	<2.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
carbaryl	mg kg-1	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	Below Detection Limit	Below Detection Limit	Below Detection Limit
carbofuran	mg kg-1	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	-	<0.5	Below Detection Limit	Below Detection Limit	Below Detection Limit
maneb	mg kg-1	n/a	n/a	-	n/a	n/a	n/a	n/a	n/a	n/a	-	n/a	-	n/a	-	-	-
PCBs as Aroclor 1242	mg kg-1	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	-	<1.0	Below Detection Limit	Below Detection Limit	Below Detection Limit
Ametryn	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Atraton	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Atrazine	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Prometon	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Prometryn	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Propazine	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Secbumeton	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Simazine	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Simetryn	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Terbuthylazine	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Terbutryn	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
4,4'-DDD	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
4,4'-DDE	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
4,4'-DDT	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Aldrin	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
alpha-Chlordane	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
alpha-HCH	mg kg-1	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit

beta-HCH	mg kg^{-1}	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
delta-HCH	mg kg^{-1}	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Dieldrin	mg kg^{-1}	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Endosulfan I	mg kg^{-1}	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Endosulfan II	mg kg^{-1}	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Endosulfan sulfate	mg kg^{-1}	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Endrin aldehyde	mg kg^{-1}	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Endrin ketone	mg kg^{-1}	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Endrin	mg kg^{-1}	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
gamma-Chlordane	mg kg^{-1}	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
gamma-HCH	mg kg^{-1}	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Heptachlor epoxide	mg kg^{-1}	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Heptachlor	mg kg^{-1}	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Hexachlorobutadiene	mg kg^{-1}	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
Methoxychlor	mg kg^{-1}	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	Below Detection Limit	Below Detection Limit	Below Detection Limit
pH 2.5 to 1	-	-	-	8.4	-	-	-	-	-	-	-	-	-	-	-	-	-
pH		-	-	-	-	-	8.3	-	-	-	8.2	-	8.3	6.7	-	-	-
Boron (hot water soluble)	mg kg^{-1}	-	-	-	-	-	0.6	-	-	-	-	-	-	0.7	-	-	-
Sulfate (2:1 water soluble) as SO4	g l^{-1}	-	-	0.2	-	-	<0.01	-	-	-	<0.01	-	<0.01	0.03	-	-	-
Sulfur (total TRL report 447)	%	-	-	0.14	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfur (elemental)	mg kg^{-1}	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-
Asbestos Containing Material		not found	not found	-	not found	not found	not found	not found	not found	not found	-	not found	-	not found	-	-	-
Chloride (extractable)	g l^{-1}	-	-	-	-	-	<0.010	-	-	-	<0.010	-	<0.010	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Chloride (acid soluble)	%	-	-	-	-	-	-	-	-	-	<0.01	-	<0.01	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Carbonate	%	-	-	-	-	-	-	-	-	-	11.6	-	18.9	-	-	-	
Magnesium (soluble)	g l^{-1}	-	-	<0.01	-	-	-	-	-	-	-	-	-	-	Below Detection Limit	Below Detection Limit	Below Detection Limit
Sulfate (total) by BS1377 (HCl extract)	%	-	-	0.1	-	-	0.49	-	-	-	0.24	-	0.59	0.02	-	-	
Loss on ignition	%	-	-	-	-	-	-	-	-	-	2.67	-	3.01	-	-	-	
Organic matter	%	-	-	-	-	-	-	-	-	-	1.4	-	3.8	-	-	-	
Total Petroleum Hydrocarbons	mg kg^{-1}	< 10	< 10	-	< 10	< 10	< 10	< 10	< 10	< 10	-	< 10	-	< 10	Below Detection Limit	Below Detection Limit	Below Detection Limit

Summary of Chemical Analysis
WAC Leachate

IGSL Ltd, 2012, Report No. 16419

Test	Method	LOD	Units				
Lab No							
.Sample ID				TP5	TP18	TP31	TP43
Depth				0.8	0.2	0.7	0.7
Other ID							
Sample Type				SOIL	SOIL	SOIL	SOIL
Sampling Date				14/08/2012	14/08/2012	14/08/2012	14/08/2012
Sampling Time				DBC	TS	DBC	DBC
Metals							
Dissolved Antimony	TM30/PM17	<0.02	mg/kg	<0.02	<0.02	<0.02	<0.02
Dissolved Arsenic	TM30/PM17	<0.025	mg/kg	<0.025	<0.025	<0.025	<0.025
Dissolved Barium	TM30/PM17	<0.03	mg/kg	0.12	<0.03	<0.03	<0.03
Dissolved Cadmium	TM30/PM17	<0.005	mg/kg	<0.005	<0.005	<0.005	<0.005
Dissolved Chromium	TM30/PM17	<0.015	mg/kg	<0.015	<0.015	<0.015	<0.015
Dissolved copper	TM30/PM17	<0.07	mg/kg	<0.07	<0.07	<0.07	<0.07
Dissolved Lead	TM30/PM17	<0.05	mg/kg	<0.05	<0.05	<0.05	<0.05
Dissolved Molybdenum	TM30/PM17	<0.02	mg/kg	<0.02	<0.02	0.02	0.03
Dissolved Nickel	TM30/PM17	<0.02	mg/kg	<0.02	<0.02	<0.02	<0.02
Dissolved Selenium	TM30/PM17	<0.03	mg/kg	<0.03	<0.03	<0.03	<0.03
Dissolved Zinc	TM30/PM17	<0.03	mg/kg	<0.03	<0.03	<0.03	<0.03
Mercury Dissolved by CVAF	TM61/PM38	<0.0001	mg/kg	0.0016	<0.0001	<0.0001	<0.0001
Fluoride	TM27/PM0	<3	mg/kg	3	4	5	8
Chloride	TM27/PM0	<3	mg/kg	4	11	3	<3
Sulphate	TM27/PM0	<0.5	mg/kg	12.4	11.1	13.3	11
Mas of raw test portion	NONE/PM17		kg	0.113	0.1088	0.1039	0.1027
Leachant volume	NONE/PM17		l	0.877	0.881	0.886	0.888
Eluate Volume	NONE/PM17		l	0.82	0.8	0.8	0.7
Dissolved Organic Carbon	TM60/PM0	<20	mg/kg	140	240	100	60
Phenol Index	TM101/PM0	<0.5	mg/kg	2.5	<0.5	<0.5	<0.5
Total Dissolved Solids	TM20/PM0	<350	mg/kg	1150	470	440	420

Summary of Chemical Analysis

Water Samples

Test	Method	LOD	Units	IGSL Ltd, 2013 , Report No. 17136		IGSL Ltd, 2012, Report No. 16419		EQS Directive screening criteria
Lab No				1-4	5-8	13	14	
.Sample ID				WS01 RC07	RC13	TP11	TP32	
Depth				3.46	3.59	2.5	2.5	
Other ID								
Sample Type				Ground Water	Ground Water	Ground Water	Ground Water	
Sampling Date				15/11/2013	15/11/2013	14/08/2012	14/08/2012	
Sampling Time								
				LUCAN	LUCAN	DBC	DBC	
Metals								
Dissolved Aluminium #	TM30/PM14	<20	ug/l	<20	<20	<20	<20	-
Dissolved Arsenic #	TM30/PM14	<0.0025	mg/l	0.0055	0.0073	<0.0025	<0.0025	No EQS Screening Values
Dissolved Boron	TM30/PM14	<0.012	mg/l	0.046	0.030	0.016	<0.012	No EQS Screening Values
Dissolved Cadmium #	TM30/PM14	<0.0005	mg/l	<0.0005	<0.0005	<0.0005	<0.0005	Below detection
Dissolved Calcium #	TM30/PM14	<0.2	mg/l	107.1	192.2	-	-	No EQS Screening Values
Total Dissolved Chromium #	TM30/PM14	<0.0015	mg/l	<0.0015	<0.0015	<0.0015	<0.0015	Below detection
Dissolved Copper #	TM30/PM14	<0.007	mg/l	<0.007	<0.007	<0.007	<0.007	Below detection
Total Dissolved Iron #	TM30/PM14	<0.02	mg/l	<0.02	<0.02	<0.02	<0.02	Below detection
Dissolved Lead #	TM30/PM14	<0.005	mg/l	<0.005	<0.005	<0.005	<0.005	Below detection
Dissolved Magnesium #	TM30/PM14	<0.1	mg/l	21.1	10.3	6.90	3.40	No EQS Screening Values
Dissolved Manganese #	TM30/PM14	<0.002	mg/l	0.055	0.165	-	-	No EQS Screening Values
Dissolved Mercury #	TM30/PM14	<0.001	mg/l	<0.001	<0.001	<0.001	<0.001	Below detection
Dissolved Nickel #	TM30/PM14	<0.002	mg/l	0.004	0.006	<0.002	<0.002	0.02
Dissolved Phosphorus #	TM30/PM14	<5	ug/l	14	17	-	-	No EQS Screening Values
Dissolved Potassium #	TM30/PM14	<0.1	mg/l	0.5	0.3	0.70	0.50	No EQS Screening Values
Dissolved Selenium #	TM30/PM14	<0.003	mg/l	0.087	<0.003	-	-	No EQS Screening Values
Dissolved Silver	TM30/PM14	<0.001	mg/l	<0.001	<0.001	-	-	Below detection
Dissolved Sodium #	TM30/PM14	<0.1	mg/l	12.6	6.1	7.50	6.70	No EQS Screening Values
Dissolved Zinc #	TM30/PM14	<0.003	mg/l	0.004	<0.003	<0.003	<0.003	No EQS Screening Values
Bicarbonate Hardness Disolved	TM30/PM0	<1	mg/l	-	-	357	156	No EQS Screening Values
Total Hardness Dissolved (as CaCO3)	TM30/PM0	<1	mg/l	-	-	443	257	No EQS Screening Values
PAH MS				-	-			
Naphthalene #	TM4/PM30	<0.014	ug/l	-	-	<0.014	<0.014	Below detection
Acenaphthylene	TM4/PM30	<0.013	ug/l	-	-	<0.013	<0.013	Below detection
Acenaphthene #	TM4/PM30	<0.013	ug/l	-	-	<0.013	<0.013	Below detection
Fluorene #	TM4/PM30	<0.014	ug/l	-	-	<0.014	<0.014	Below detection
Phenanthrene #	TM4/PM30	<0.011	ug/l	-	-	<0.011	<0.011	Below detection
Anthracene #	TM4/PM30	<0.013	ug/l	-	-	<0.013	<0.013	Below detection
Fluoranthene #	TM4/PM30	<0.012	ug/l	-	-	<0.012	<0.012	Below detection
Pyrene #	TM4/PM30	<0.013	ug/l	-	-	<0.013	<0.013	Below detection
Benzo(a)anthracene #	TM4/PM30	<0.015	ug/l	-	-	<0.015	<0.015	Below detection
Chrysene #	TM4/PM30	<0.011	ug/l	-	-	<0.011	<0.011	Below detection
Benzo(bk)fluoranthene #	TM4/PM30	<0.018	ug/l	-	-	<0.018	<0.018	Below detection
Benzo(a)pyrene #	TM4/PM30	<0.016	ug/l	-	-	<0.016	<0.016	Below detection
Indeno(123cd)pyrene #	TM4/PM30	<0.011	ug/l	-	-	<0.011	<0.011	Below detection
Dibenzo(ah)anthracene #	TM4/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Benzo(ghi)perylene #	TM4/PM30	<0.011	ug/l	-	-	<0.011	<0.011	Below detection
PAH 6 Total	TM4/PM30	<0.195	ug/l	-	-	<0.195	<0.195	Below detection
Benzo(b)fluoranthene	TM4/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Benzo(k)fluoranthene	TM4/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
PAH Surrogate % Recovery	TM4/PM30	<0	ug/l	-	-	86	79	-
Pesticides MS								
Organochlorine Pesticides								
Aldrin	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Alpha-BHC	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Beta-BHC	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Dieldrin	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Endosulphan I	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Endosulphan II	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Endosulphan sulphate	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Endrin	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Gamma-BHC	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Heptachlor	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Heptachlor Epoxide	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
p,p'-DDE	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
p,p'-DDT	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
p,p'-TDE	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Total Methoxychlor	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Organophosphorous Pesticides				-	-			
Azinphos methyl	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Diazinon	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Dichlorvos	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Disulfoton	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Ethion	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Ethyl Parathion (Parathion)	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Fenitrothion	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Malathion	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Methyl Parathion	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
Mevinphos	TM42/PM30	<0.01	ug/l	-	-	<0.01	<0.01	Below detection
EPH (C8-C40) #	TM5/PM30	<0.01	mg/l	<0.01	<0.01	<0.01	<0.01	Below detection
Mineral Oil (Calculation)	TM5/PM30	<0.01	mg/l	-	-	<0.01	<0.01	Below detection
GRO (>C4-C8) #	TM36/PM12	<0.01	mg/l	<0.01	<0.01	<0.1	<0.1	Below detection
GRO (>C8-C12) #	TM36/PM12	<0.01	mg/l	<0.01	<0.01	<0.1	<0.1	Below detection
GRO (>C4-C12) #	TM36/PM12	<0.01	mg/l	<0.01	<0.01	<0.1	<0.1	Below detection
MTBE	TM36/PM12	<5	ug/l	-	-	<5	<5	Below detection
Benzene	TM36/PM12	<5	ug/l	-	-	<5	<5	Below detection
Toulene	TM36/PM12	<5	ug/l	-	-	<5	<5	Below detection
Ethylbenzene	TM36/PM12	<5	ug/l	-	-	<5	<5	Below detection
m/p-Xylene	TM36/PM12	<5	ug/l	-	-	<5	<5	Below detection
o-xylene	TM36/PM12	<5	ug/l	-	-	<5	<5	Below detection
Sulphate #	TM38/PM0	<0.05	mg/l	58.37	81.37	48.37	13.9	No EQS Screening Values
Chloride #	TM38/PM0	<0.3	mg/l	23.0	15.1	20.9	30.5	No EQS Screening Values
Phenol #	TM26/PM0	<0.01	mg/l	<0.01	<0.01	-	-	Below detection
Fluoride	TM27/PM0	<0.3	mg/l	0.5	<0.3	-	-	No EQS Screening Values
Nitrate as NO3 #	TM38/PM0	<0.2	mg/l	16.6	7.6	13.4	39.3	No EQS Screening Values
Nitrite as NO2 #	TM38/PM0	<0.02	mg/l	<0.02	0.22	<0.02	<0.02	No EQS Screening Values
Ortho Phosphate as PO4 #	TM38/PM0	<0.06	mg/l	<0.06	<0.06	<0.06	<0.06	Below detection
Nitrate as N #	TM38/PM0	<0.05	mg/l	3.75	1.71	-	-	No EQS Screening Values
Nitrite as N #	TM38/PM0	<0.006	mg/l	<0.006	0.067	-	-	No EQS Screening Values
Ortho Phosphate as P #	TM38/PM0	<0.03	mg/l	<0.03	<0.03	-	-	-
Total Oxidised Nitrogen as N #	TM38/PM0	<0.2	mg/l	3.7	1.8	-	-	No EQS Screening Values
Total Cyanide #	TM89/PM0	<0.01	mg/l	<0.01	<0.01	-	-	Below detection
Total Ammonia as N #	TM38/PM0	<0.03	mg/l	0.05	0.06	-	-	No EQS Screening Values
Total Alkalinity as CaCO3 #	TM75/PM0	<1	mg/l	424	592	-	-	No EQS Screening Values
Dissolved Oxygen	TM59/PM0	<1	mg/l	<1	<1	-	-	Below detection
Electrical Conductivity @25C #	TM76/PM0	<2	uS/cm	747	985	-	-	No EQS Screening Values
Faecal Coliforms*	Subcontracted		CFU/100ml	6	4	-	-	No EQS Screening Values
pH #	TM73/PM0	<0.01	pH units	7.42	7.11	7.66	7.42	No EQS Screening Values
Carbonate Alkalinity as CaCO3	TM75/PM0	<1	mg/l	-	-	<1	<1	Below detection
BOD (Settled)	TM58/PM0	<1	mg/l	-	-	<1	<1	Below detection
Free Amonia as NH4	TM53/PM0	<0.08	mg/l	-	-	0.33	<0.08	No EQS Screening Values
Manganese II	TM62/PM0	<0.02	mg/l	-	-	<0.02	<0.02	Below detection
Total Organic Carbon #	TM60/PM0	<2	mg/l	2	<2	-	-	No EQS Screening Values
Total Coliforms*	Subcontracted		CFU/100ml	6	4	-	-	No EQS Screening Values
Total Solids #	TM20/PM0	<5	mg/l	1205	1692	-	-	No EQS Screening Values

Annex B

HazWaste Online Output

ARUP

HazWasteOnline™

Waste Classification Report

2AAFQ-KPYY8-FJH8L

HazWasteOnline™ classifies waste as either **hazardous** or **non-hazardous** based on its chemical composition, related legislation and the rules and data defined in the current UK or EU technical guidance (Appendix C) (note that HP 9 Infectious is not assessed). It is the responsibility of the classifier named below to:

a) understand the origin of the waste
b) select the correct List of Waste code(s)
c) confirm that the list of determinands, results and sampling plan are fit for purpose
d) select and justify the chosen metal species (Appendix B)
e) correctly apply moisture correction and other available corrections
f) add the meta data for their user-defined substances (Appendix A)
g) check that the classification engine is suitable with respect to the national destination of the waste (Appendix C)

To aid the reviewer, the laboratory results, assumptions and justifications managed by the classifier are highlighted in pale yellow.

Job name

PPK3 Campus Plan Refresh

Description/Comments

Project

PPK3a

Site

Buckingham

Classified by

Name:

Jack Walton

Date:

18 Apr 2024 10:01 GMT

Telephone:

44 29 2076 9081

Company:

Ove Arup

4 Pierhead Street Capital Waterside Cardiff CF10 4QP

HazWasteOnline™ provides a two day, hazardous waste classification course that covers the use of the software and both basic and advanced waste classification techniques. Certification has to be renewed every 3 years.

HazWasteOnline™ Certification:	**CERTIFIED**
Course	**Date**
Hazardous Waste Classification	05 Oct 2023

Next 3 year Refresher due by Oct 2026

Purpose of classification

2 - Material Characterisation

Address of the waste

TBC **Post Code** TBC

SIC for the process giving rise to the waste

41201 Construction of commercial buildings

Description of industry/producer giving rise to the waste

Development of the site and construction of the proposed building.

Description of the specific process, sub-process and/or activity that created the waste

Waste generated during development of the site and construction of the proposed building.

Description of the waste

Topsoil

Made Ground comprising compact grey sandy gravel. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse. Natural soils comprising firm grey brown slightly sandy slightly gravelly clay with a low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.

Job summary

#	Sample name	Depth [m]	Classification Result	Hazard properties	Page
1	TP6	0.50	Non Hazardous		3
2	TP17	0.50	Non Hazardous		5
3	TP39	0.40	Non Hazardous		7
4	TP41	0.30	Non Hazardous		9
5	TP42	0.30	Non Hazardous		11
6	TP47	0.70	Non Hazardous		13
7	TP54	0.80	Non Hazardous		15
8	TP55	0.50	Non Hazardous		17
9	TP67	0.20	Non Hazardous		19
10	TP76	0.65	Non Hazardous		21
11	TP82	0.60	Non Hazardous		23
12	TP93	0.50	Non Hazardous		25
13	TP48	0.50	Non Hazardous		27
14	TP6 (2019)	0.50	Non Hazardous		29
15	TP17 (2019)	0.50	Non Hazardous		31
16	TP39 (2019)	0.40	Non Hazardous		33
17	TP41 (2019)	0.30	Non Hazardous		35
18	TP42 (2019)	0.30	Non Hazardous		37
19	TP47 (2019)	0.70	Non Hazardous		39
20	TP54 (2019)	0.80	Non Hazardous		41
21	TP55 (2019)	0.50	Non Hazardous		43
22	TP67 (2019)	0.20	Non Hazardous		45
23	TP76 (2019)	0.65	Non Hazardous		47
24	TP82 (2019)	0.60	Non Hazardous		49
25	TP93 (2019)	0.50	Non Hazardous		51
26	TP48 (2019)	0.50	Non Hazardous		53
27	TP10 (2013)	0.6-0.7	Non Hazardous		55
28	TP12 (2013)	0.7-0.8	Non Hazardous		57
29	TP01 (2011)	0.6	Non Hazardous		59
30	TP02 (2011)	0.6	Non Hazardous		61
31	TP03 (2011)	0.8	Non Hazardous		63
32	TP04 (2011)	0.7	Non Hazardous		65
33	TP05 (2011)	0.2	Non Hazardous		67
34	TP06 (2011)	0.2	Non Hazardous		69
35	TP07 (2011)	0.2	Non Hazardous		71
36	TP08 (2011)	0.2	Non Hazardous		73
37	TP09 (2011)	0.2	Non Hazardous		75
38	TP10 (2011)	0.2	Non Hazardous		77

Related documents

#	Name	Description
1	Example waste stream template for contaminated soils	waste stream template used to create this Job

Report

Created by: Jack Walton

Created date: 18 Apr 2024 10:01 GMT

Appendix A: Classifier defined and non GB MCL determinands

chromium(III) oxide (worst case) (EC Number: 215-160-9, CAS Number: 1308-38-9)

Description/Comments: Data from C&L Inventory Database

Data source: https://echa.europa.eu/information-on-chemicals/cl-inventory-database/-/discli/details/33806

Data source date: 17 Jul 2015

Hazard Statements: Acute Tox. 4; H332 , Acute Tox. 4; H302 , Eye Irrit. 2; H319 , STOT SE 3; H335 , Skin Irrit. 2; H315 , Resp. Sens. 1; H334 , Skin Sens. 1; H317 , Repr. 1B; H360FD , Aquatic Acute 1; H400 , Aquatic Chronic 1; H410

acenaphthylene (EC Number: 205-917-1, CAS Number: 208-96-8)

Description/Comments: Data from C&L Inventory Database

Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database

Data source date: 17 Jul 2015

Hazard Statements: Acute Tox. 4; H302 , Acute Tox. 1; H330 , Acute Tox. 1; H310 , Eye Irrit. 2; H319 , STOT SE 3; H335 , Skin Irrit. 2; H315

acenaphthene (EC Number: 201-469-6, CAS Number: 83-32-9)

Description/Comments: Data from C&L Inventory Database

Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database

Data source date: 17 Jul 2015

Hazard Statements: Eye Irrit. 2; H319 , STOT SE 3; H335 , Skin Irrit. 2; H315 , Aquatic Acute 1; H400 , Aquatic Chronic 1; H410 , Aquatic Chronic 2; H411

fluorene (EC Number: 201-695-5, CAS Number: 86-73-7)

Description/Comments: Data from C&L Inventory Database

Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database

Data source date: 06 Aug 2015

Hazard Statements: Aquatic Acute 1; H400 , Aquatic Chronic 1; H410

phenanthrene (EC Number: 201-581-5, CAS Number: 85-01-8)

Description/Comments: Data from C&L Inventory Database

Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database

Data source date: 06 Aug 2015

Hazard Statements: Acute Tox. 4; H302 , Eye Irrit. 2; H319 , STOT SE 3; H335 , Carc. 2; H351 , Skin Sens. 1; H317 , Aquatic Acute 1; H400 , Aquatic Chronic 1; H410 , Skin Irrit. 2; H315

anthracene (EC Number: 204-371-1, CAS Number: 120-12-7)

Description/Comments: Data from C&L Inventory Database

Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database

Data source date: 17 Jul 2015

Hazard Statements: Eye Irrit. 2; H319 , STOT SE 3; H335 , Skin Irrit. 2; H315 , Skin Sens. 1; H317 , Aquatic Acute 1; H400 , Aquatic Chronic 1; H410

fluoranthene (EC Number: 205-912-4, CAS Number: 206-44-0)

Description/Comments: Data from C&L Inventory Database

Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database

Data source date: 21 Aug 2015

Hazard Statements: Acute Tox. 4; H302 , Aquatic Acute 1; H400 , Aquatic Chronic 1; H410

pyrene (EC Number: 204-927-3, CAS Number: 129-00-0)

Description/Comments: Data from C&L Inventory Database; SDS Sigma Aldrich 2014

Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database

Data source date: 21 Aug 2015

Hazard Statements: Skin Irrit. 2; H315 , Eye Irrit. 2; H319 , STOT SE 3; H335 , Aquatic Acute 1; H400 , Aquatic Chronic 1; H410

indeno[123-cd]pyrene (EC Number: 205-893-2, CAS Number: 193-39-5)

Description/Comments: Data from C&L Inventory Database

Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database

Data source date: 06 Aug 2015

Hazard Statements: Carc. 2; H351

benzo[ghi]perylene (EC Number: 205-883-8, CAS Number: 191-24-2)

Description/Comments: Data from C&L Inventory Database; SDS Sigma Aldrich 28/02/2015

Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database

Data source date: 23 Jul 2015

Hazard Statements: Aquatic Acute 1; H400 , Aquatic Chronic 1; H410

TPH (C6 to C40) petroleum group (CAS Number: TPH)

Description/Comments: Hazard statements taken from WM3 1st Edition 2015; Risk phrases: WM2 3rd Edition 2013

Data source: WM3 1st Edition 2015

Data source date: 25 May 2015

Hazard Statements: Flam. Liq. 3; H226 , Asp. Tox. 1; H304 , STOT RE 2; H373 , Muta. 1B; H340 , Carc. 1B; H350 , Repr. 2; H361d , Aquatic Chronic 2; H411

ethylbenzene (EC Number: 202-849-4, CAS Number: 100-41-4) GB MCL index number: 601-023-00-4

Description/Comments:

Additional Hazard Statement(s): Carc. 2; H351

Reason for additional Hazards Statement(s):

20 Nov 2021 - Carc. 2; H351 hazard statement sourced from: IARC Group 2B (77) 2000

salts of hydrogen cyanide with the exception of complex cyanides such as ferrocyanides, ferricyanides and mercuric oxycyanide and those specified elsewhere in this Annex

GB MCL index number: 006-007-00-5

Description/Comments: Conversion factor based on a worst case compound: sodium cyanide Additional Hazard Statement(s): EUH032 >= 0.2 %

Reason for additional Hazards Statement(s):

20 Nov 2021 - EUH032 >= 0.2 % hazard statement sourced from: WM3, Table C12.2

polychlorobiphenyls; PCB (EC Number: 215-648-1, CAS Number: 1336-36-3) GB MCL index number: 602-039-00-4

Description/Comments: Worst Case: IARC considers PCB Group 1; Carcinogenic to humans;

POP specific threshold from ATP1 (Regulation 756/2010/EU) to POPs Regulation (Regulation 850/2004/EC). Where applicable, the calculation method laid down in European standards EN 12766-1 and EN 12766-2 shall be applied.

Additional Hazard Statement(s): Carc. 1A; H350

Reason for additional Hazards Statement(s):

20 Nov 2021 - Carc. 1A; H350 hazard statement sourced from: IARC Group 1 (23, Sup 7, 100C) 2012

pH (CAS Number: PH)

Description/Comments:
Appendix C4

Data source: WM3 1st Edition 2015 Data source date: 25 May 2015 Hazard Statements: None.

1,1-dichloroethane and 1,2-dichloroethane (combined) (EC Number: 203-458-1, 200-863-5, CAS Number: 107-06-2, 75-34-3)

Description/Comments: Combines the hazard statements and risk phrases for 1,1-dichloroethane and 1,2-dichloroethane

Data source: N/a

Data source date: 14 Oct 2016

Hazard Statements: Flam. Liq. 2; H225 , Acute Tox. 4; H302 , Skin Irrit. 2; H315 , Eye Irrit. 2; H319 , STOT SE 3; H335 , Carc. 1B; H350 , Aquatic Chronic 3; H412

Appendix B: Rationale for selection of metal species

arsenic {arsenic trioxide}

Reasonable case CLP species based on hazard statements/molecular weight and most common (stable) oxide of arsenic. Industrial sources include: smelting; main precursor to other arsenic compounds (edit as required)

boron {diboron trioxide}

Reasonable case CLP species based on hazard statements/ molecular weight, physical form and low solubility. Industrial sources include: fluxing agent for glass/enamels; additive for fibre optics, borosilicate glass (edit as required)

cadmium {cadmium oxide}

Reasonable case CLP species based on hazard statements/molecular weight, very low solubility in water. Industrial sources include:

electroplating baths, electrodes for storage batteries, catalysts, ceramic glazes, phosphors, pigments and nematocides. (edit as required) Worst case compounds in CLP: cadmium sulphate, chloride, fluoride & iodide not expected as either very soluble and/or compound's industrial usage not related to site history (edit as required)

chromium in chromium(III) compounds {chromium(III) oxide (worst case)}

Reasonable case species based on hazard statements/molecular weight. Industrial sources include: tanning, pigment in paint, inks and glass (edit as required)

chromium in chromium(VI) compounds {chromium (VI) compounds, with the exception of barium chromate and of compounds specified elsewhere in this Annex}

Worst case species based on hazard statements/molecular weight (edit as required)

copper {dicopper oxide; copper (I) oxide}

Reasonable case CLP species based on hazard statements/molecular weight and insolubility in water. Industrial sources include:

oxidised copper metal, brake pads, pigments, antifouling paints, fungicide. (edit as required) Worse case copper sulphate is very soluble and likely to have been leached away if ever present and/or not enough soluble sulphate detected. (edit as required)

lead {lead chromate}

Worst case CLP species based on hazard statements/molecular weight (edit as required)

mercury {mercury dichloride}

Worst case CLP species based on hazard statements/molecular weight (edit as required)

molybdenum {molybdenum(VI) oxide}

Worst case CLP species based on hazard statements/molecular weight (edit as required)

nickel {nickel chromate}

Worst case CLP species based on hazard statements/molecular weight (edit as required)

selenium {nickel selenate}

Worst case CLP species based on hazard statements/molecular weight (edit as required)

zinc {zinc chromate}

Worst case CLP species based on hazard statements/molecular weight (edit as required)

cyanides {salts of hydrogen cyanide with the exception of complex cyanides such as ferrocyanides, ferricyanides and mercuric oxycyanide and those specified elsewhere in this Annex}

Harmonised group entry used as most reasonable case as complex cyanides and those specified elsewhere in the annex are not likely to be present in this soil: [Note conversion factor based on a worst case compound: sodium cyanide] (edit as required)

Appendix C: Version

HazWasteOnline Classification Engine: WM3 1st Edition v1.2.GB - Oct 2021
HazWasteOnline Classification Engine Version: 2024.108.6016.11150 (17 Apr 2024)

HazWasteOnline Database: 2024.108.6016.11150 (17 Apr 2024)

This classification utilises the following guidance and legislation:

WM3 v1.2.GB - Waste Classification - 1st Edition v1.2.GB - Oct 2021 **CLP Regulation** - Regulation 1272/2008/EC of 16 December 2008 **1st ATP** - Regulation 790/2009/EC of 10 August 2009

2nd ATP - Regulation 286/2011/EC of 10 March 2011 **3rd ATP** - Regulation 618/2012/EU of 10 July 2012 **4th ATP** - Regulation 487/2013/EU of 8 May 2013

Correction to 1st ATP - Regulation 758/2013/EU of 7 August 2013

5th ATP - Regulation 944/2013/EU of 2 October 2013

6th ATP - Regulation 605/2014/EU of 5 June 2014

WFD Annex III replacement - Regulation 1357/2014/EU of 18 December 2014 **Revised List of Waste 2014** - Decision 2014/955/EU of 18 December 2014 **7th ATP** - Regulation 2015/1221/EU of 24 July 2015

8th ATP - Regulation (EU) 2016/918 of 19 May 2016 **9th ATP** - Regulation (EU) 2016/1179 of 19 July 2016 **10th ATP** - Regulation (EU) 2017/776 of 4 May 2017

HP14 amendment - Regulation (EU) 2017/997 of 8 June 2017 **13th ATP** - Regulation (EU) 2018/1480 of 4 October 2018 **14th ATP** - Regulation (EU) 2020/217 of 4 October 2019

15th ATP - Regulation (EU) 2020/1182 of 19 May 2020

The Chemicals (Health and Safety) and Genetically Modified Organisms (Contained Use)(Amendment etc.) (EU Exit) Regulations 2020 - UK: 2020 No. 1567 of 16th December 2020

The Waste and Environmental Permitting etc. (Legislative Functions and Amendment etc.) (EU Exit) Regulations 2020 - UK: 2020 No. 1540 of 16th December 2020

GB MCL List - version 1.1 of 09 June 2021

GB MCL List v2.0 - version 2.0 of 20th October 2023
GB MCL List v3.0 - version 3.0 of 11th January 2024
GB MCL List v4.0 - version 4.0 of 2nd March 2024

Solar Photovoltaic Glint and Glare Study

Aviation Specific

DC3 Data Centre Development

May 2024

Executive Summary

Report Overview

This report assesses the potential for ocular impact of glare emanating from sunlight reflections for a proposed Solar PV Array at the DC3 Data Centre Development, Grange Castle Business Park South, Baldonnel Rd, Dublin, D22 X602, and its potential to cause an impact to users of the nearby Casement Aerodrome.

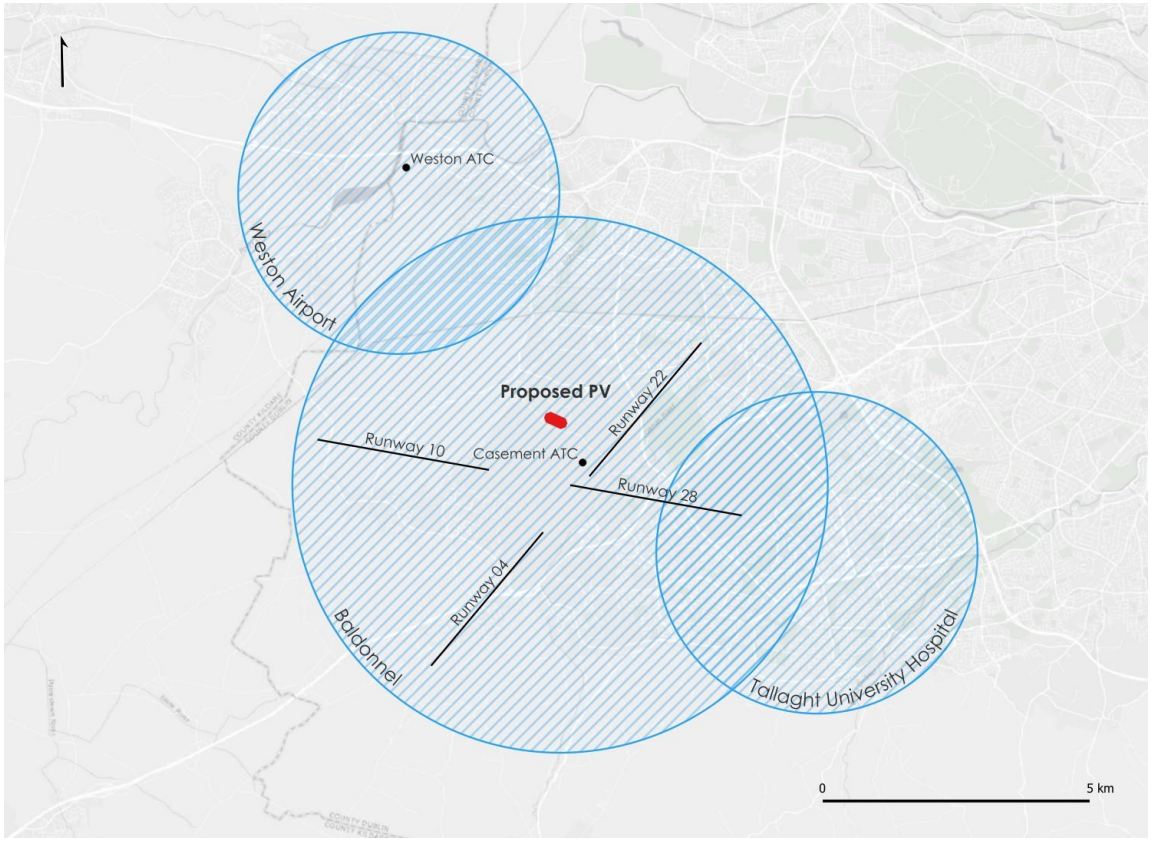


FIGURE 1 OVERVIEW MAP OF STUDY AREA, WITH SOLAR SAFEGUARDING ZONES FOR CASEMENT, TALLAGHT HOSPITAL AND WESTIN AERODROME INDICATED[1]

[1] Sources: Esri, DeLorme, HERE, MapmyIndia

LINT Geospatial

LINT GEOSPATIAL is a leading geospatial and data analysis company. Our innovative team has over ten years' experience in the GIS sector, working on a wide range of analysis and optimisation projects across the public and private sector, including numerous wind and solar farms, in Ireland and the UK.

Receptors

For this analysis, the aviation facilities as defined by the solar safeguarding zones[2] which overlap with the proposed development were considered, with the following receptors identified:

TABLE 1 RECEPTOR DETAILS

Location	Name	Type
Casement Aerodrome	ATC-T	ATC Tower
	Runway 10	2 mile approach path
	Runway 04	2 mile approach path
	Runway 28	2 mile approach path
	Runway 22	2 mile approach path

PV Array Details

The proposed PV Array configuration is shown in red in Figure 2. The array will have an approximately East-West orientation, at 115° and 295° respectively with a nominal pitch of 15°. For the purpose of the analysis, the entire roof surface was modelled as one block for each of the orientations.

[2] https://data.gov.ie/dataset/solar-safeguarding-zones

FIGURE 2 CONFIGURATION OF ARRAY ON ROOFTOP OF THE NEW DATA CENTRE HALL, BALDONNEL[3]

Guidance and Studies

No formal policy or methodology exists at present within Ireland with respect to the interaction of solar PV installations and aviation activity. Any guidance that has been published is relatively high level and does not indicate a formal approach to the assessment of glint and glare hazard.

The methodology used by LINT Geospatial follows the guidance published by the US Federal Aviation Authority in 2013[18], which recommends the use of a specific analysis tool, the Solar Glare Hazard Analysis Tool (SGHAT), when carrying out glint & glare assessments of solar PV systems for aviation receptors. Further detail on guidance and studies can be found later in this document.

[3] Imagery from Bing Maps

With respect to the ocular hazard posed by reflections from solar PV panels, the intensity has been repeatedly found to be similar to or less than those caused by standing water and substantially less than reflections from glass or polished metal[4].

Overall Conclusions – Aviation Receptors

- No potential for glare has been identified for personnel in the ATC-Tower at Casement Aerodrome.
- No potential for glare above the permitted green glare (low potential for after-image) has been identified for pilots on 2 mile approach to the four runways at Casement Aerodrome. **It can be therefore concluded that no potential for hazardous glare exists.**

Table 2 outlines the results of the analysis, across all receptors.

TABLE 2 SUMMARY RESULTS OF GLINT AND GLARE ANALYSIS FOR AVIATION RECEPTORS

Location	Name	Result
Casement Aerodrome	ATC-T	No Glare
	Runway 10	No Glare
	Runway 04	No Glare
	Runway 28	No Glare
	Runway 22	Green Glare

Since there is

- no glare to be experienced for the ATC tower
- no potential for glare for the 2-mile approaches to Runway 10, Runway 04 or Runway 28

[4] Sreenath, S., Sudhakar, K. and Yusop, A.F., 2021. Solar PV in the airport environment: A review of glare assessment approaches & metrics. Solar Energy, 216, pp.439-451.

- potential for green glare only (low potential for after-image which is acceptable under the relevant guidance) at Runway 22

this development can be viewed as posing no potential for glint and glare hazard to aviation users of Casement Aerodrome.

Table of Contents

Table of Figures

TABLE OF TABLES

Introduction

Overview

LINT has been appointed by GIL to carry out a glint and glare study for a roof mounted Solar PV Array on their facility at the DC3 Data Centre Development (Figure 1 and Figure 2). The modules will be mounted to frames on the roof surface, with a bi-directional East-West aspect, with an inclination of 15°. The assessment is for all aviation receptors from the Solar Safeguardig Zones[5] that overlap with the proposed site:

- the runway approaches Casement Aerodrome;
- the Air Traffic Control Towers at Casement.

The report contains the following:

- Solar Development Details
- Receptor Details
- Glint and Glare Overview
- Overview of Relevant Guidance and Studies
- Assessment Methodology
- Assessment Results
- Conclusions

Report Summary

Using desk-based analysis, this report has assessed the potential for glare on aircraft taking off and landing and for the Air Traffic Control Towers at Casement Aerodrome.

Using sun-path algorithms for every minute of the year (assuming 100% sunshine for all daylight hours), it is determined when reflections may occur at these selected receptors. If reflection is found geometrically possible from a particular location,

[5] https://data.gov.ie/dataset/solar-safeguarding-zones

further analysis is then carried out. This further analysis determines the significance of the glare that could potentially be experienced and if these effects are likely to be experienced by an observer at that location. In certain cases, where glare is found to be significant and a likely source of hazard or nuisance, mitigation factors can then be recommended.

Proposed Solar PV Array and Receptor Details

Solar Development Details

The proposed layout of the PV arrays on the roof of the DC3 Data Centre Development scheme is shown again in Figure 3.

FIGURE 3 LAYOUT OF PROPOSED DEVELOPMENT, WITH LOCATION OF SOLAR PANEL ARRAY IN RED.[1]

Receptor Details

Aviation Receptors

Only Casement Aerodrome, directly to the south of the proposed development was found to be in scope for this analysis.

Figure 1 shows the relative location of the proposed solar PV installation to the aviation receptors at the above location.

Relevant Guidance and Studies

A comprehensive review of applicable guidance and studies is presented in Appendix I. In summary, the conclusions from these studies are as follows:

- Reflection from solar panel surfaces is possible and has been known to cause a potential for hazard to aviation in rare cases;
- The amount of sunlight reflected by a solar PV panel can range from between 2% to 30% and is primarily dependent on the angle of incidence of sunlight to the panel surface.
- Studies have shown that the intensity of sunlight reflection from solar panel surfaces is similar to that of standing water, and less than that of snow, concrete or glass facades.
- The Solar Glare Hazard Analysis Tool is the only methodology that has been recommended by a national aviation authority (the US FAA).

Glint and Glare Overview

What are Glint and Glare?

Glint and glare are phenomenon caused by many reflective materials, whereby light from the sun is reflected off such materials with a potential to cause hazard, nuisance or unwanted visual impact. Glint and glare have been best defined by the United States Federal Aviation Administration (FAA) in their "*Technical Guidance for Evaluating Selected Solar Technologies on Airports*"[6]:

> ***Glint*** *is a momentary flash of bright light.*
>
> ***Glare*** *is a continuous source of bright light.*

Glint and Glare are also commonly referred to as 'solar reflection'. To determine the impact that solar reflection could potentially have on members of the public, it is

[6] Federal Aviation Administration, November 2010: *Technical Guidance for Evaluating Selected Solar Technologies on Airports*

sometimes necessary to carry out a glint and glare assessment for proposed solar PV farms or roof mounted arrays.

When do Glint and Glare Occur?

The sun rises in the east and sets in the west and in the northern hemisphere, tracks a southerly arc across the sky (Figure 4). The elevation angle that the sun reaches varies depending on the time of year, with high angles in the summer months and much lower angles in winter.

Once the sun reaches a certain elevation in the sky, the incident angle of the sun will reflect off the solar panels at an opposing angle that will not impact on any ground-based receptors. As a result of this, for ground-based receptors, glint and glare from solar farms will generally only occur in the mornings and the evenings. At these times, the sun will also be shining from a similar direction as any potential glare. For aviation receptors however, glare can potentially occur at any time of day depending on the location of the aircraft.

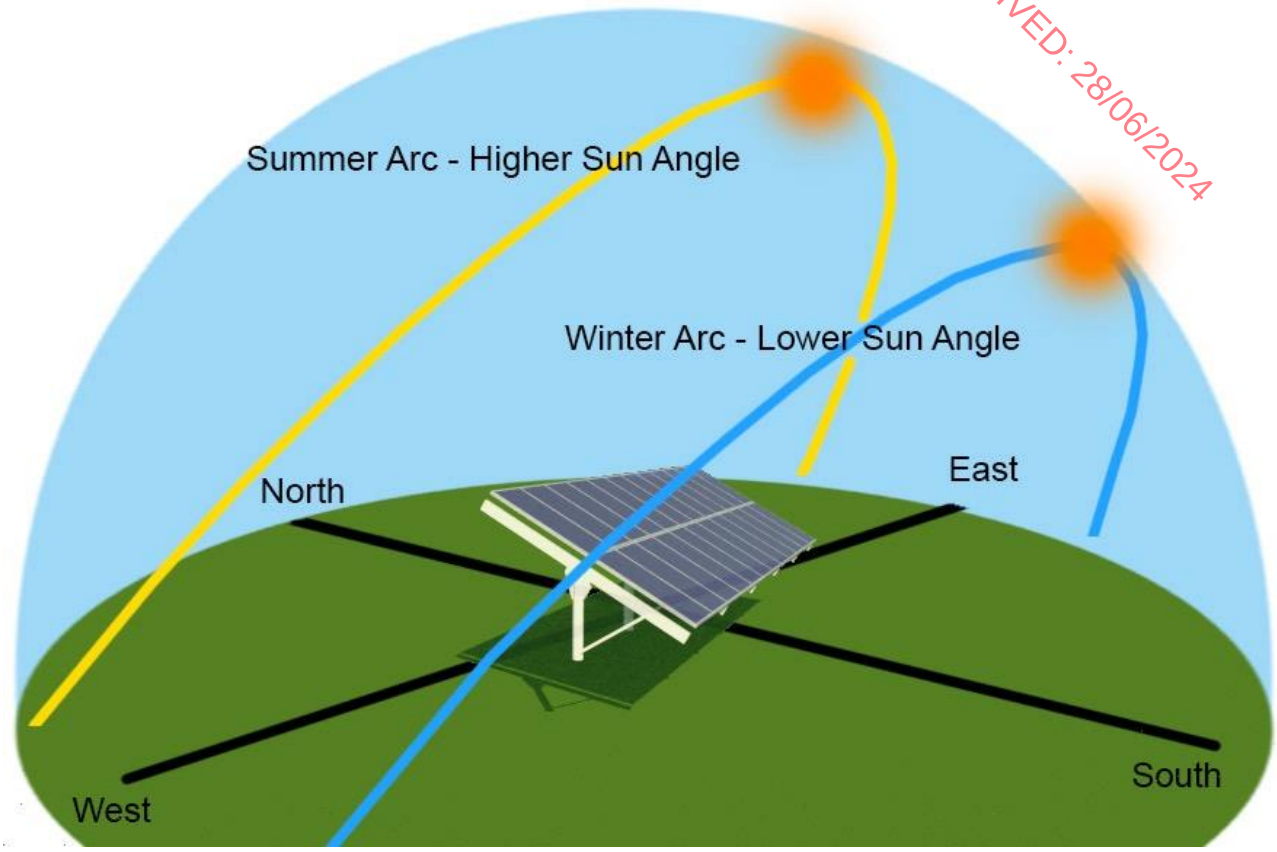


FIGURE 4 ARCS TRACKED BY SUN AT DIFFERENT TIMES OF THE YEAR

Meteorological & Atmospheric Conditions

It is also worth noting that glint and glare can only occur when there is direct sunlight reaching the solar panels. In overcast or rainy conditions, no glint or glare will occur. Based on historical data from Casement Aerodrome, the average amount of sunshine in a year is 1465 hours, which is less than 33% of the maximum possible 4476 daylight hours.

In Figure 5, it can be seen that in Dublin, even in the sunniest months, the daily ratio of sunshine to daylight hours ranges from 30% to 50%

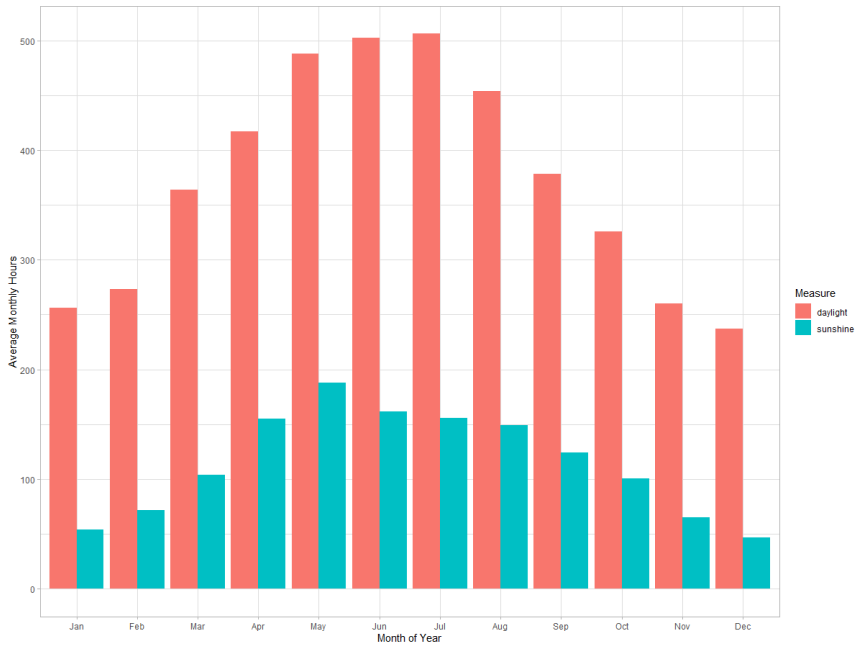


FIGURE 5 CASEMENT SUNSHINE VERSUS DAYLIGHT[7]

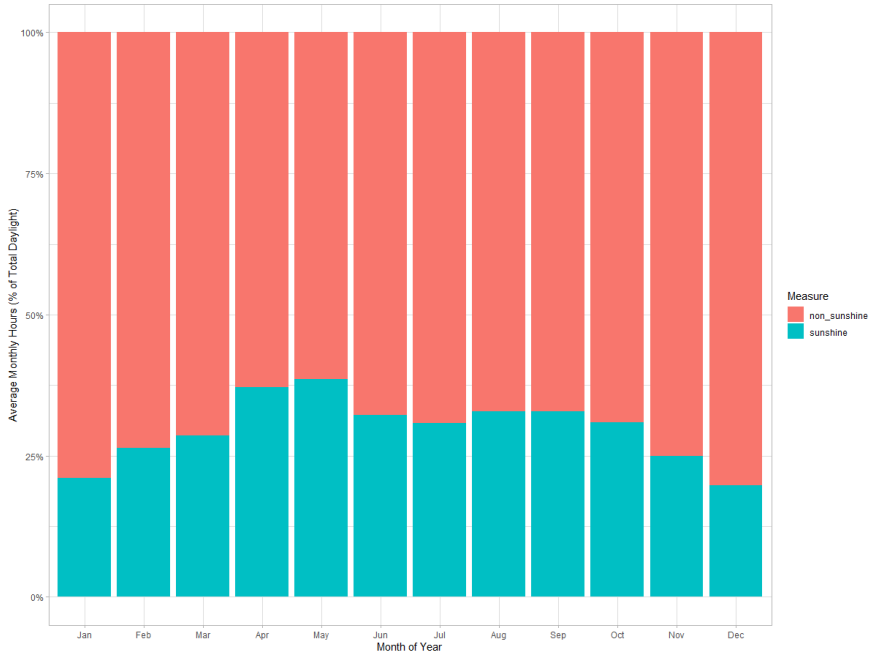


FIGURE 6 PROPORTION OF SUNSHINE TO DAYLIGHT

[7] https://cli.fusio.net/cli/climate_data/webdata/hly3723.csv

Solar Reflectance from PV Panels

Surface Reflectance

All surface types have different reflectivity characteristics. This results in varying degrees of sunlight reflection. Solar panels, by their nature, are designed to absorb as much sunlight as possible, thus converting the sun's energy to electricity. As a result, the amount of light reflected off these installations is far less than one might expect. The figure below () is taken from the FAA's "*Technical Guidance for Evaluating Selected Solar Technologies on Airports*"[4] and illustrates that the reflectance of solar PV panels is of a similar nature to water. Typical values for the reflectance levels of solar PV panels are far less than that of materials such as snow, concrete and even vegetation. It should be noted however, that at certain times of the day, generally

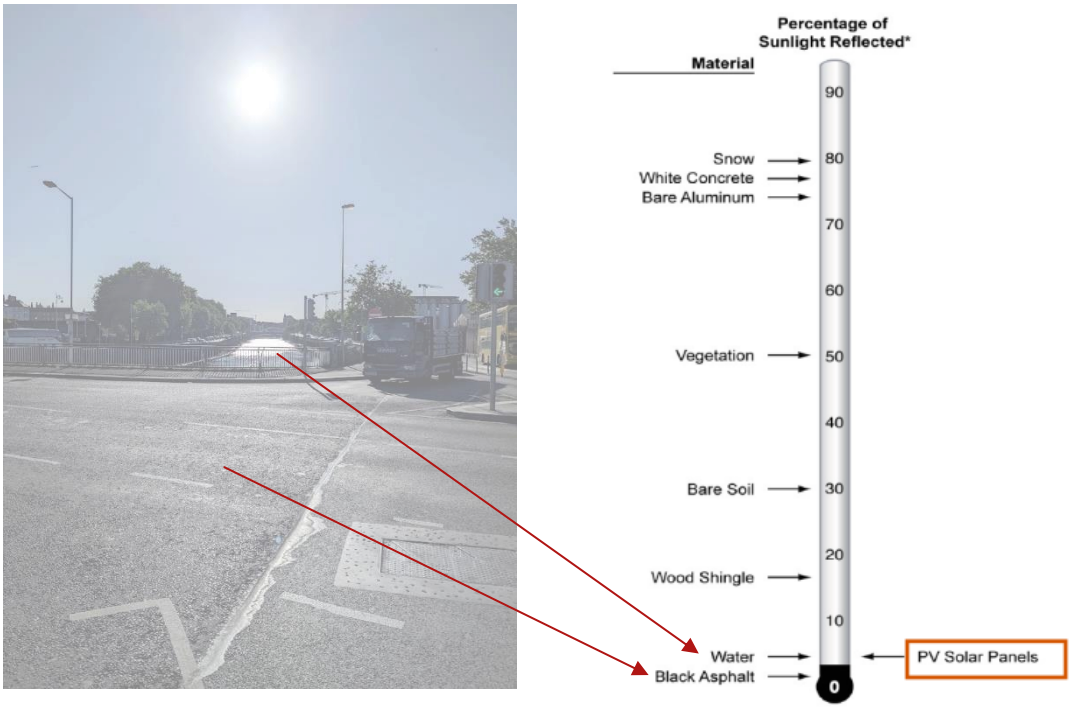


FIGURE 7 REFLECTIVITY PRODUCED BY DIFFERENT SURFACES (SOURCE FAA)

early morning and late evening, with the sun low in the sky, the amount of light reflected off solar panels can increase, causing a potential for glare in certain directions.

Types of Reflection

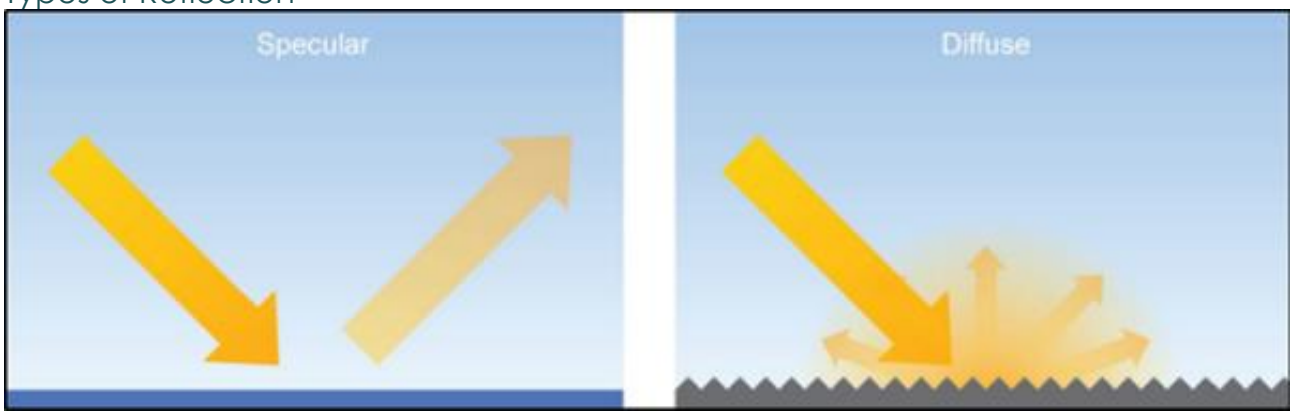


FIGURE 8 DIFFERENT TYPES OF REFLECTION (SOURCE FAA)

There are two types of reflection which can occur on a surface; specular and diffuse. Specular reflection is a direct reflection which produces a more "focused" type of light. It occurs when light reflects off a smooth or polished surface like glass or still water. Diffuse reflection, on the other hand, produces a less "focused" type of light. Diffuse reflection occurs because of light reflecting off a rough surface such as vegetation, concrete or wavy water. Figure 8 helps to illustrate the difference between these two types of reflection. The main type of reflectance from solar PV panels is specular due to the glass like texture of the outer layer of the panels. However, like all surfaces there will be a combination of both specular and diffuse reflection. As discussed earlier, the level of potential glare from solar PV panels is like that of water and much less than that of materials such as concrete and vegetation. Many common elements of the Irish landscape offer similar, if not higher levels of glare than that caused by solar PV systems such as shed roofs, still lakes and even the strips of plastic sheeting used on farms to produce maize (Figure 9).

FIGURE 9 PLASTIC MAIZE WRAP IN A FIELD WITH POTENTIAL TO CAUSE SIMILAR LEVELS OF GLARE AS SOLAR PV FARMS

Methodology

LINT's methodology can be broken down into six key stages:

1. Study Area Selection
2. Receptor Identification
3. Geometric Analysis
4. Examination of Screening and Receptor Orientation
5. Determination of Impact
6. Mitigation

Study Area Selection

The first stage of any glint and glare assessment is to identify the study area. In the case of this development, any aviation location that defines a Solar Safeguarding Zone that intersects with the proposed PV will be considered for analysis.

Receptor Identification

Once the study area has been defined, receptors can then be identified. For this site, the receptors are;

Location	Name
Casement Aerodrome	ATC-T
	Runway 10
	Runway 04
	Runway 28
	Runway 22

The map outlining the location of the aviation receptors can be seen at Figure 1.

Airports & Airstrips

The two main receptors that need to be considered when assessing the glint and glare effects of solar PV panels on aerodromes are Air Traffic Control Towers (ATC-T) and the final approach path to a runway. An ATC-T is assessed much like any other receptor point using the correct altitude of the tower. For final runway approach paths, a line is extrapolated 2 miles back from the runway threshold (the point at which an aircraft enters the runway) at an angle of 3 degrees. This results in a continuous analysis of every point along the final approach to the runway. For this report, the above process is carried out for Casement Aerodrome. It should also be noted that these calculations take the pilots field of view into consideration and thus limit the angle of view to 100 degrees in the horizontal and a downward viewing angle of 30 degrees.

Geometric Analysis

As discussed previously in this document, LINT employs the use of the SGHAT to run the calculations for its glint and glare analysis. This is currently the only widely accepted tool for measuring the ocular impact of solar PV systems on receptors.

Several parameters are considered to run these geometric analyses. These include, but are not limited to:

- The apparent position and height of the sun at a particular time of day and year for every minute of the year.
- The position, height, orientation & pitch of the solar PV array.
- The position and height of the receptor.

The severity of the glare is influenced mainly by two factors:

- The distance of the observer from the glare spot, and
- The angle of the sunlight hitting the solar panels relevant to the observer

Examination of Screening and Receptor Orientation

The geometrical glare analysis does not consider screening from landform such as hills and mountains, or any vegetative or built environment elements of the landscape that may screen the development from view. For this reason, once the receptors that could potentially experience glare have been identified, their level of existing screening must be assessed. This is done through a combination of desk-based analysis of both Google StreetView and aerial photography, analysis using digital elevation models or high-resolution digital surface models and may sometimes require a site visit for further verification. Receptor orientation is also considered. Geometric analysis may suggest that a receptor will experience glare, but the orientation of the receptor also needs to be considered. If a receptor is facing away from the solar array, any potential glare could have little or no impact. Similarly, a road may show up as having potential to experience glare, but unless the direction of travel is towards the source of glare, it is unlikely to cause significant impact.

Determination of Impact – Aviation Receptors

Once all the above steps are carried out, a determination of likely impacts can be made for each receptor. The ocular impact of glare is visualized with the Glare Hazard Plot (Figure 10). This chart displays the ocular impact as a function of glare subtended source angle and retinal irradiance. The interim guidance from the FAA of 2013 concerning aviation glint and glare dictates;

- No potential for glare at ATC Towers
- Only glare in the "Green" zone allowable for 2-mile approach paths to runways

Therefore, it is necessary to determine whether any of the array / receptor combinations fall outside of these criteria.

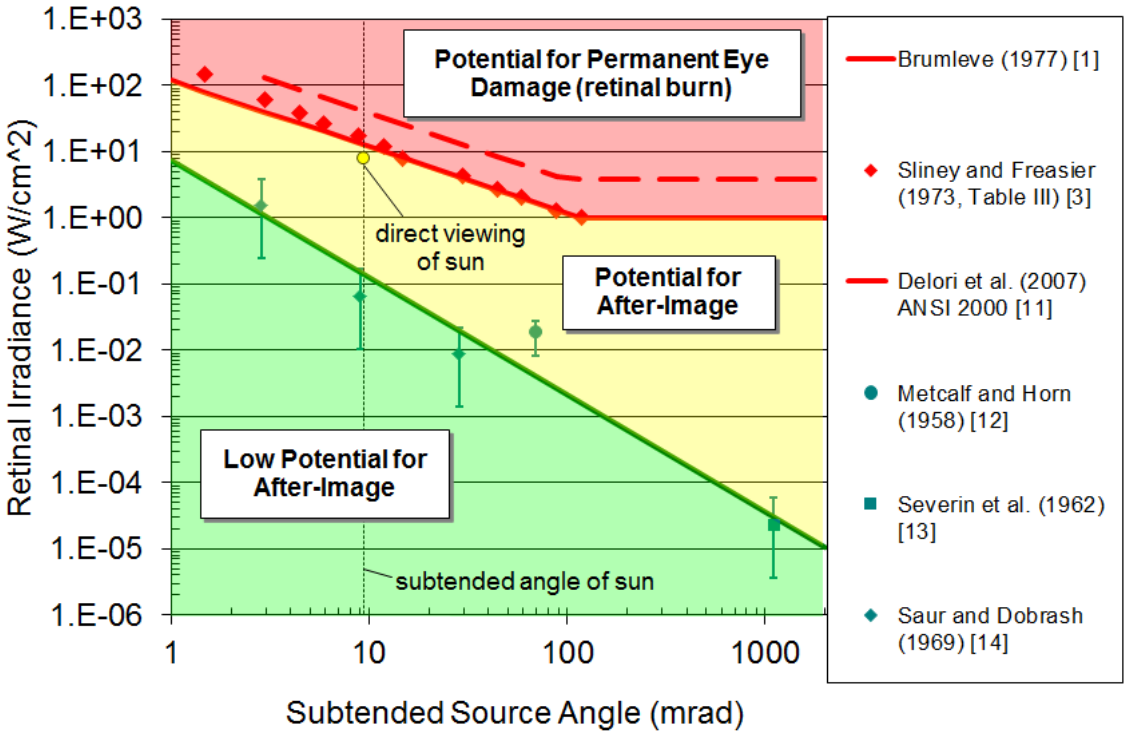


FIGURE 10 SOLAR GLARE HAZARD PLOT

Determination of Impact – Non-Aviation Receptors

As discussed, there is some guidance available on how to measure and determine the impact of glint and glare on aviation receptors. For other receptors however, there is no explicit guidance and it is necessary to look to other fields to build a reasonable approach. A document by Pager Power titled "Solar-Photovoltaic-Glint-and-Glare-Guidance-Fourth-Edition"[8] outlines a rationale based on the guidance for Wind Turbine Shadow Flicker impact, recommending:

> *If visible glint and glare is predicted for a surrounding dwelling for longer than 60 minutes per day, for three or more months of the year, then the impact should be considered significant with respect to residential amenity. In this scenario, mitigation should be implemented.*

For road and amenity receptors, due to the transient nature of a viewer experiencing glint and glare from a solar panel reflection, the duration and intensity of the glint and glare should be evaluated and considered against the characteristics of the receptor. Results of the geometric analysis and screening examination are collated into a table with comments as to the likely glint and glare impact or otherwise, of the proposed solar PV panels on all assessed receptors. An initial determination is made using the table below, based purely on the theoretical amount of time a receptor may potentially experience glare.

TABLE 3 DETERMINATION OF IMPACT FOR NON-AVIATION RECEPTORS

Classification	Description
High	Potential for more than 60 mins of glare per day and/or for more than 150 days in a year

[8] https://www.pagerpower.com/wp-content/uploads/2022/09/Solar-Photovoltaic-Glint-and-Glare-Guidance-Fourth-Edition.pdf

Medium	Potential for 30 to 60 mins of glare per day and/or for 60 to 90 days in a year
Low	Potential for 20 to 30 mins of glare per day and/or for 30 to 60 days in a year
Very Low	Potential for 10 to 20 mins of glare per day and/or for 15 to 30 days in a year
Negligible	Potential for 0 to 10 mins of glare per day and/or for 7 to 15 days in a year
None	No geometric potential for glare / Screening of source from receptor

Table 3 is used as a guide only and final classification is based on a combination of additional factors including level of intervening screening (vegetative or otherwise), receptor orientation, position of sun in relation to source of glare, as well as professional judgement.

Mitigation

If it is determined that glare will be experienced at a particular receptor and there is no screening between the receptor and the solar array, mitigation may be recommended depending on the severity of the glare. Mitigating glare impact from a solar array can be achieved in several different ways. The most common method is to add vegetative screening to essentially form a visual barrier between the receptor and the development. This type of mitigation is often required for ecological and visual impact reasons also. Other forms of mitigation include changing the design of the solar array, such as a change in pitch and orientation of the panels.

Assessment Results

Runway Results

For all the runway approaches considered, no potential for Glare outside the recommended limits of Green Glare was found. No potential for Glare was identified for Runway 28, 10 and 04, while Runway 22 has only potential for Green Glare.

Air Traffic Control Tower Results

Casement Aerodrome ATC-T[1,2]

No potential for Glare was indicated for the proposed solar PV array for the ATC Tower at Casement Aerodrome.

Conclusion

This Solar PV Array Aviation Specific Glint and Glare Analysis has sought to determine whether any aviation receptors, for the 2 mile runway approach paths and ATC Tower at Casement Aerodrome have the potential to experience hazardous glint and glare from the installation of Solar PV panels to the roof of New Data Centre Hall at DC3 Google Campus in Dublin.

The analysis has concluded that there is no potential for glare outside of the allowed green glare for any of the approaches to runways at Casement Aerodrome. These results are **acceptable** under the recommendations in the FAA guidance (which is broadly accepted as international best practice).

It was concluded that there is no potential for the Air Traffic Control Tower at Casement Aerodrome to experience any hazardous glare emanating from the proposed PV arrays, which is **acceptable** under the recommendations in the FAA guidance.

Appendix I: Relevant Guidance & Studies

Guidance

United Kingdom

In the United Kingdom (UK), where the development of large scale solar PV is more mature, certain studies have been carried out which help to establish an accepted best practice and planning guidance recommends the assessment of glint and glare effects. However, there is still no specific guidance by way of a prescriptive methodology document. In the absence of formal policy, the UK's Civil Aviation Authority (CAA) provided interim guidance in 2010 in relation to the development of solar PV systems on, and in the vicinity (<15km) of aerodromes. This guidance recommends that solar PV developers should "*provide safety assurance documentation regarding the full potential impact of the SPV installation on aviation interests.*" [11] More recently, Civil Aviation Publication 738, entitled "Safeguarding of Aerodromes"[12] was updated in 2020 and the policy refers to US FAA research and guidance (detailed below). It also states that despite an increase in solar panel developments, with some located close to aerodromes, the CAA has "not received any detrimental comments or issues of glare at these established sites".

Air Navigation Order 2009[13] also has several articles (137: Endangering safety of an aircraft, 221: Lights liable to endanger and 222: Lights that dazzle or distract) that relate to the effect of glare aspects that are relevant to Solar PV developments; glare with a detrimental impact on aviation safety must be avoided and should be taken care of by solar developers and Local Planning Authorities.

The Building Research Establishment (BRE) have also issued several relevant papers, however neither the BRE nor the CAA have produced a methodology for assessing the effects of glint and glare on aviation, road & rail users or residential buildings.

[11] Civil Aviation Authority. December 2010. "Interim CAA Guidance - Solar Photovoltaic Systems".
[12] Safeguarding of Aerodromes - Civil Aviation Authority https://publicapps.caa.co.uk/docs/33/CAP738%20Issue%203.pdf accessed June 2022

[13] https://www.legislation.gov.uk/uksi/2009/3015/contents/made

Republic of Ireland

In the Republic of Ireland (ROI), there is currently no guidance, policy or recommendations in relation to the assessment of glint and glare effects on aviation, road & rail users or residential buildings. Future Analytics in conjunction with the Sustainable Energy Authority of Ireland (SEAI) have produced planning and development guidance recommendations for utility scale solar photovoltaic schemes in Ireland [14]. While this is not formal guidance, it does set out recommended elements of the assessment based on international practice.

Germany

In Germany, glare is considered an emission not unlike noise, odour or vibration. "*Licht-Leitlinie*" [15] or Light Guidelines produced by The Federal Ministry of the Environment defines acceptable levels of glare as being anything less than 30 minutes per day or 30 hours per year. The guidance also states that there is only additional impact to an observer as a result of glare from a solar array if the angle between the source of the glare and the sun is greater than ten degrees. It also places an emphasis on solar PV developments on a east-west axis relative to the receptor, rather than south-north which will cause less impact due to the nature of sun movement across the sky (no reflection possible from relatively northern sources and southern sources having the sun in the same viewing direction).

Switzerland

A guideline on solar glare assessment was established with the help of the Swiss Trade Association in Switzerland. This guideline sets numeric parameters on the acceptability of glint and glare, based on the incident angle of the sun, the intensity of emmitted radiation, and the luminance The solar reflections are termed as non-risky if its

[14] Future Analytics. October 2016. Planning and Development Guidance Recommendations for Utility Scale Solar Photovoltaic Schemes in Ireland
[15] Leitlinie des Ministeriums fur Umwelt. Gesundheit und Verbraucherschutz zur Messung und Beurteilung von Lichtimmissionen (Licht-Leitlinie). 2014 Available: http://www.mlul.brandenburg.de/media_fast/4055/licht_leitlinie.pdf

duration is less than 30 min per day or the solar PV installation is small, or the receptor is located far away from glare source.

Australia

No specific regiulation pertaining to glint and glare form solar PV arrays exists, but general limits on reflectivity from glass facades have been set by several local authorities, with under or equal to 20% reflectance being acceptable.

Canada

A publication by Transport Canada (TP1247E)[16] includes guidelines useful for glare assessment. It states in summary, that glare analysis must consider the movement of aircraft at landing, take-offs and during maneuvers and suggests ways for a solar PV designer to vary orientation and tilt of solar PV modules in order to mitigate the adverse impact from glare, with an application threshold of 3km from an aviation site.

United States of America

The main form of guidance in assessing the likely effects of glint and glare (on aviation infrastructure) comes from the FAA in the United States. Their document, "*Technical Guidance for Evaluating Selected Solar Technologies on Airports*"[17] is accepted internationally as the most detailed methodology for assessing the effects of glint and glare. This interim policy document[18] was produced in October 2013. The 2013 interim policy further addresses glint and glare issues and recommends the use of a particular analysis tool, the Solar Glare Hazard Analysis Tool (SGHAT), when carrying out glint & glare assessments of solar PV systems. This is a tool that was developed by the US Department of Energy research laboratories, Sandia National Laboratories, to assess the ocular impact of proposed solar energy systems.

[16] Land Use In The Vicinity of Aerodromes, https://tc.canada.ca/sites/default/files/migrated/tp1247e.pdf accessed February 2021
[17] Federal Aviation Administration. November 2010. "*Technical Guidance for Evaluating Selected Solar Technologies on Airports"*
[18] Federal Aviation Administration. October 2013. *"Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports."*

In 2021, this interim guidance was superseded by a final policy, with the main changes being;

- There is less emphasis on the potential glint and glare hazard to pilots using a runway approach path, and specific requirements around the assessment of the ATC Tower.
- The FAA have withdrawn their pervious recommendation for a tool to assess ocular hazard – this means there is now no specific requirement to use the SGHAT methodology.

However, it is expected that national aviation regulators will continue to follow the original 2013 guidance, for which the SGHAT approach is acceptable.

Studies

Sreenath et al, 2021[19]

A comprehensive review performed by Sreenath et al, 2021of Solar PV and its relationship with airport environments lists several different methodologies that can be used for assessment of solar PV glint and glare hazard, and gives comprehensive details on the SGHAT analysis approach used by LINT Geospatial. It concludes;

- that the SGHAT approach does not factor in mitigating factors such as landscape screening or cloud cover and as such, can overestimate the likelihood for glint and glare
- the steps in a desirable methodology for glare assessment from solar PV installations are:
    1. Identification of solar reflections that can reach an observer's eye
    2. Calculation of the duration and intensity of these reflections

[19] Sreenath, S., Sudhakar, K. and Yusop, A.F., 2021. "*Solar PV in the airport environment: A review of glare assessment approaches & metrics."* Solar Energy, 216, pp.439-451.

3. Comparison of calculated results with threshold values for harmful glare impact

Sreenath et al, 2020a[20], 2020b[21], 2020c[22]

These studies outline the reflectivity of different materials used for Solar PV arrays, and the factors that affect glint and glare from the surfaces of these arrays.

Riley and Olson, 2011[23]

This study outlines empirical research done using a PV system in Las Vegas. It found that reflectivity of the panels varied from 5% to 30%, depending on the incidence angle, and concluded that the potential for hazardous glare from solar-PV arrays is similar to that of standing water, and that common surfaces such as Portland white cement concrete (commonly used in airport runways), snow and glass building facades all have higher reflectivity than flat plate PV arrays.

Conclusions from Guidance and Studies

LINT has created a methodology for assessing glint and glare taking all of the above studies and guidelines into consideration. Until formal and specific guidance on a preferred methodology is provided in Ireland, LINT will continue to follow international guidelines and best practice.

[20] Sreenath, S., Sudhakar, K., Ahmad Fitri, Y., 2020. Airport-based photovoltaic applications. Progress in Photovoltaics: Research and Applications. https://doi.org/10.1002/pip.3265

[21] Sreenath, S., Sudhakar, K., Yusop, A.F., 2020b. Solar photovoltaics in airport: Risk assessment and mitigation strategies. Environ. Impact Assess. Rev. 84 (May) https://doi.org/10.1016/j.eiar.2020.106418.

[22] Sreenath, S., Sudhakar, K., Yusop, A.F., Cuce, E., Solomin, E., 2020. Analysis of solar PV glare in airport environment: Potential solutions. Results in Engineering, 5 (November 2019), 100079. https://doi.org/10.1016/j.rineng.2019.100079.

[23] Riley, E. and Olson, S., 2011. A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems. International Scholarly Research Notices, 2011.

Appendix II: Analysis Details

FORGESOLAR GLARE ANALYSIS

Project: **DC3**
Site configuration: **DC3 East**
Analysis conducted by Michael O'Donnell (info@lint.ie) at 15:56 on 25 Apr, 2024.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
2-mile flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	PASS	Receptor(s) marked as ATCT do not receive glare

Default glare analysis parameters and observer eye characteristics (for reference only):

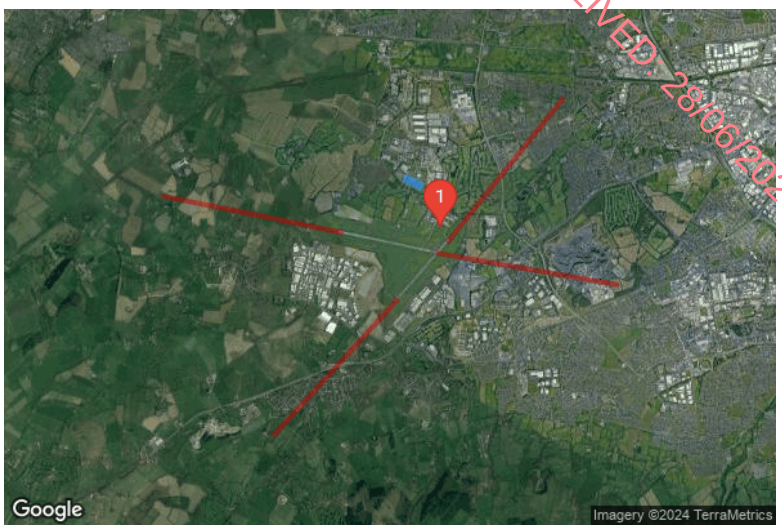
- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at https://www.federalregister.gov/d/2013-24729

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 117609.20219
Methodology: V2



PV Array(s)

Name: DC3 East
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 115.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.312383	-6.446749	80.02	10.00	90.02
2	53.313565	-6.450893	80.02	10.00	90.02
3	53.312903	-6.451418	80.02	10.00	90.02
4	53.311720	-6.447269	80.02	10.00	90.02

Flight Path Receptor(s)

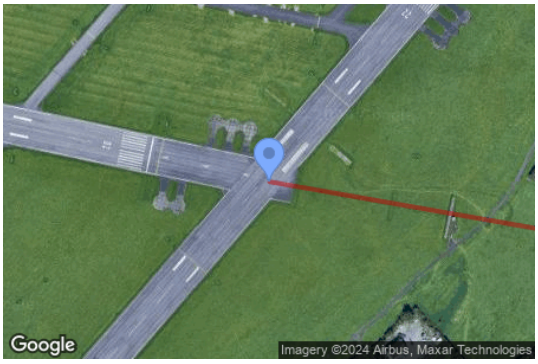
Name: FP 1
Description: None
Threshold height: 15 m
Direction: 220.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.303344	-6.439671	93.40	15.20	108.60
Two-mile	53.325848	-6.409259	63.10	214.20	277.30

Name: FP 2
Description: None
Threshold height: 15 m
Direction: 42.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.293865	-6.453522	98.10	15.20	113.30
Two-mile	53.272480	-6.486116	149.70	132.30	282.00

Name: FP 3
Description: None
Threshold height: 15 m
Direction: 280.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.301341	-6.442450	96.50	15.20	111.70
Two-mile	53.296351	-6.394740	109.50	170.90	280.40

Name: FP 4
Description: None
Threshold height: 15 m
Direction: 100.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.304650	-6.468328	86.30	15.20	101.50
Two-mile	53.310443	-6.515787	73.70	196.50	270.20

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
1-ATCT	1	53.305518	-6.441761	93.51	6.00

Map image of 1-ATCT

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
DC3 East	15.0	115.0	5,284	0	-

Total annual glare received by each receptor

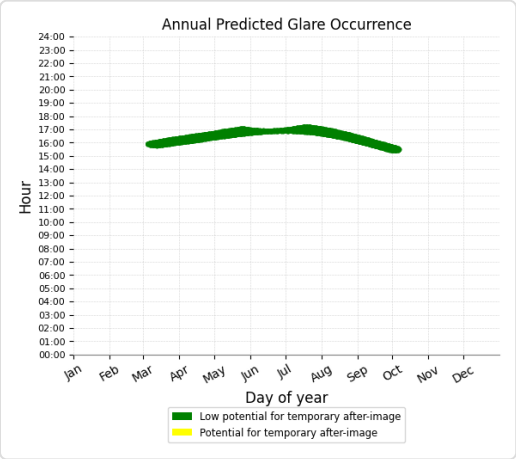
Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
FP 1	5284	0
FP 2	0	0
FP 3	0	0
FP 4	0	0
1-ATCT	0	0

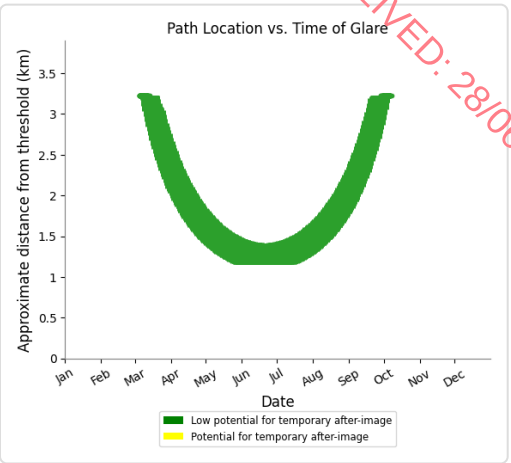
Results for: DC3 East

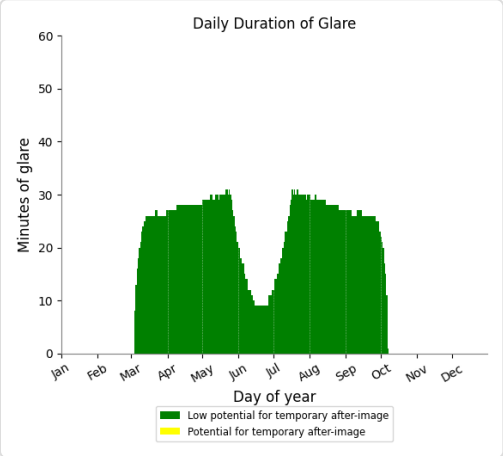
Receptor	Green Glare (min)	Yellow Glare (min)
FP 1	5284	0
FP 2	0	0
FP 3	0	0
FP 4	0	0
1-ATCT	0	0

Flight Path: FP 1

0 minutes of yellow glare
5284 minutes of green glare







Flight Path: FP 2

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 3

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 4

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to V1 algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

FORGESOLAR GLARE ANALYSIS

Project: **DC3**
Site configuration: **DC3 West**
Analysis conducted by Michael O'Donnell (info@lint.ie) at 15:58 on 25 Apr, 2024.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
2-mile flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	PASS	Receptor(s) marked as ATCT do not receive glare

Default glare analysis parameters and observer eye characteristics (for reference only):

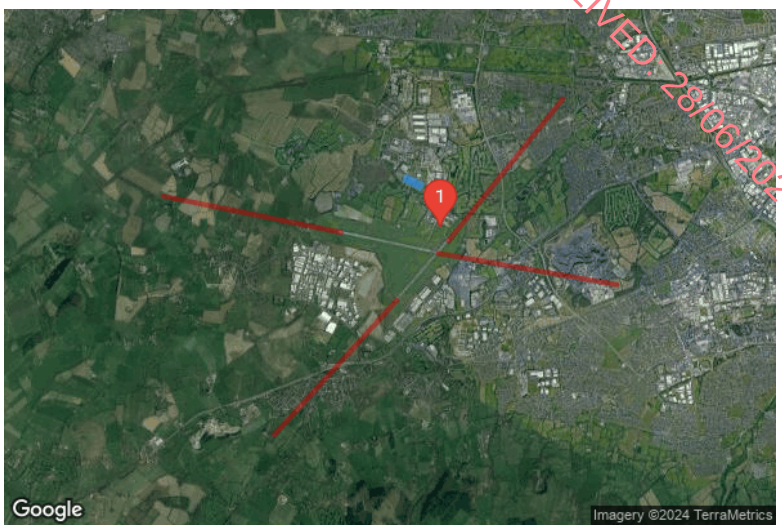
- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at https://www.federalregister.gov/d/2013-24729

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 117590.20219
Methodology: V2



PV Array(s)

Name: DC3 West
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 295.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.312383	-6.446749	80.02	10.00	90.02
2	53.313565	-6.450893	80.02	10.00	90.02
3	53.312903	-6.451418	80.02	10.00	90.02
4	53.311720	-6.447269	80.02	10.00	90.02

Flight Path Receptor(s)

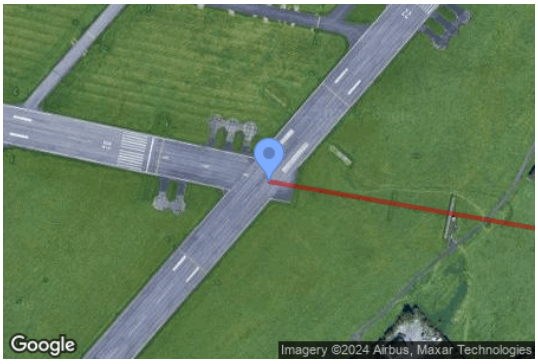
Name: FP 1
Description: None
Threshold height: 15 m
Direction: 220.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.303344	-6.439671	93.40	15.20	108.60
Two-mile	53.325848	-6.409259	63.10	214.20	277.30

Name: FP 2
Description: None
Threshold height: 15 m
Direction: 42.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.293865	-6.453522	98.10	15.20	113.30
Two-mile	53.272480	-6.486116	149.70	132.30	282.00

Name: FP 3
Description: None
Threshold height: 15 m
Direction: 280.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.301341	-6.442450	96.50	15.20	111.70
Two-mile	53.296351	-6.394740	109.50	170.90	280.40

Name: FP 4
Description: None
Threshold height: 15 m
Direction: 100.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.304650	-6.468328	86.30	15.20	101.50
Two-mile	53.310443	-6.515787	73.70	196.50	270.20

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
1-ATCT	1	53.305517	-6.441760	93.51	6.00

Map image of 1-ATCT

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
DC3 West	15.0	295.0	0	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
FP 1	0	0
FP 2	0	0
FP 3	0	0
FP 4	0	0
1-ATCT	0	0

Results for: DC3 West

Receptor	Green Glare (min)	Yellow Glare (min)
FP 1	0	0
FP 2	0	0
FP 3	0	0
FP 4	0	0
1-ATCT	0	0

Flight Path: FP 1

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 2

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 3

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 4

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to V1 algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

ARUP

Google Ireland Limited

Data Centre Development DC3

Main Environmental Impact Assessment Report

Reference: Chapter 16 Appendix

1 | June 2024

Job number 298479-20

Ove Arup & Partners Ireland Limited
50 Ringsend Road
Dublin 4
D04 T6X0
Ireland
arup.com

ARUP

Document Verification

Project title	Data Centre Development DC3
Document title	Main Environmental Impact Assessment Report
Job number	298479-20
Document ref	Chapter 16 Appendix
File reference	1

Revision	**Date**	**Filename**	Appendix 16.1 (Resource and Waste Management) - Legislation, Policy and Guidance and Appendix 16.2 (Resource and Waste Management) - List of Waste Codes
Draft 1	16/05/2024	**Description**	Draft for review

	Prepared by	**Checked by**	**Approved by**
Name	Daire Bryne		
Signature			

	Filename		
	Description		
	Prepared by	**Checked by**	**Approved by**
	Name		
	Signature		

	Filename		
	Description		
	Prepared by	**Checked by**	**Approved by**
	Name		
	Signature		

Issue Document Verification with Document ✓

Contents

Appendix 16.1 Resource and Waste Management - Legislation, Policy, and Guidance

Legislation, Policy and Guidelines

European Legislation

Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance)

Directive 2008/98/EC, known as the "Waste Framework Directive" came into force on 12th December 2008, and Ireland had two years from this date to implement it into national law. It provides for a general framework of waste management requirements and sets the basic waste management definitions for the EU.

The Directive lays down the five-step hierarchy of waste management options, with waste prevention as the preferred option, followed by re-use, recycling, recovery and safe disposal, in descending order. In addition, the Directive also deals with the issue of 'end of waste' and clarifies the definitions of recovery, disposal and by-product. The directive states that, "The recovery of waste and the use of recovered material as raw materials should be encouraged in order to conserve natural resources."

Directive 2008/98/EC amending Directive 2008/98/EC on waste

This Directive amends the Waste Framework Directive or Directive 2008/98/EC. It provides a number of updated waste management definitions. The Directive allows Member States to use economic instruments including taxes and levies as an incentive for the application of the waste hierarchy. The Directive was transposed into national law in August 2020 - S.I. No. 322 of 2020.

The Directive sets targets for the preparing for re-use and the recycling of municipal waste as follows:

- By 2025, at a minimum 55% (by weight) will be prepared for re-use or recycling;
- By 2030, at a minimum 60% (by weight) will be prepared for re-use or recycling; and
- By 2035, at a minimum 65% (by weight) will be prepared for re-use or recycling.

With regards construction and demolition waste, Member States must take measures to promote selective demolition in order to enable removal and safe handling of hazardous substances, facilitate re-use and high-quality recycling. It obligates Member States to take measures to prevent waste generation including reduction of waste generation in processes related to construction and demolition, taking into account best available techniques.

Commission Decision of 18 December 2014, amending Decision 2000/532/EC on the list of waste pursuant to Directive 2008/98/EC of the European parliament and of the Council (2014/955/EEC) and Commission Regulation (EU) No 1357/2014 of 18 December 2014, replacing Annex III to Directive 2008/98/EC of the European Parliament and of the Council on waste and repealing certain Directives

This decision (referred to as 'the List of Waste' (LoW)) and regulation consolidate the legislation relating to waste classification and allow the generators of waste to classify the waste as hazardous or non-hazardous and in the process assign the correct List of Waste entry codes. Each list of waste entry is a six-digit code which is closely linked to the list of the main characteristics which render waste hazardous contained in Annex III to the Waste Framework Directive. It is noted that Council Regulation (EU) 2017/997 of 8 June 2017 amending Annex 111 to Directive 2008/98//EC of the European parliament and of the Council as regards the hazardous property HP 14 'Ecotoxic' provides additional criteria in relation to determining whether the ecotoxicity of wastes would result in a hazardous classification.

National Legislation

Circular Economy and Miscellaneous Provisions Act 2022

The Circular Economy and Miscellaneous Provisions Act 2022 aims to place the Whole-of-Government Circular Economy Strategy 2022-2023, and the commitment to a circular economy, on a clear statutory footing.

This Act places the Strategy and the commitment to a circular economy on a clear statutory footing. It underpins Ireland's shift from a "take-make-waste" linear model to a more sustainable pattern of production and consumption, that retains the value of resources in our economy for as long as possible and that will to significantly reduce our greenhouse gas emissions. The Act is a key step in the successful transition of Ireland's economy to a circular economy and is evidence of Government's commitment to the achievement of that goal.

Climate Action Plan 2024

The Climate Action Plan (CAP) 2024 represents the third annual update to Ireland's CAP 2019 and was published on 20th December 2023. CAP 2024 establishes sectoral emission ceilings and the implementation of carbon budgets and represents a roadmap to halve Ireland's emissions by 2030 and reach net zero by no later than 2050.

CAP 2024 notes that Ireland currently has a circularity rate of 1.8% which is below the EU average of 12.8% and indicates significant capacity for improvement.

Several actions are presented in CAP 2024 which are of direct relevance to the proposed development.

Waste Management Acts, 1996, as amended and Regulations Made under the Acts

The Waste Management Act, 1996 was enacted in May 1996 and sets out the responsibilities and functions of various persons in relation to waste. This was subsequently amended by a number of subsequent acts including the Waste Management (Amendment) Act 2001 and the Protection of the Environment Act 2003. The Act:

- Prohibits any person from holding, transporting, recovering or disposing of waste in a manner which causes or is likely to cause environmental pollution;
- Requires any person who carries on activities of an agricultural, commercial or industrial nature to take all such reasonable steps as are necessary to prevent or minimise the production of waste;
- Prohibits the transfer of waste to any person other than an authorized person (i.e. a holder of a waste collection permit or a local authority);
- Requires the Environmental Protection Agency (EPA) to make a national plan in relation to hazardous waste;
- Requires local authorities to make waste management plans in relation to non-hazardous waste;
- Imposes certain obligations on local authorities to ensure that a service is provided for collection of household waste and to provide facilities for the recovery and disposal of such waste;
- Enables the Minister for the Environment and Local Government to make Regulations for various purposes to promote better waste management; and
- Provides for substantial penalties for offences including fines, imprisonment and/or liability for clean-up measures.

Waste Management (Collection Permit) Regulations, 2016, S.I. No 820 of 2007, as amended

Waste from the proposed development may only be collected by the holder of a waste collection permit or a local authority. Waste collection permits are granted in accordance with the Waste Management (Collection Permit) Regulations, 2007 as amended. Waste storage and collection areas on site should be designed to prevent environmental pollution. These regulations were amended and updated in 2008, 2012 and 2016.

Waste Management (Shipments of Waste) Regulations 2007, S.I. No. 419 of 2007

Where waste from the proposed development is exported outside of Ireland for recovery or disposal the National Transfrontier Shipment (TFS) Office within Dublin City Council must be notified. Certain financial guarantees must be in place and a certificate issued by the National TFS Office prior to the waste movement taking place.

S.I. No. 323/2020 - European Union (Waste Directive) Regulations 2020 amending European Communities (Waste Directive) Regulations 2011, S.I. No.0126 of 2011

The amended regulations which were adopted in 2011 significantly changed the provisions of the Waste Management Acts, 1996 to 2008.

The 2011 regulations are now amended by S.I. No. 323/2020 - European Union (Waste Directive) Regulations 2020 giving effect to Directive 2018/8511 of the European Parliament and of the Council of 30 May 2018 on waste as per the above. This amends definition of “waste” and “non-hazardous waste.”

The Regulations define “waste disposal” and “waste recovery” as well as setting out tests which must be complied with in order for material to be described as a “by-product” or achieve “end of waste” status.

The Regulations formally set out the following waste hierarchy which shall apply as a priority order in waste prevention and management legislation and policy:

a. Prevention;

b. Preparation for re-use;

c. Recycling;

d. Other recovery (including energy recovery); and

e. Disposal.

The Regulations require that all waste management plans and hazardous waste management plans in existence at the commencement of the Regulations shall be evaluated by 31 December 2012 and where appropriate be revised to be brought into line with Directive 2006/12/EC on Waste.

The Regulations also require the Environment Agency to establish a waste prevention programme by December 2013.

European Union (Waste Directive) Regulations 2020 S.I. No. 323/2020

These regulations give effect to Directive 2018/8511 of the European Parliament and of the Council of 30 May 2018 on waste as per the above.

This provides new definitions for a number of key terms including “waste” and “non-hazardous waste”, “biowaste”, “waste management”, “waste prevention”, “backfilling” and “construction and demolition waste”.

European Policy

8th Environmental Action Programme, European Commission (2022)

The 8th Environmental Action Programme came into force in May 2022 and will guide European environment policy until 2030 and will form the basis for achieving the United Nation's 2030 Agenda and its Sustainable Development Goals. A key objective of the programme reiterates the EU's long-term vision of living well and within planetary boundaries by 2050. There is a special focus on turning waste into a resource, with more prevention, re-use and recycling, and phasing out wasteful and damaging practices like landfilling. By 2030, there are six priority objectives for the European Union and member states:

- Achieving the 2030 greenhouse gas emission reduction target and climate neutrality by 2050;
- Enhancing adaptive capacity, strengthening resilience, and reducing vulnerability to climate change;
- Advancing towards a regenerative growth model, decoupling economic growth from resource use and environmental degradation, and accelerating the transition to a circular economy;
- Pursuing a zero-pollution ambition, including for air, water, and soil, and protecting the health and well-being of Europeans;
- Protecting, preserving, and restoring biodiversity, and enhancing natural capital; and
- Reducing environmental and climate pressures related to production and consumption (particularly in the areas of energy, industry, buildings and infrastructure, mobility, tourism, international trade and the food system).

European Commission Circular Economy Strategy (2015; 2018; 2020)

In December 2015, the European Commission adopted an ambitious Circular Economy Package, which includes revised legislative proposals on waste to stimulate Europe's transition towards a circular economy.

The Circular Economy Package consists of an EU Action Plan for the Circular Economy that establishes a programme of action, with measures covering the whole cycle: from production and consumption to waste management and the market for secondary raw materials. The annex to the action plan sets out the timeline when the actions will be completed.

The proposed actions will contribute to "closing the loop" of product lifecycles through greater recycling and re-use and bring benefits for both the environment and the economy. The revised legislative proposals on waste set clear targets for reduction of waste and establish an ambitious and credible long-term path for waste management and recycling. Key elements of the revised waste proposal include:

- An EU target for recycling 65% of municipal waste by 2030;
- An EU target for recycling 75% of packaging waste by 2030;
- A target to reduce landfill to maximum of 10% of all waste by 2030;
- A ban on landfilling of separately collected waste;
- Promotion of economic instruments to discourage landfilling;
- Simplified, improved definitions and harmonised calculation methods for recycling rates throughout the EU;
- Concrete measures to promote re-use and stimulate industrial symbiosis - turning one industry's byproduct into another industry's raw material; and
- Economic incentives for producers to put greener products on the market and support recovery and recycling schemes (e.g., for packaging, batteries, electric and electronic equipment, vehicles).

The Circular Economy Package was updated in 2018 to comprise a new set of measures including:

- A Europe-wide EU Strategy for Plastics in the Circular Economy;
- A Communication on options to address the interface between chemical, product and waste legislation;
- A Monitoring Framework on progress towards a circular economy at EU and national level; and
- A Report on Critical Raw Materials and the circular economy.

Key legislative measures adopted to date under the plan include:

- Directive (EU) 2018/851 amending Directive 2008/98/EC on waste;
- Directive (EU) 2018/850 amending Directive 1999/31/EC on the landfill of waste;
- Directive (EU) 2018/852 amending Directive 94/62/EC on packaging and packaging waste; and
- Directive (EU) 2018/849 amending Directives 2000/53/EC on end-of-life vehicles, Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators, and Directive 2012/19/EU on waste electrical and electronic equipment.

European Commission, 2020. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – A new Circular Economy Action Plan For a cleaner and more competitive Europe. COM (2020).

The European Commission has adopted a new Circular Economy Action Plan, which is one of the main blocks of the European Green Deal, Europe's new agenda for sustainable growth.

The new Action Plan announces initiatives along the entire life cycle of products, targeting for example their design, promoting circular economy processes, fostering sustainable consumption, and aiming to ensure that the resources used are kept in the EU economy for as long as possible.

The new Action Plan introduces legislative and non-legislative measures targeting areas where action at the EU level brings real added value.

The new Circular Economy Action Plan presents measures to:

- Make sustainable products the norm in the EU;
- Empower consumers and public buyers;
- Focus on the sectors that use most resources and where the potential for circularity is high such as: electronics and ICT; batteries and vehicles; packaging; plastics; textiles; construction and buildings; food; water and nutrients;
- Ensure less waste;
- Make circularity work for people, regions and cities; and
- Lead global efforts on circular economy.

European Commission (2019) European Green Deal

The European Green Deal, published by the European Commission in December 2019, provides an action plan to boost the efficient use of resources by moving to a clean, circular economy while cutting pollution and restoring biodiversity.

The plan outlines investments needed and financing tools available. It explains how to ensure a just and inclusive transition.

National Policy

The National Waste Management Plan for a Circular Economy 2024-2030

The National Waste Management Plan for a Circular Economy 2024-2030 was published in March 2024 and replaces the Regional Waste Management Plans (see below). The plan sets out a framework for the prevention and management of waste in Ireland for the period 2024 to 2030.

The plan recognises climate change as a key driver for both behavioural change and improved waste management practices. The ambition of the plan is 0% total waste growth per person over the life of the plan with an emphasis on non-household wastes including waste from commercial activities and the construction and demolition sector. This ambition is underpinned with a comprehensive series of targets, policies, actions and a suite of key deliverables.

Key challenges identified in the plan include resources, organisational capability, policy requirements, specific material stream targets, the provision of infrastructure and waste generation.

The plan aims to shift Ireland towards a more circular economy where resources are reused or recycled as much as possible and therefore waste generation is minimised. Maintaining and enhancing existing waste services will provide a platform for improved circular behaviours and practices to accelerate the transition to a more circular economy. A successful circular economy will improve consumption behaviours and reduce waste generation and will have wider environmental benefits through reduced greenhouse gas emissions and reduced biodiversity loss.

A Waste Action Plan for a Circular Economy – Ireland's National Waste Policy 2020-2025

This plan is a roadmap for Ireland's waste planning and management. This plan shifts focus away from waste disposal and looks instead to how we the preservation of resources through the creation of a circular economy.

The plan sets out a range of aims and targets for the State and the measures by which these will be achieved, including increased regulation and measures across various waste areas such as Circular Economy, Municipal Waste, Consumer Protection and Citizen Engagement, Plastics and Packaging, Construction and Demolition, Textiles, Green Public Procurement and Waste Enforcement.

Section 11 of the plan sets out the delivery roadmap to achieve the targets, policies and actions identified to reach the plan's ambition within the Construction and Demolition Sector.

Of the challenges facing the sector, the plan establishes the target to prepare for reuse, recycling, and other material recovery (including beneficial backfilling operations using waste as a substitute) of 70% by weight of construction and demolition non-hazardous waste (excluding natural soils and stone).

Regional Policy

The Eastern Midlands Region Waste Management Plan 2015-2021

For the purposes of waste management planning, Ireland is divided into three regions: Southern, Eastern-Midlands, and Connacht-Ulster.

The Eastern-Midlands Region includes all of the Dublin Local Authority areas (Dublin City Council, Dún Laoghaire-Rathdown County Council, Fingal County Council and South Dublin County Council), as well as Kildare, Laois, Longford, Meath, Offaly, Westmeath, and Wicklow County Council areas.

The Eastern Midlands Region Waste Management Plan 2015-2021 was launched in 2015. The strategic approach of the plan places a stronger emphasis on preventing wastes and material reuse activities. Three strategic targets have been set in the plan which include:

- 1% reduction per annum in the quantity of household waste generated per capita over the period of the plan;
- Achieve a recycling rate of 50% of managed municipal waste by 2020; and
- Reduce to 0% the direct disposal of unprocessed residual municipal waste to landfill in favour of higher value pre-treatment processes and indigenous recovery practices.

The plan looks to 2030 and includes a long-term goal of reaching a recycling rate of 60%.

It should be noted that the Eastern Region Waste Management Plan 2015 - 2021 was recently replaced by the 'National Waste Management Plan for a Circular Economy 2024-2030' in March 2024 (see above).

Construction and Demolition Waste Soil and Stone Recovery / Disposal Capacity – Eastern Midlands Region / Connacht Ulster Region / Southern Region and RPS (2016)

This report was undertaken on behalf of the Irish regional waste management offices to analyse the national waste capacity market for safe treatment of waste soils. A review was undertaken of soil waste generation and available capacity to accept soil waste in authorised facilities within the three waste regions. The report identifies that the future authorised capacity available to recover soil and stones is an issue in each waste region in the context of likely strong construction activity. Possible options recommended include existing capacities at existing sites and the use of Regulation 27 By Product notifications.

South Dublin County Council Development Plan 2022-2028

The South Dublin County Development Plan 2022-2028 sets out the land use framework to guide future development within the County with a focus on households, workplaces and how the population interacts and moves between these places while protecting the environment. The Plan outlines South Dublin County Council's approach to waste management to ensure adherence to the EU Waste Hierarchy and the circular economy.

The policies and objectives listed within the Plan were prepared in line with the Eastern Midlands Region Waste Management Plan and the National Waste Management Plan for a Circular Economy preparing the policies and objectives within the Plan. The policies of relevance to the proposed development are:

EDE2 Objective:

To support the measures in South Dublin's Climate Change Action Plan (2019-2024), or any superseding plan, to integrate the Circular Economy approach with economic development initiatives, in order to optimise opportunities in design and operation to reduce energy and material consumption and recycling of materials in support of sustainable development.

EDE7 Objective 2:

Measures to support the just transition to a circular economy.

IE7 Objective 1:

To encourage a just transition from a waste management economy to a green circular economy to enhance employment and increase the value, recovery and recirculation of resources through compliance with the provisions of the Waste Action Plan for a Circular Economy 2020-2025 and to promote the use of, but not limited to, reverse vending machines and deposit return schemes or similar to ensure a wider and varying ways of recycling.

IE7 Objective 2:

To support the implementation of the Eastern Midlands Region Waste Management Plan 2015-2021 or as amended by adhering to overarching performance targets, policies and policy actions.

IE7 Objective 3:

To provide for, promote and facilitate high quality sustainable waste recovery and disposal infrastructure / technology in keeping with the EU waste hierarchy and to adequately cater for a growing residential population and business sector.

IE7 Objective 5:

To ensure the provision of adequately sized public recycling facilities in association with new commercial developments and in tandem with significant change of use / extensions of existing commercial developments where appropriate.

IE7 Objective 7:

To require the appropriate provision for the sustainable management of waste within all developments, ensuring it is suitably designed into the development, including the provision of facilities for the storage, separation and collection of such waste.

IE7 Objective 8:

To adhere to the recommendations of the National Hazardous Waste Management Plan 2014-2020 and any subsequent plan, and to co-operate with other agencies including the EPA in the planning, organisation and supervision of the disposal of hazardous waste streams, including hazardous waste identified during construction and demolition projects.

IE7 Objective 9:

To support the development of indigenous capacity for the treatment of nonhazardous and hazardous wastes where technically, economically and environmentally practicable subject to the relevant environmental protection criteria for the planning and development of such activities being applied.

Guidelines

EPA (2021) Best Practice Guidelines for the Preparation of Resource Management Plans for Construction and Demolition Projects

These guidelines supersede the 'Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Waste Projects' which were published by the Government in July 2006.

The replacement guidelines reflect current waste legislation and policy including 'A Waste Action Plan for a Circular Economy Ireland's National Waste Policy 2020-2025' published in September 2020. Since the publication of the 2006 guidelines, waste management legislation and policy have evolved towards prioritising waste prevention and life cycle thinking as follows:

- An increased emphasis on waste prevention, in line with the waste hierarchy, through established principles such as designing out waste and the use of green procurement; and
- The guidelines have also been prepared to promote more circular design and construction principles in line with the EU Circular Economy Action Plan under the EU Green Deal. The circular economy model tries to avoid using unnecessary resources in the first place and keep resources 'in flow' by means of effective and smart reuse and recycling strategies reducing the use of virgin materials.

The guidelines provide a practical and informed mechanism to document the prevention and management of C&D wastes and resources from design to construction or demolition of a project. They provide clients, developers, designers, practitioners, contractors, sub-contractors, and competent authorities with a common approach to preparing and determining Resource and Waste Management Plans (RWMP) for the construction and demolition sector in Ireland.

The guidelines address the best practice approach for the following phases of a project:

- Prior to Construction – including the stages of design, planning and procurement in advance of works on site; and
- During Construction – relating to the effective management of resources and wastes during construction or demolition operations.

European Commission (2016) EU Construction & Demolition Waste Management Protocol

This protocol was published by the European Commission in September 2016.

The overall aim of the protocol is to increase confidence in the C&D waste management process and the trust in the quality of C&D recycled materials. This will be achieved by:

- Improved waste identification, source separation and collection;
- Improved waste logistics;
- Improved waste processing;
- Quality management; and
- Appropriate policy and framework conditions.

EPA (2019) Guidance on Soil and Stone By-products in the context of Article 27 of the European Communities (Waste Directive) Regulations 2011

Regulation 27 of the European Communities (Waste Directive) Regulations, 2011, as substituted by Regulation 15 S.I. No. 323 of 2020, states the following:

'the Agency shall take appropriate measures to ensure that a substance or object, resulting from a production process, the primary aim of which is not the production of that substance or object is considered not to be waste, but to be a by-product if the following conditions are met:

a. *further use of the substance or object is certain;*
b. *the substance or object can be used directly without any further processing other than normal industrial practice.*
c. *the substance or object is produced as an integral part of a production process; and*
d. *further use is lawful in that the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts.'*

Decisions made by economic operators under Regulation 27 must be notified to the Environmental Protection Agency. Conditions a) to d) must be satisfied for a Regulation 27 notification to be successful.

The purpose of the guidance is to inform economic operators how to prevent waste soil and stone by classifying it as a by-product in accordance with the legislation and the EPA's regulatory approach to determinations on soil and stone by-products. This guidance document covers soil and stone only.

It is aimed at local authorities, developers, the construction sector, the waste management sector and consultants.

Its environmental objective is by making certain that excess uncontaminated soil and stone is beneficially used with no overall adverse impacts on the environment or human health, a material producer will ensure that the material is regarded as a by-product rather than a waste.

EPA (2020) By Product - Guidance Note. A guide to by-products and submitting a by-product notification under Article 27 of the European Communities (Waste Directive) Regulations, 2011

This guidance note published in 2020 applies to all other sectors and materials apart from soil and stones. It aims to inform economic operators how to prevent waste by classifying it as a by-product in accordance with the applicable Regulations.

EPA (2020) End of Waste Guidance Part 1 and Part 2

Part 1: describes the context and benefits and introducing the end-of-waste test to potential under Regulation 28.

Part 2: provides guidance for applicants on how to address the requirements of the end-of-waste test under Regulation 28 of the European Communities (Waste Directive) Regulations, 2011.

Appendix 16.2 Resource and Waste Management – List of Waste Codes

Relevant List of Waste (LoW) Code Descriptions

03	**Wastes from Wood Processing and the Production of Panels and Furniture, Pulp, Paper, and Cardboard**
03 02	**Wastes from Wood preservation**
03 02 01*	non-halogenated organic wood preservatives
03 02 02*	organochlorinated wood preservatives
03 02 03*	organometallic wood preservatives
03 02 04*	inorganic wood preservatives
03 02 05*	other wood preservatives containing hazardous substances
03 02 99	wood preservatives not otherwise specified
13	**Oil Wastes and Wastes of Liquid Fuels (except edible oils, and those in chapters 05, 12 and 19)**
13 07	**Wastes of Liquid Fuels**
13 07 01*	fuel oil and diesel
13 07 02*	petrol
13 07 03*	other fuels (including mixtures)
15	**Waste Packaging; Absorbents, Wiping Cloths, Filter Materials and Protective Clothing not Otherwise Specified**
15 01	**Packaging (including separately collected municipal packaging waste)**
15 01 01	paper and cardboard packaging
15 01 02	plastic packaging
15 01 03	wooden packaging
15 01 04	metallic packaging
15 01 05	composite packaging
15 01 06	mixed packaging
15 01 07	glass packaging
15 01 09	textile packaging
15 01 10*	packaging containing residues of or contaminated by hazardous substances
15 01 11*	metallic packaging containing a hazardous solid porous matrix (for example asbestos), including empty pressure containers
16	**Wastes not otherwise specified in the List**
16 02	**Wastes from Electrical and Electronic Equipment**
16 02 09*	transformers and capacitors containing PCBs
16 02 10*	discarded equipment containing or contaminated by PCBs other than those mentioned in 16 02 09
16 02 11*	discarded equipment containing chlorofluorocarbons, HCFC, HFC
16 02 12*	discarded equipment containing free asbestos
16 02 13*	discarded equipment containing hazardous components other than those mentioned in 16 02 09 to 16 02 12
16 02 14	discarded equipment other than those mentioned in 16 02 09 to 16 02 13
16 02 15*	hazardous components removed from discarded equipment

16 02 16	components removed from discarded equipment other than those mentioned in 16 02 15
16 06	**Batteries and Accumulators**
16 06 01*	lead batteries
16 06 02*	Ni-Cd batteries
16 06 03*	mercury-containing batteries
16 06 04	alkaline batteries (except 16 06 03)
16 06 05	other batteries and accumulators
16 06 06*	separately collected electrolyte from batteries and accumulators
17	**Construction and Demolition Waste (Including Excavated Soil from Contaminated Sites)**
17 01	**Concrete, bricks, tiles and ceramics**
17 01 01	concrete
17 01 02	bricks
17 01 03	tiles and ceramics
17 01 06*	mixtures of, or separate fractions of concrete, bricks, tiles and ceramics containing hazardous substances
17 01 07	mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06
17 02	**Wood, glass and plastic**
17 02 01	wood
17 02 02	glass
17 02 03	plastic
17 02 04*	glass, plastic and wood containing or contaminated with hazardous substances
17 03	**Bituminous mixtures, coal tar and tarred products**
17 03 01*	bituminous mixtures containing coal tar
17 03 02	bituminous mixtures other than those mentioned in 17 03 01
17 03 03*	coal tar and tarred products
17 04	**Metals (including their alloys)**
17 04 01	copper, bronze, brass
17 04 02	aluminium
17 04 03	lead
17 04 04	zinc
17 04 05	iron and steel
17 04 06	tin
17 04 07	mixed metals
17 04 09*	metal waste contaminated with hazardous substances
17 04 10*	cables containing oil, coal tar and other hazardous substances
17 04 11	cables other than those mentioned in 17 04 10
17 05	**Soil (including excavated soil from contaminated sites), stones and dredging spoil**
17 05 03*	soil and stones containing hazardous substances
17 05 04	soil and stones other than those mentioned in 17 05 03
17 05 05*	dredging spoil containing hazardous substances

17 05 06	dredging spoil other than those mentioned in 17 05 05
17 05 07*	track ballast containing hazardous substances
17 05 08	track ballast other than those mentioned in 17 05 07
17 06	**Insulation materials and asbestos-containing construction materials**
17 06 01*	insulation materials containing asbestos
17 06 03*	other insulation materials consisting of or containing hazardous substances
17 06 04	insulation materials other than those mentioned in 17 06 01 and 17 06 03
17 06 05*	construction materials containing asbestos
17 08	**Gypsum-based construction material**
17 08 01*	gypsum-based construction materials contaminated with hazardous substances
17 08 02	gypsum-based construction materials other than those mentioned in 17 08 01
17 09	**Other construction and demolition wastes**
17 09 01*	construction and demolition wastes containing mercury
17 09 02*	construction and demolition wastes containing PCB (for example PCB-containing sealants, PCB-containing resin-based floorings, PCB-containing sealed glazing units, PCB-containing capacitors)
17 09 03*	other construction and demolition wastes (including mixed wastes) containing hazardous substances
17 09 04	mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03
20	**Municipal Wastes (Household waste and similar commercial industrial and institutional wastes) including separately collected fractions**
20 01	**separately collected fractions (except 15 01)**
20 01 01	paper and cardboard
20 01 02	glass
20 01 08	biodegradable kitchen and canteen waste
20 01 11	textiles
20 01 21*	fluorescent tubes and other mercury-containing waste
20 01 25	edible oil and fat
20 01 27*	paint, inks, adhesives and resins containing hazardous substances
20 01 33*	batteries and accumulators included in 16 06 01, 16 06 02 or 16 06 03 and unsorted batteries and accumulators containing these batteries
20 01 36	discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35
20 01 39	plastics
20 01 40	metals
20 03	**other municipal wastes**
20 03 01	mixed municipal waste
20 03 07	bulky waste