Appendix 3

Causeway Geotech Geotechnical Report

Kilkenny Landfills - Oldcourt

Client:	Kilkenny County Council
Client's Representative:	Fehily Timoney
Report No.:	18-0847C
Date:	October 2018
Status:	Final for Issue

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APPENDICES

Document Control Sheet

Report No.:		18-0847C			
Project Title:		Kilkenny Landfills - Oldcourt			
Client:		Kilkenny County Council			
Client's Representative:		Fehily Timoney			
Revision:	A00	**Status:**	Final for Issue	**Issue Date:**	16 October 2018
Prepared by:		**Reviewed by:**		**Approved by:**	
Sean Ross BSc MSc				Darren O'Mahony BSc MSc MIEI	

The works were conducted in accordance with:

British Standards Institute (2015) BS 5930:2015, Code of practice for site investigations.

BS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing.

Geotechnical Society of Ireland (2016), Specification & Related Documents for Ground Investigation in Ireland

Laboratory testing was conducted in accordance with:

British Standards Institute BS 1377:1990 parts 2, 4, 5, 7 and 9

METHODS OF DESCRIBING SOILS AND ROCKS

Soil and rock descriptions are based on the guidance in BS5930:2015, The Code of Practice for Site Investigation.

Abbreviations used on exploratory hole logs	
U	Nominal 100mm diameter undisturbed open tube sample (thick walled sampler)
UT	Nominal 100mm diameter undisturbed open tube sample (thin walled sampler)
P	Nominal 100mm diameter undisturbed piston sample
B	Bulk disturbed sample
LB	Large bulk disturbed sample
D	Small disturbed sample
C	Core sub-sample (displayed in the Field Records column on the logs)
L	Liner sample from dynamic sampled borehole
W	Water sample
ES / EW	Soil sample for environmental testing / Water sample for environmental testing
SPT (s)	Standard penetration test using a split spoon sampler (small disturbed sample obtained)
SPT (c)	Standard penetration test using 60 degree solid cone
x,x/x,x,x,x	Blows per increment during the standard penetration test. The initial two values relate to the seating drive (150mm) and the remaining four to the 75mm increments of the test length. The length achieved is stated (mm) for any test increment less than 75mm
N=X	SPT blow count 'N' given by the summation of the blows 'X' required to drive the full test length (300mm)
N=X/Z	Incomplete standard penetration test where the full test length was not achieved. The blows 'X' represent the total blows for the given test length 'Z' (mm)
V VR	Shear vane test (borehole) Hand vane test (trial pit) Shear strength stated in kPa V: undisturbed vane shear strength VR: remoulded vane shear strength
dd/mm/yy: 1.0 dd/mm/yy: dry	Date & water level at the borehole depth at the end of shift and the start of the following shift
Abbreviations relating to rock core – reference Clause 36.4.4 of BS 5930: 2015	
TCR (%)	Total Core Recovery: Ratio of rock/soil core recovered (both solid and non-intact) to the total length of core run.
SCR (%)	Solid Core Recovery: Ratio of solid core to the total length of core run. Solid core has a full diameter, uninterrupted by natural discontinuities, but not necessarily a full circumference and is measured along the core axis between natural fractures.
RQD (%)	Rock Quality Designation: Ratio of total length of solid core pieces greater than 100mm to the total length of core run.
FI	Fracture Index: Number of natural discontinuities per metre over an indicated length of core of similar intensity of fracturing.
NI	Non Intact: Used where the rock material was recovered fragmented, for example as fine to coarse gravel size particles.
AZCL	Assessed zone of core loss: The estimated depth range where core was not recovered.
DIF	Drilling induced fracture: A fracture of non-geological origin brought about by the rock coring.

Kilkenny Landfills - Oldcourt

1 AUTHORITY

On the instructions of Fehily Timoney Consulting Engineers, ("the Client's Representative"), acting on the behalf of Kilkenny County Council ("the Client"), a ground investigation was undertaken at the above location to provide geotechnical and environmental information to aid in the remediation of an old landfill site.

This report details the work carried out both on site and in the geotechnical and chemical testing laboratories; it contains a description of the site and the works undertaken, the exploratory hole logs and the laboratory test results.

All information given in this report is based upon the ground conditions encountered during the site investigation works, and on the results of the laboratory and field tests performed. However, there may be conditions at the site that have not been taken into account, such as unpredictable soil strata, contaminant concentrations, and water conditions between or below exploratory holes. It should be noted that groundwater levels usually vary due to seasonal and/or other effects and may at times differ to those recorded during the investigation. No responsibility can be taken for conditions not encountered through the scope of work commissioned, for example between exploratory hole points, or beneath the termination depths achieved.

This report was prepared by Causeway Geotech Ltd for the use of the Client and the Client's Representative in response to a particular set of instructions. Any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded.

2 SCOPE

The extent of the investigation, as instructed by the Client's Representative, included boreholes, trial pits, soil sampling, in-situ and laboratory testing, and the preparation of a factual report on the findings.

3 DESCRIPTION OF SITE

As shown on the site location plan in Appendix A, the works were conducted on the site of an old landfill east of the small town of Inistioge on a meander of the River Nore. The site is heavily forested and is bounded by a local access road to the north, east and west, and a dwelling to the south.

4 SITE OPERATIONS

4.1 Summary of site works

Site operations, which were conducted between 3rd and 4th October 2018, comprised:

- two boreholes by light percussion methods;
- standpipe installation in two boreholes;
- three hand dug pits; and
- two machine dug trial pits.

The exploratory holes and in-situ tests were located as instructed by the Client's Representative, as shown on the exploratory hole location plan in Appendix A.

4.2 Boreholes

Two boreholes (BH01-BH02) were put down to completion by light percussion boring techniques using a Dando Terrier dynamic sampling rig. The boreholes were put down initially in 150mm diameter, reducing in diameter with depth as required, down to 50mm by use of the smallest sampler.

The boreholes were taken to depths ranging between 3.0m and 3.8m where they were terminated on encountering virtual refusal on obstructions.

Standard penetration tests were carried out in accordance with BS EN 22476-3: 2005 at standard depth intervals using the split spoon sampler ($SPT_{(s)}$) or solid cone attachment ($SPT_{(c)}$). The penetrations are stated for those tests for which the full 150mm seating drive or 300mm test drive was not possible. The *N*-values provided on the borehole logs are uncorrected and no allowance has been made for energy ratio corrections. The SPT hammer energy measurement report is provided in Appendix F.

Disturbed (small bag) samples were taken within the encountered strata. Environmental samples were taken at standard intervals, as directed by the Client's Representative.

Any water strikes encountered during boring were recorded along with any changes in their levels as the borehole proceeded. Details of the water strikes are presented on the individual borehole logs.

Appendix B presents the borehole logs.

4.3 Standpipe installations

A groundwater monitoring standpipe was installed in boreholes BH01 – BH02.

Details of the installations, including the depth range of the response zone, are provided in Appendix B on the individual borehole logs.

4.4 Trial Pits

Three trial pits (TP01–TP03) were excavated using hand tools to depths of 1.0 - 1.2m. Two trial pits (TP04 – TP05) were excavated using a 3T tracked excavator fitted with a 600mm wide bucket, to depths of 2.0 – 3.0m.

Environmental samples were taken at depths of 1.0 and 2.5m in TP04 and 0.7 and 1.7m in TP05.

Any water strikes encountered during excavation were recorded along with any changes in their levels as the excavation proceeded. The stability of the trial pit walls was noted on completion.

Appendix C presents the trial pit logs with photographs of the pits and arising provided in Appendix D.

4.5 Surveying

The as-built exploratory hole positions were surveyed following completion of site operations by a Site Engineer from Causeway Geotech. Surveying was carried out using a Trimble R6 GPS system employing VRS and real time kinetic (RTK) techniques.

The plan coordinates (Irish National Grid) and ground elevation (mOD Malin) at each location are recorded on the individual exploratory hole logs. The exploratory hole plan presented in Appendix A shows these as-built positions.

5 LABORATORY WORK

Upon their receipt in the laboratory, all disturbed samples were carefully examined and accurately described, and their descriptions incorporated into the borehole logs.

5.1 Environmental laboratory testing of soils

Environmental testing, in the form of WAC testing was conducted on two environmental soil samples by Chemtest at its laboratory in Newmarket, Suffolk.

Results of environmental laboratory testing are presented in Appendix E.

6 GROUND CONDITIONS

6.1 General geology of the area

Published geological mapping indicate the superficial deposits underlying the site comprise glacial till with local bedrock outcrops present. These deposits are underlain by schists and quartzites of the Oldcourt Member.

6.2 Ground types encountered during investigation of the site

A summary of the ground types encountered in the exploratory holes is listed below, in approximate stratigraphic order:

- **Topsoil:** encountered in BH02, TP04 and TP05 with thicknesses of 100mm.
- **Made Ground (fill):** reworked clay/silt fill with localised pockets of concrete, plastic, glass and steel, encountered to a maximum depth of 3.0m in TP04.
- **Glacial Till:** sandy gravelly clay, frequently with low cobble content, typically firm or stiff in upper horizons, becoming very stiff with increasing depth. Soft stratum was encountered along the local access road in TP01 – TP03.

6.3 Groundwater

Groundwater was not noted during drilling at any of the borehole locations. However, it should be noted that the casing used in supporting the borehole walls during drilling may have sealed out any groundwater strikes and the possibility of encountering groundwater during excavation works should not be ruled out.

Groundwater was not noted during excavation of any of the trial pits.

Seasonal variation in groundwater levels should be factored into design considerations.

Continued monitoring of the two installed standpipes will give an indication of the seasonal variation in groundwater level.

7 REFERENCES

Geotechnical Society of Ireland (2016), Specification & Related Documents for Ground Investigation in Ireland

IS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing.

BS 1377: 1990: Methods of test for soils for civil engineering purposes. British Standards Institution.

BS 5930: 2015: Code of practice for ground investigations. British Standards Institution.

BS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing. British Standards Institution.

BS EN ISO 14688-1:2018: Geotechnical investigation and testing. Identification and classification of soil. Part 1 Identification and description. British Standards Institution.

BS EN ISO 14688-2:2004+A1:2013: Geotechnical investigation and testing. Identification and classification of soil. Part 2 Principles for a classification.

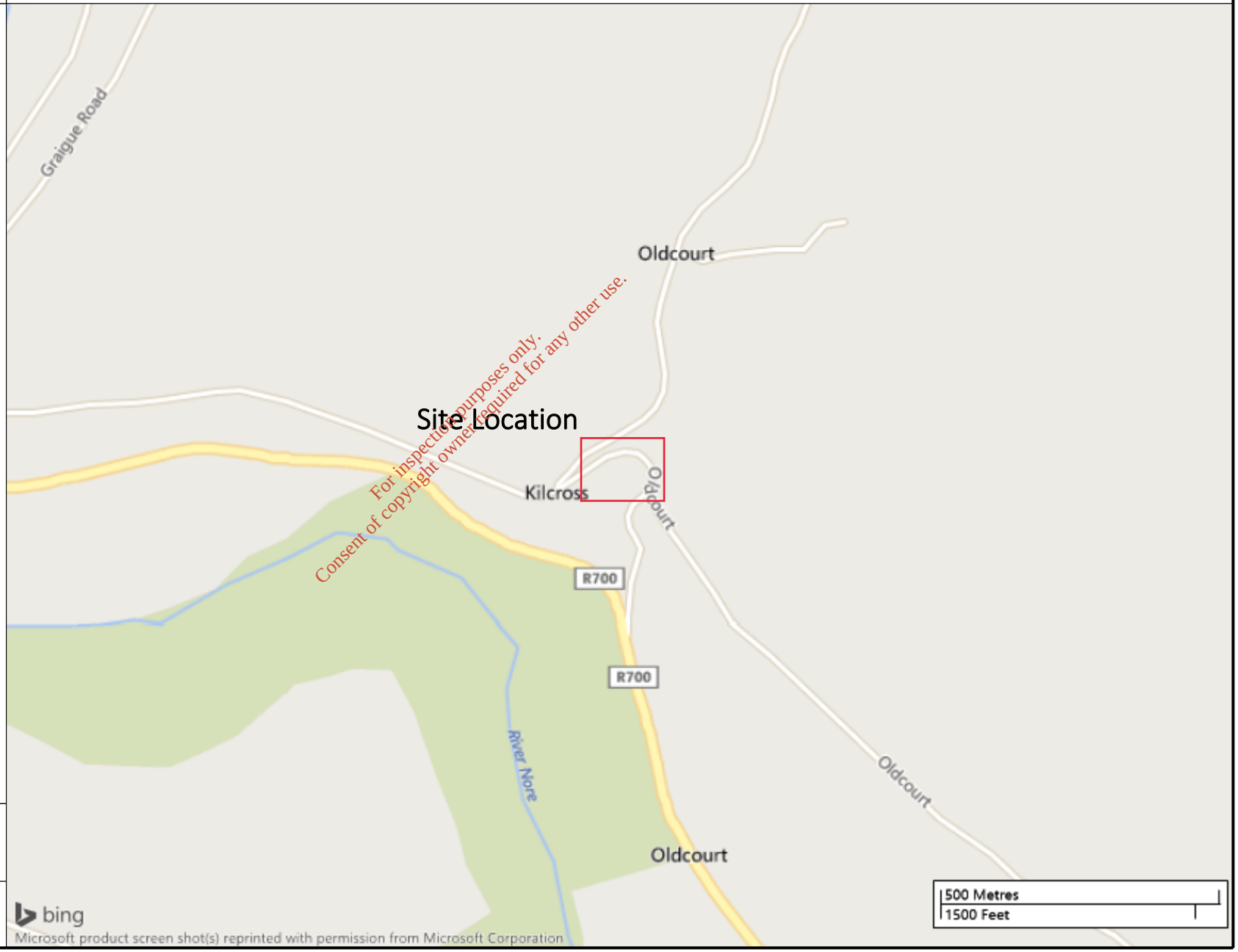
BS EN ISO 22476-3:2005+A1:2011: Geotechnical investigation and testing. Field testing. Standard penetration test.

APPENDIX A

SITE AND EXPLORATORY HOLE LOCATION PLANS

Project No.:	18-0847C	**Client:**	Kilkenny County Council
Project Name:	Kilkenny Landfills Oldcourt	**Client's Representative:**	Fehily Timoney and Company

Legend Key



Title:
Site Location Plan

Last Revised:	**Scale:**
10/10/2018	1:10000

CAUSEWAY GEOTECH

Project No.:	18-0847C	**Client:**	Kilkenny County Council
Project Name:	Kilkenny Landfills Oldcourt	**Client's Representative:**	Fehily Timoney and Company

Legend Key

- Locations By Type - CP
- Locations By Type - TP

Title:
Exploratory Hole Location Plan

Last Revised:	**Scale:**
10/10/2018	1:1000

CAUSEWAY GEOTECH

APPENDIX B

BOREHOLE LOGS

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Light Percussion	Dando Terrier	0.00	3.80

Project No.: 18-0847C

Project Name: Kilkenny Landfills Oldcourt

Borehole No.: BH01

Coordinates: 264982.61 E, 137487.84 N

Client: Kilkenny County Council

Sheet 1 of 1

Client's Representative: Fehily Timoney and Company

Scale: 1:50

Ground Level: 64.00 mOD

Dates: 04/10/2018 - 04/10/2018

Driller: PL

Logger: CH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
0.00 - 1.00	B8							MADE GROUND: Brown slightly clayey sandy subangular fine to coarse GRAVEL with low cobble content, fragments of concrete, glass, plastic and slate. Sand is fine to coarse. Cobbles are subrounded.		
0.50	ES3					(1.00)				
1.00	ES4				63.00	1.00		MADE GROUND: Firm brown sandy gravelly CLAY with low cobble content, fragments of plastic, metal and cloth. Sand is fine to coarse. Gravel is subrounded fine to medium. Cobbles are subrounded.		
1.20	D1									
1.20 - 1.65	SPT (S) N=12			N=12 (1,6/6,3,2,1)		(1.00)				
2.00	ES5				62.00	2.00		MADE GROUND: Firm becoming stiff brown sandy gravelly CLAY with low cobble content, fragments of plastic, metal and cloth. Sand is fine to coarse. Gravel is subrounded fine to medium. Cobbles are subrounded.		
2.00 - 2.38	SPT (S)			N=50 (1,1/50 for 235mm)		(1.00)				
3.00	D2				61.00	3.00		Stiff to very stiff brownish grey sandy gravelly SILT with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse. Cobbles are subrounded.		
	ES6									
3.00 - 3.45	SPT (S) N=29			N=29 (3,3/8,12,4,5)		(0.80)				
3.80	ES7				60.20	3.80		End of Borehole at 3.80m		
3.80 - 4.07	SPT (S)			N=50 (14,18/50 for 115mm)						

Remarks

No groundwater encountered.

Reduced recovery between 1.0 and 3.0m.

Terminated on obstruction.

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)

Casing Details

To (m)	Diam (mm)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Light Percussion	Dando Terrier	0.00	3.00

Project No.: 18-0847C

Project Name: Kilkenny Landfills Oldcourt

Borehole No.: BH02

Coordinates: 265008.96 E, 137488.29 N

Client: Kilkenny County Council

Sheet 1 of 1

Client's Representative: Fehily Timoney and Company

Scale: 1:50

Ground Level: 65.13 mOD

Dates: 04/10/2018 - 04/10/2018

Driller: PL

Logger: CH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
0.10 - 1.00	B5				65.03	0.10 (0.10)		TOPSOIL		
0.50	ES1					(0.90)		MADE GROUND: Orangish brown slightly sandy very clayey subangular fine to coarse GRAVEL with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse. Cobbles are subrounded.		
1.00	ES2				64.12	1.00				
1.00 - 2.00	B6							MADE GROUND: Soft orangish brown sandy very gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse. Cobbles are subrounded.		
1.20 - 1.65	SPT (S) N=6			N=6 (1,2/2,2,1,1)		(1.00)				
2.00	ES3				63.12	2.00				
2.00 - 2.45	SPT (S) N=13			N=13 (4,9/3,3,3,4)				Firm grey sandy very gravelly SILT with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse. Cobbles are subrounded.		
2.50	ES4					(1.00)				
3.00 - 3.10	SPT (S)			N=50 (25 for 50mm/50 for 55mm)	62.12	3.00		End of Borehole at 3.00m		

Remarks

No groundwater encountered.

Reduced recovery between 2.0 and 3.0m.

Terminated on obstruction.

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)

Casing Details

To (m)	Diam (mm)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

CAUSEWAY GEOTECH

APPENDIX C

TRIAL PIT LOGS

CAUSEWAY GEOTECH

Project No.: 18-0847C	**Project Name:** Kilkenny Landfills Oldcourt		**Trial Pit No.:** TP01
Co-ordinates: 264955.60 E	**Client:** Kilkenny County Council		Sheet 1 of 1
Method: Hand Dug Pit	137502.64 N	**Client's Representative:** Fehily Timoney and Company	**Scale:** 1:25
Plant: Hand Tools	**Ground Level:** 64.69 mOD	**Date:** 03/10/2018	**Logger:** PL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
				(0.50)		Soft brown slightly gravelly sandy CLAY with low cobble and high boulder content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles and boulders are subrounded.	
0.50	ES1		64.19	0.50			
				(0.50)		Firm orangish brown sandy gravelly CLAY with rootlets and high cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse. Cobbles are subrounded.	
1.00	ES2		63.69	1.00		End of trial pit at 1.00m	

Remarks
No obvious contamination.
Glass bottles present at ground level.

Water Strikes:	
Struck at (m):	Remarks:

Stability:

Width:

Length:

CAUSEWAY GEOTECH

Project No.: 18-0847C	**Project Name:** Kilkenny Landfills Oldcourt		**Trial Pit No.:** TP02
Co-ordinates: 264930.24 E	**Client:** Kilkenny County Council		Sheet 1 of 1
Method: Hand Dug Pit	137478.15 N	**Client's Representative:** Fehily Timoney and Company	**Scale:** 1:25
Plant: Hand Tools	**Ground Level:** 64.41 mOD	**Date:** 04/10/2018	**Logger:** PL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
			64.31	(0.10) 0.10		Firm bluish grey sandy gravelly SILT with high cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse.	
				(0.50)		Firm orangish grey slightly gravelly sandy SILT with high cobble content. Sand is fine to coarse. Gravel is subangular to angular fine to coarse. Cobbles are subrounded.	
0.50	ES1		63.80	0.60		Firm greyish orange sandy gravelly SILT with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse. Cobbles are subrounded.	
				(0.40)			
1.00	ES2		63.40	1.00		End of trial pit at 1.00m	

Remarks
No obvious contamination.
Plastic fragments present at ground level..

Water Strikes:	
Struck at (m):	Remarks:

Stability:

Width:

Length:

CAUSEWAY GEOTECH

Project No.: 18-0847C	**Project Name:** Kilkenny Landfills Oldcourt	**Trial Pit No.:** TP03
Co-ordinates: 264901.80 E 137460.91 N	**Client:** Kilkenny County Council	Sheet 1 of 1
Method: Hand Dug Pit	**Client's Representative:** Fehily Timoney and Company	**Scale:** 1:25
Plant: Hand Tools	**Ground Level:** 63.96 mOD	**Date:** 04/10/2018	**Logger:** PL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
				(0.60)		Orangish brown slightly clayey gravelly fine to coarse SAND with low cobble content. Sand is fine to coarse. Gravel is subangular fine to medium. Cobbles are subrounded.	
0.50	ES1		63.36	0.60			
				(0.60)		Orangish brown slightly clayey very gravelly fine to coarse SAND with medium cobble content. Gravel is subangular fine to coarse. Cobbles are subrounded.	
1.00	ES2		62.76	1.20		End of trial pit at 1.20m	

Remarks
No obvious contamination.
Plastic and bottles present at ground level.

Water Strikes:	
Struck at (m):	Remarks:

Stability:

Width:

Length:

CAUSEWAY GEOTECH

Project No.: 18-0847C	**Project Name:** Kilkenny Landfills Oldcourt		**Trial Pit No.:** TP04
Co-ordinates: 264995.15 E 137494.14 N	**Client:** Kilkenny County Council		Sheet 1 of 1
Method: Trial Pitting	**Client's Representative:** Fehily Timoney and Company		**Scale:** 1:25
Plant: 3T 360 Tracked Excavator	**Ground Level:** 64.59 mOD	**Date:** 03/10/2018	**Logger:** MMC

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
			64.49	(0.10) 0.10		TOPSOIL	
						MADE GROUND: Firm brown slightly sandy CLAY with plastic bottles, glass bottles, plastic bags, pieces of steel, clothing and plastic fibre straps.	
				(1.20)			
1.00	ES1						
			63.29	1.30		MADE GROUND: Firm brownish grey slightly sandy CLAY with plastic bottles, glass bottles, plastic bags, pieces of steel, clothing and plastic fibre straps.	
				(1.70)			
2.50	ES2						
			61.59	3.00		End of trial pit at 3.00m	

Remarks
No groundwater encountered.
Extent of fill not concluded.

Terminated due to maximum reach of excavator.

Water Strikes:

Struck at (m):	Remarks:

Stability: Stable

Width: 0.80

Length: 3.00

CAUSEWAY GEOTECH

Project No.: 18-0847C	**Project Name:** Kilkenny Landfills Oldcourt		**Trial Pit No.:** TP05
Co-ordinates: 265019.52 E	**Client:** Kilkenny County Council		Sheet 1 of 1
Method: Trial Pitting	137479.08 N	**Client's Representative:** Fehily Timoney and Company	**Scale:** 1:25
Plant: 3T 360 Tracked Excavator	**Ground Level:** 65.30 mOD	**Date:** 03/10/2018	**Logger:** MMC

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
			65.19	(0.10) 0.10		TOPSOIL: Firm brown peaty CLAY with rootlets.	
				(0.40)		MADE GROUND: Firm brown sandy gravelly CLAY with glass bottles, plastic bottles and fragments of plastic.	
			64.80	0.50			
0.70	ES1			(0.30)		MADE GROUND: Light orangish brown ash like material.	
			64.50	0.80		MADE GROUND: Firm greyish brown slightly gravelly CLAY with fragments of plastic.	
				(0.80)			
1.70	ES2		63.70	1.60		Firm light brown CLAY with medium boulder content. Boulders are sub-angular.	
				(0.40)			
			63.30	2.00		End of trial pit at 2.00m	

Remarks
No groundwater encountered.

Terminated on obstruction.

Water Strikes:	
Struck at (m):	Remarks:

Stability: Stable

Width: 1.00

Length: 3.00

CAUSEWAY GEOTECH

APPENDIX D

TRIAL PIT PHOTOGRAPHS

TP04

TP04

TP04

TP04