Appendix A14.2
Ground Investigation Report

Bus Connects Route 13 Bray to City Centre – Ground Investigation

Client:	National Transport Authority (NTA)
Client's Representative:	Jacobs
Report No.:	20-0399E
Date:	December 2020
Status:	Final for Issue

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Approved: ISO 9001 • ISO 14001 • OHSAS 18001

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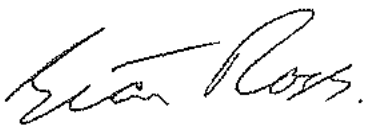
APPENDICES

Document Control Sheet

Report No.:		20-0399E			
Project Title:		Bus Connects Route 13 Bray to City Centre			
Client:		National Transport Authority (NTA)			
Client's Representative:		Jacobs			
Revision:	A01	**Status:**	Final for Issue	**Issue Date:**	17th December 2020
Prepared by:		**Reviewed by:**		**Approved by:**	
 Sean Ross BSc MSc MIEI		 Colm Hurley BSc FGS PGeo		 Darren O'Mahony BSc MSc MIEI EurGeol PGeo	

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.
(Y for Z/ Y for Z)	Incomplete standard penetration test where the full test length was not achieved. The blows 'X' represent the total blows for the given seating or test length 'Z' (mm).
N=X	SPT blow count 'N' given by the summation of the blows 'X' required to drive the full test length (300mm).
HVP / HVR	In situ hand vane test result (HVP) and vane test residual result (HVR). Results presented in kPa.
V VR	Shear vane test (borehole). Shear strength stated in kPa. V: undisturbed vane shear strength VR: remoulded vane shear strength
Soil consistency description	In cohesive soils, where samples are disturbed and there are no suitable laboratory tests, N values may be used to indicate consistency on borehole logs – a median relationship of Nx5=Cu is used (as set out in Stroud & Butler 1975).
dd-mm-yyyy	Date at the end and start of shifts, shown at the relevant borehole depth. Corresponding casing and water depths shown in the adjacent columns.
▽	Water strike: initial depth of strike.
▼	Water strike: depth water rose to.
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.
(xxx/xxx/xxx)	Spacing between discontinuities (minimum/average/maximum) measured in millimetres.

Bus Connects Route 13 Bray to City Centre

1 AUTHORITY

On the instructions of Jacobs, ("the Client's Representative"), acting on the behalf of National Transport Authority (NTA) ("the Client"), a ground investigation was undertaken at the above location to provide geotechnical and environmental information to inform the planning stage design and enable the design of Bus Connects Core Bus Corridors.

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, slit trenches, soil sampling, environmental sampling, groundwater monitoring, 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 along the route of the proposed Bus Connects Route from Bray to the City Centre with investigation points at the N11 junction with the Lower Kilmacud Road, junction of the N11 with the Old Bray Road and within the ground of Ravenswell Primary School in Bray, Co. Wicklow.

Borehole works were undertaken in housing estates off the N11 while slit trenches were undertaken within the central median of the road.

4 SITE OPERATIONS

4.1 Summary of site works

Site operations, which were conducted between 16th October and 2nd November 2020, comprised:

- three light cable percussion boreholes
- one borehole by dynamic (windowless) sampling methods
- a standpipe installation in three boreholes
- six slit trenches

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

A total of four boreholes were put down in a minimum diameter of 150mm through soils strata to their completion depths by a combination of methods, including light percussion boring using a Dando Terrier rig and light cable percussion boring by a Dando 2000 rig.

The borehole logs state the methodology and plant used for each location, as well as the appropriate depth ranges.

A summary of the boreholes, subdivided by category in accordance with the methods employed for their completion, is presented in the following sub-sections.

4.2.1 Light cable percussion boreholes

Three boreholes (R13-CP01 – R13-CP03) were put down to completion in minimum 200mm diameter using Dando 2000 light cable percussion boring rigs. All boreholes were terminated either at their scheduled completion depths, or else on encountering virtual refusal on obstructions, including large boulders and weathered bedrock.

Hand dug inspection pits were carried out between ground level and 1.20m depth to ensure boreholes were put down at locations clear of services or subsurface obstructions.

Disturbed (bulk and small bag) samples were taken within the encountered strata. Undisturbed (U100) samples were taken where appropriate and as directed within fine soils. Environmental samples were taken at standard intervals, as directed by the Client's Representative.

Standard penetration tests were carried out in accordance with BS EN 22476-3:2005+A1:2011 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 G.

Any water strikes encountered during boring were recorded along with any changes in their levels as the borehole proceeded.

Where water was added to assist with boring, a note has been added to the log to account for same.

Appendix B presents the borehole logs.

4.2.2 Dynamic sampled boreholes

One borehole (R12-WS01) was put down to completion by light percussion boring techniques using a Dando Terrier dynamic sampling rig. The borehole was put down initially in 150mm diameter, reducing in diameter with depth as required, down to 50mm by use of the smallest sampler.

A hand dug inspection pit was carried out between ground level and 1.20m depth to ensure the boreholes was put down clear of services or subsurface obstructions. The borehole was taken to a depth of 2.0m where it was terminated on encountering virtual refusal.

Standard penetration tests were carried out in accordance with BS EN 22476-3:2005+A1:2011 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 G.

Groundwater was not encountered during boring.

Appendix B presents the borehole logs.

4.3 Standpipe installations

A groundwater monitoring standpipe was installed in BH01-BH03.

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

4.4 Slit trenches

Six slit trenches (R13-SLT01-R13-SLT03, R13-SLT03A and R13-SLT04-R13-SLT15) were excavated by a combination of hand digging and mechanical excavation using a compact 3t tracked excavator fitted with a 600mm wide toothless bucket, to locate and identify buried services at the site.

Drawing of the trenches and the locations of services encountered during excavation are shown along with the slit trench logs in Appendix D, with photographs presented in Appendix E.

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

4.6 Groundwater monitoring

Following completion of site works, groundwater monitoring was conducted on one round. Ground water monitoring was carried out using a water interface probe.

The monitoring records are presented in Section 6.3.

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 Geotechnical laboratory testing of soils

Laboratory testing of soils comprised:

- **soil classification:** moisture content measurement, Atterberg Limit tests and particle size distribution analysis.

- **soil chemistry:** BRE Test Suite B

Laboratory testing of soils samples was carried out in accordance with British Standards Institute: *BS 1377, Methods of test for soils for civil engineering purposes; Part 1 (2016), and Parts 2-9 (1990).*

The test results are presented in Appendix H.

5.2 Environmental laboratory testing of soils

Environmental testing, as specified by the Client's Representative was conducted on selected environmental soil samples by Chemtest at its laboratory in Newmarket, Suffolk.

Testing was carried out on a number of samples according to Engineer's Ireland Suite E and Suite H including testing for a range of determinants:

- Metals
- Speciated total petroleum hydrocarbons (TPH)
- Speciated polycyclic aromatic hydrocarbons (PAH)
- Cyanides
- Asbestos screen
- pH
- Waste acceptance criteria (WAC) testing

Results of environmental laboratory testing are presented in Appendix F.

6 GROUND CONDITIONS

6.1 General geology of the area

Published geological mapping indicate the superficial deposits underlying the site comprise Glacial Till, fluvioglacial sands and gravels and made ground. These deposits are underlain by Leinster Granite in the north of the route and by the Maulin Formation in the section of the route.

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:

- **Paved surface:** boreholes R13-CP01 and R13-CP02 encountered 100-200mm of macadam surfacing.

- **Topsoil:** encountered in R13-CP03, R13-WS01 and R13-SLT01-R13-SLT05 ranging in thickness from 100-500mm.

- **Made Ground (sub-base):** approximately 200 to 1200mm of aggregate fill beneath the paved surface in R13-CP01 and R13-CP02,

- **Made Ground (fill):** reworked sandy gravelly clay or silty sandy gravel or brown fine to coarse sand fill encountered at all locations to a maximum depth of 3.50m in R13-CP03. Varying amounts of red brick, concrete, tin and plastic fragments were encountered in R13-CP03, R13-SLT01, R13-SLT02, R13-SLT03 and R13-SLT03A to a maximum depth of 2.30m in R13-CP03.

- **Fluvioglacial deposits:** typically, medium dense sands and gravels interspersed with layers of sandy gravelly clay encountered at all borehole locations.

- **Glacial Till:** sandy gravelly clay or silt, frequently with low cobble content, typically firm or stiff in upper horizons, becoming very stiff with increasing depth.

6.3 Groundwater

Details of the individual groundwater strikes, along with any relative changes in levels as works proceeded, are presented on the exploratory hole logs for each location.

Groundwater was encountered during percussion boring in R13-CP02 through soil as a water strike at 2.30m in R13-CP02.

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

Groundwater was not noted during excavation of any of the slit trenches.

Subsequent groundwater monitoring of the standpipe installations recorded water levels as shown in Table 1.

Table 1: Groundwater monitoring

Date	Water level (mbgl)		
	R13-CP01	R13-CP02	R13-CP03
19/11/2020	2.47	2.24	Dry

Seasonal variation in groundwater levels should also be factored into design considerations and continued monitoring of the installed standpipes will give an indication of the seasonal variation.

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. National Standards Authority of Ireland.

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

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

BS EN ISO 14688-2:2018: Geotechnical investigation and testing. Identification and classification of soil. Part 2 Principles for a classification.

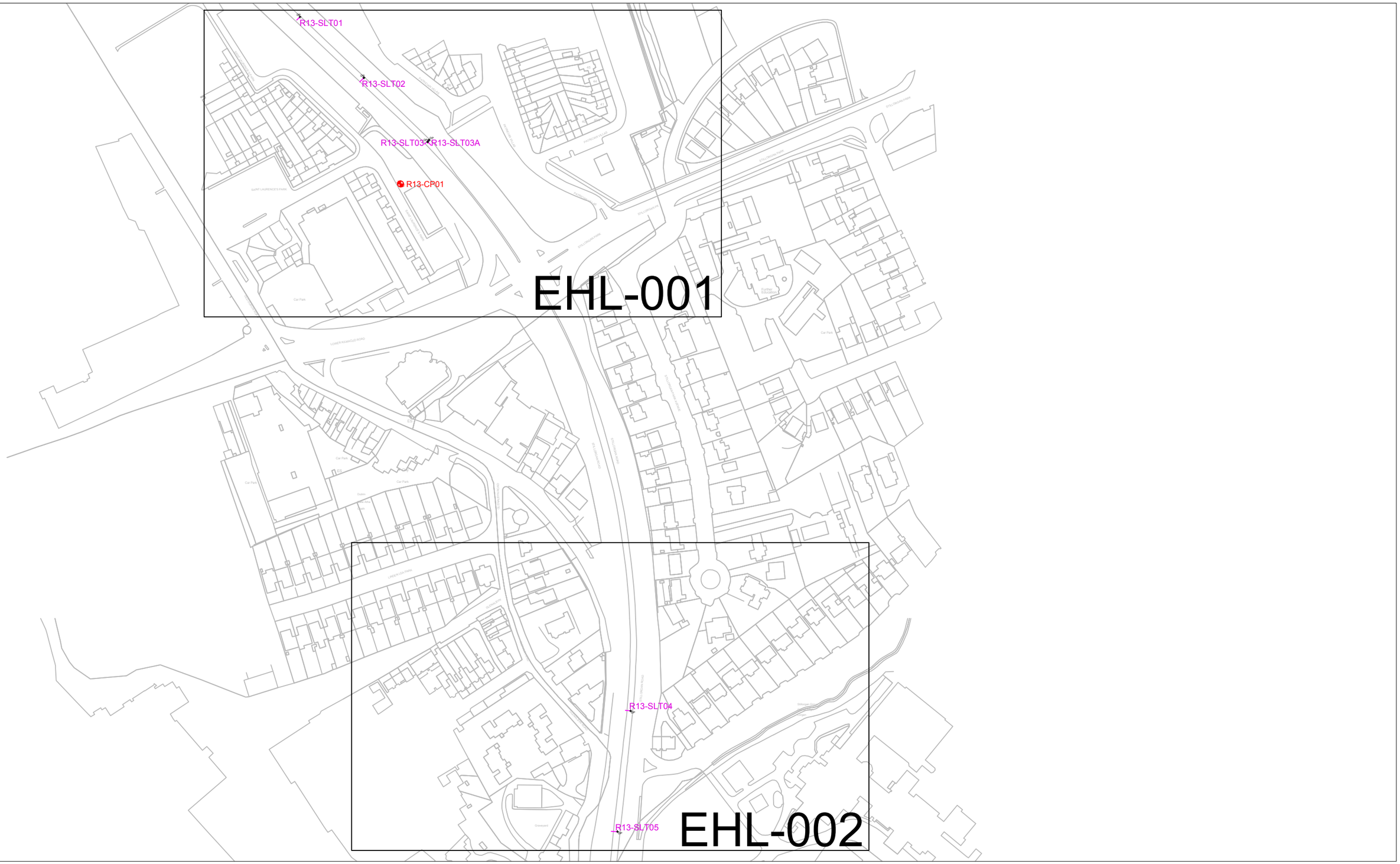
BS 1377: 1990: Methods of test for soils for civil engineering purposes. British Standards Institution.

BS EN ISO 14689-1:2018: Geotechnical investigation and testing. Identification and classification of rock. Identification and description.

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

APPENDIX A

SITE AND EXPLORATORY HOLE LOCATION PLAN



PROJECT: Bus Connects Route 13 Bray to City Centre

TITLE: Exploratory hole location plan (Overview)

CLIENT: National Transport Authority (NTA)

KEY:
- Borehole
- Slit Trench

ENGINEER: Jacobs

CAUSEWAY GEOTECH

SCALE: NTS@A3

DATE: 18/11/2020

DRWN: BS

CHCK: CH

SERIES: 1 of 4

DWG No: 20-0399E-EHL-OW-001

PROJECT: Bus Connects Route 13 Bray to City Centre

TITLE: Exploratory hole location plan (Overview)

CLIENT: National Transport Authority (NTA)

KEY:
- Borehole
- Slit Trench

ENGINEER: Jacobs

CAUSEWAY GEOTECH

SCALE: NTS@A3

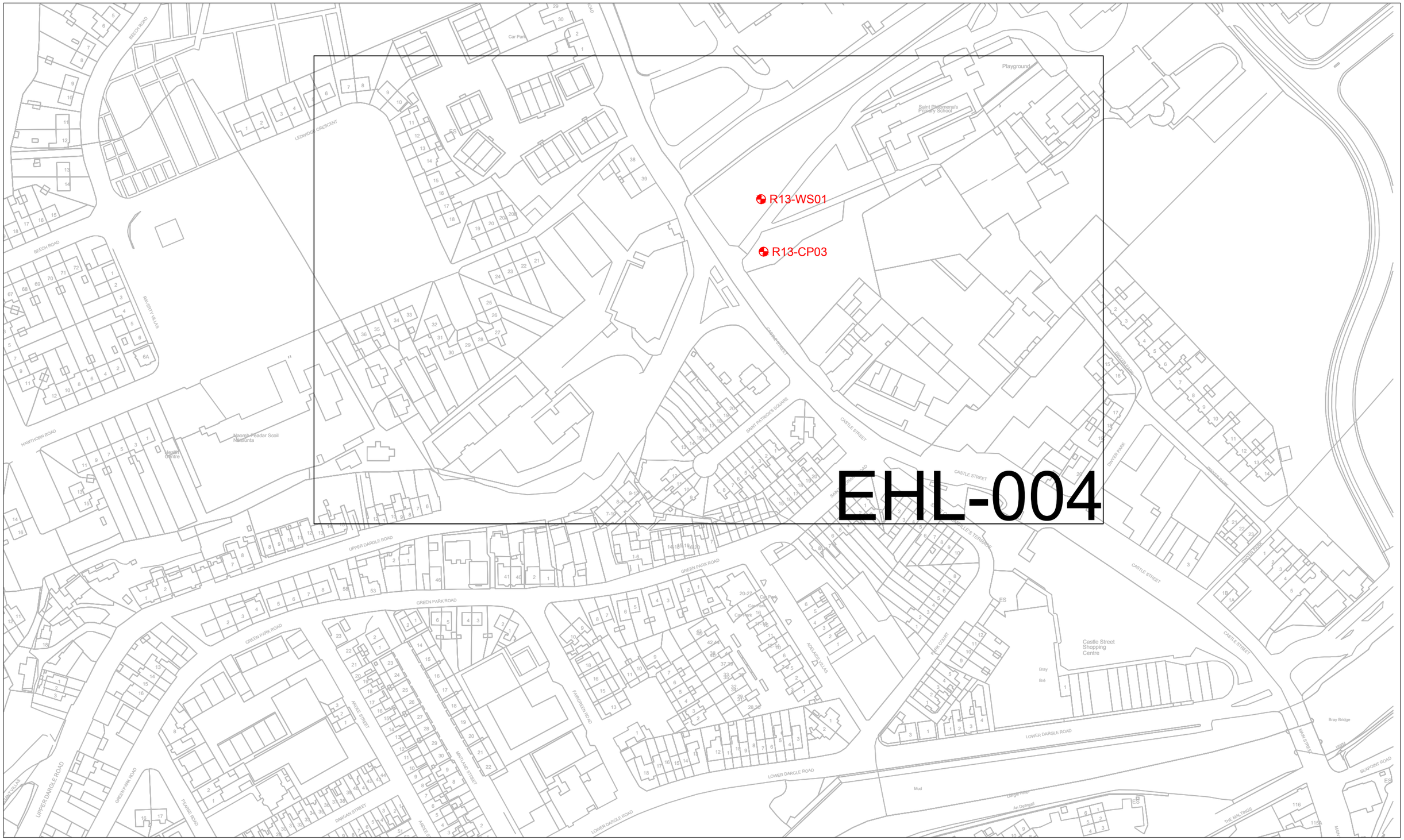
DATE: 18/11/2020

DRWN: BS

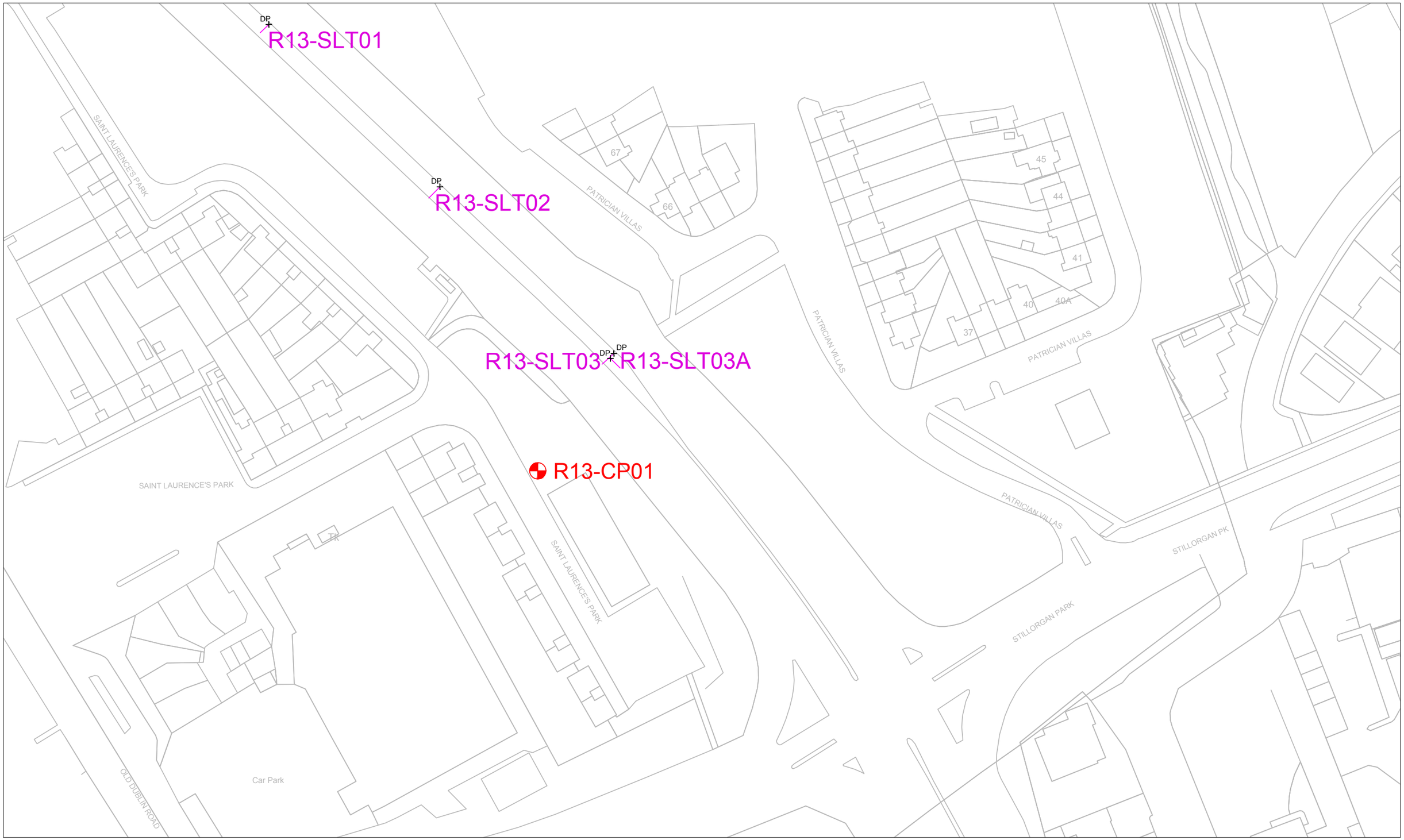
CHCK: CH

SERIES: 2 of 3

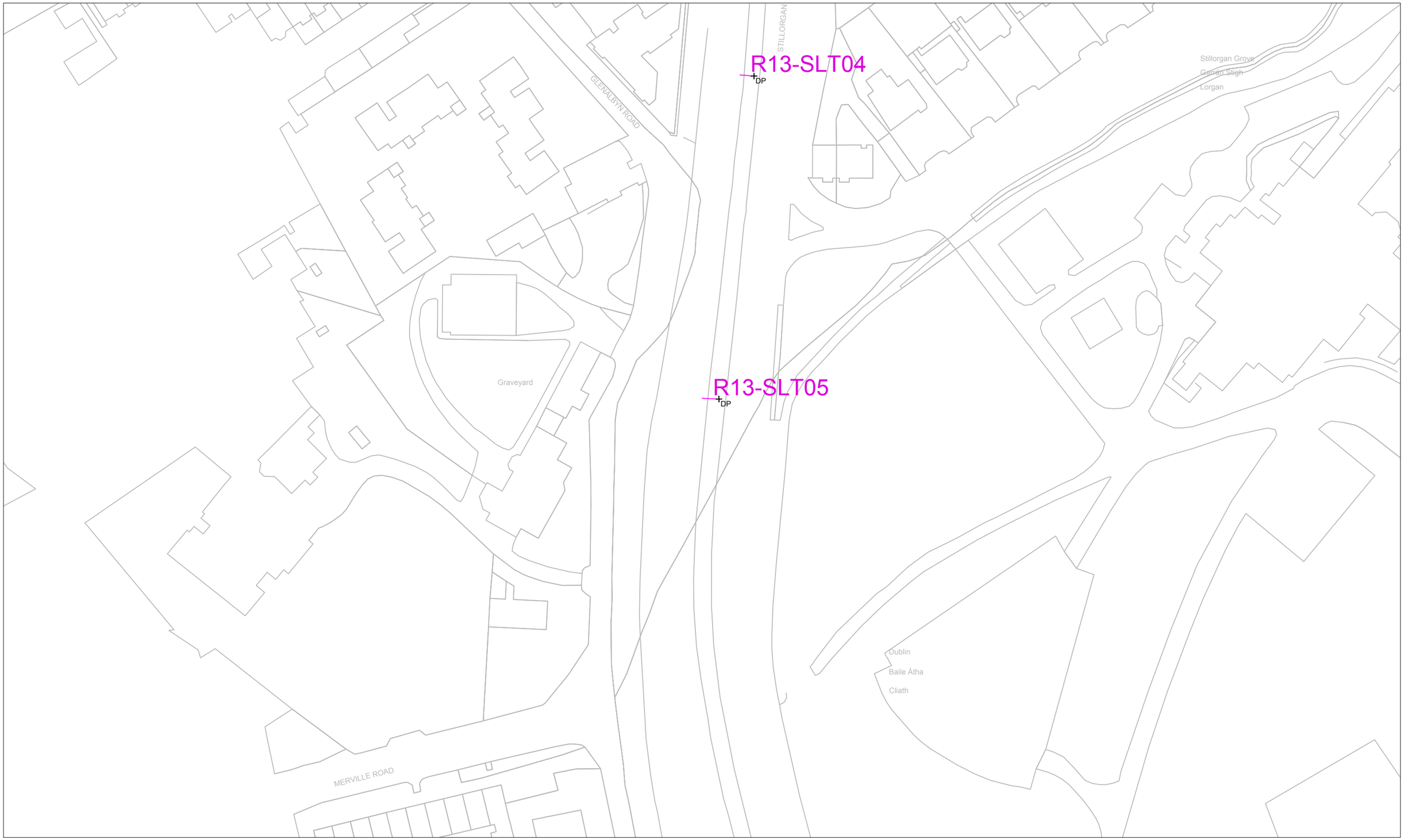
DWG No: 20-0399E-EHL-OW-001



PROJECT: Bus Connects Route 13 Bray to City Centre		TITLE: Exploratory hole location plan (Overview)			
CLIENT: National Transport Authority (NTA)	KEY: Borehole; Slit Trench	CAUSEWAY GEOTECH	SCALE: NTS@A3	DATE: 18/11/2020	
ENGINEER: Jacobs			DRWN: BS; CHCK: CH	SERIES: 3 of 3	DWG No: 20-0399E-EHL-OW-001



PROJECT: Bus Connects Route 13 Bray to City Centre		TITLE: Exploratory hole location plan			
CLIENT: National Transport Authority (NTA)	KEY: Borehole, Slit Trench	CAUSEWAY GEOTECH	SCALE: NTS@A3	DATE: 18/11/2020	
ENGINEER: Jacobs			DRWN: BS CHCK: CH	SERIES: 1 of 4	DWG No: 20-0399E-EHL-001



PROJECT: Bus Connects Route 13 Bray to City Centre

TITLE: Exploratory hole location plan

CLIENT: National Transport Authority (NTA)

KEY:
- Borehole
- Slit Trench

ENGINEER: Jacobs

CAUSEWAY GEOTECH

SCALE: NTS@A3

DATE: 18/11/2020

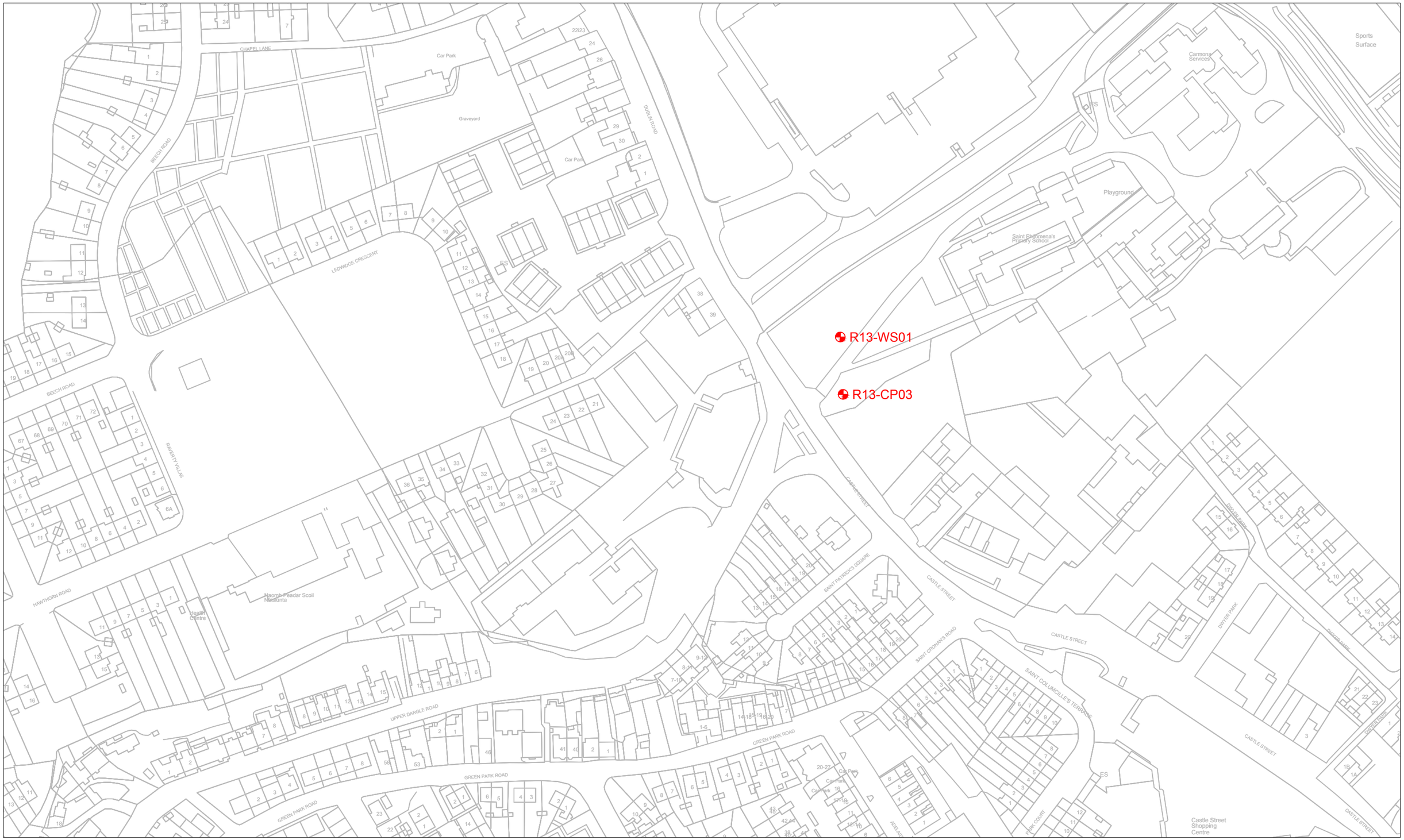
DRWN: BS

CHCK: CH

SERIES: 2 of 4

DWG No: 20-0399E-EHL-002

PROJECT: Bus Connects Route 13 Bray to City Centre		TITLE: Exploratory hole location plan			
CLIENT: National Transport Authority (NTA)	KEY: Borehole; Slit Trench	CAUSEWAY GEOTECH	SCALE: NTS@A3	DATE: 18/11/2020	
ENGINEER: Jacobs			DRWN: BS CHCK: CH	SERIES: 3 of 4	DWG No: 20-0399E-EHL-003



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CLIENT: National Transport Authority (NTA)	KEY: Borehole; Slit Trench	CAUSEWAY GEOTECH	SCALE: NTS@A3	DATE: 18/11/2020	
ENGINEER: Jacobs			DRWN: BS; CHCK: CH	SERIES: 4 of 4	DWG No: 20-0399E-EHL-004

APPENDIX B
BOREHOLE LOGS

CAUSEWAY GEOTECH

Project No.	Project Name: Bus Connects Route 13 Bray to City Centre	Borehole ID
20-0399E	Client: National Transport Authority (NTA)	R13-CP01
	Client's Rep: Jacobs	

Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth: 4.80 m	Start Date: 28/10/2020	Driller: BM	Sheet 1 of 1
Cable Percussion	Dando 2000	0.00	4.80	720216.36 E 728149.44 N	Elevation: 48.99 mOD	End Date: 28/10/2020	Logger: GH	Scale: 1:40 FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description
					48.89	0.10		BITMAC
					48.69	0.30		MADE GROUND: Grey sandy angular fine to coarse GRAVEL of limestone. Sand is fine to coarse.
0.50	B1							MADE GROUND: Soft brownish grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.
0.50	ES7							
1.00	B2							
1.00	ES8							
1.20	D11				47.79	1.20		
1.20 - 1.65	SPT (S)	N=9 (2,3/2,2,2,3) Hammer SN = 0643	0.00	Dry				Firm becoming stiff brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.
2.00	B3							
2.00	D9							
2.00	ES12							
2.00 - 2.45	SPT (S)	N=21 (4,4/7,5,4,5) Hammer SN = 0643	1.50	Dry				
3.00	B4							
3.00	D13							
3.00	ES10							
3.00 - 3.45	U15	Ublow=25 90%	3.00	Dry				
4.00	B5							
4.00 - 4.20	SPT (S)	N=50 (7,25/50 for 50mm) Hammer SN = 0643	3.00	Dry	44.89	4.10		Very stiff grey slightly sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subangular of mixed lithologies.
4.50	B6				44.39	4.60		
4.50	D14							
4.70 - 4.78	SPT (S)	N=50 (25 for 35mm/50 for 50mm) Hammer SN = 0643	3.00	Dry	44.19	4.80		Dense grey sandy GRAVEL of mixed lithologies. Sand is fine to coarse. (Possible bedrock)
								End of Borehole at 4.80m

Water

Backfill

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0

Water Strikes

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

Chiselling Details

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

Casing Details

To (m)	Diameter
3.00	200

Water Added

From (m)	To (m)

Remarks

Hand dug inspection pit excavated to 1.20m.
No groundwater encountered.

Termination Reason

Terminated on refusal.

Last Updated

17/12/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0399E	Bus Connects Route 13 Bray to City Centre	R13-CP02
	Client: National Transport Authority (NTA)	
	Client's Rep: Jacobs	

Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 1 of 1
Cable Percussion	Dando 2000	0.00	2.70	722200.70 E 726075.61 N	2.70 m	27/10/2020	BM	Scale: 1:40
					Elevation: 55.91 mOD	End Date: 27/10/2020	Logger: GH	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description
					55.70	0.20		BITMAC
0.50	B1							MADE GROUND: Grey sandy slightly silty subangular GRAVEL of mixed lithologies. Sand is fine to coarse.
0.50	ES5							
1.00	B2							
1.00	ES6							
1.20	D9				54.70	1.20		
1.20 - 1.65	SPT (S)	N=10 (2,3/2,2,3,3) Hammer SN = 0643	0.00	Dry				Medium dense brown sandy subangular to subrounded GRAVEL of mixed lithologies with low cobble content. Sand is fine to coarse. Cobbles are subrounded of mixed lithologies.
2.00	B3				53.90	2.00		
2.00	D10							Medium dense brown sandy silty subangular to subrounded GRAVEL of mixed lithologies with low cobble content. Sand is fine to coarse. Cobbles are subrounded of mixed lithologies.
2.00	ES7							
2.00 - 2.45	SPT (S)	N=10 (2,3/2,3,3,2) Hammer SN = 0643 Strike at 2.30m	1.50	Dry	53.40	2.50		
2.50	B4				53.20	2.70		Dense grey sandy GRAVEL of mixed lithologies. Sand is fine to coarse. (Possible bedrock)
2.50	ES8							End of Borehole at 2.70m
3.00 - 3.18	SPT (S)	N=50 (25 for 50mm/50 for 125mm) Hammer SN = 0643	1.50	1.50				

Water

Backfill

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
2.30		20	2.20

Casing Details

To (m)	Diameter
1.50	200

Water Added

From (m)	To (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)
2.50	2.70	01:00

Remarks

Hand dug inspection pit excavated to 1.20m.

Termination Reason

Terminated on refusal.

Last Updated

17/12/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0399E	Bus Connects Route 13 Bray to City Centre	R13-CP03
	Client: National Transport Authority (NTA)	
	Client's Rep: Jacobs	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Cable Percussion	Dando 2000	0.00	7.00	726002.77 E 719137.22 N

Final Depth:	7.00 m	Start Date:	16/10/2020	Driller:	BM
Elevation:	10.56 mOD	End Date:	17/10/2020	Logger:	

Sheet 1 of 1
Scale: 1:40
FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description
					10.46	0.10		TOPSOIL
0.50	B1							MADE GROUND: Brown very sandy silty subangular to subrounded fine to coarse GRAVEL of mixed lithologies with fragments of red brick. Sand is fine to coarse.
0.50	ES9							
1.00	B2							
1.00	ES							
1.00	ES10				9.36	1.20		
1.20	D15							MADE GROUND: Very soft greyish brown sandy gravelly CLAY with frequent fragments of brick. Sand is fine to coarse. Gravel is subangular fine to coarse of mixed lithologies.
1.20 - 1.65	SPT (S)	N=2 (0,1/0,1,0,1) Hammer SN = 0643	1.00	Dry				
2.00	B3							
2.00	D16							
2.00	ES11							
2.00 - 2.45	SPT (S)	N=4 (0,1/1,1,1,1) Hammer SN = 0643	1.50	Dry	8.26	2.30		MADE GROUND: Soft brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of mixed lithologies.
3.00	B4							
3.00	ES12							
3.00 - 3.45	U20	Ublow=20 100%	1.50	Dry				
					7.06	3.50		Very stiff brown slightly sandy slightly gravelly SILT. Sand is fine to coarse. Gravel is subrounded fine to medium of mixed lithologies.
4.00	B5							
4.00	D17							
4.00	ES13							
4.00 - 4.45	SPT (S)	N=30 (4,5/7,7,7,9) Hammer SN = 0643	3.00	Dry				
5.00	B6							
5.00	D18							
5.00	ES14							
5.00 - 5.45	SPT (S)	N=38 (6,6/8,9,9,12) Hammer SN = 0643	3.00	Dry				
					5.06	5.50		Dense brown sandy silty subrounded fine to coarse GRAVEL of mixed lithologies. Sand is fine to coarse.
6.00	B7							
6.00 - 6.45	U21	Ublow=50 60%	3.00	Dry				
					4.06	6.50		Dense brown gravelly clayey fine to coarse SAND. Gravel is subrounded fine to coarse of mixed lithologies.
7.00	B8				3.56	7.00		
7.00	D19							End of Borehole at 7.00m
7.00 - 7.38	SPT (S)	N=50 (9,11/50 for 225mm) Hammer SN = 0643	3.00	Dry				

Water | Backfill

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0

Water Strikes

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

Chiselling Details

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

Casing Details

To (m)	Diameter

Water Added

From (m)	To (m)

Remarks

Hand dug inspection pit excavated to 1.20m.

Termination Reason

Terminated on refusal.

Last Updated

17/12/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0399E	Bus Connects Route 13 Bray to City Centre	R13-WS01
	Client: National Transport Authority (NTA)	
	Client's Rep: Jacobs	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Light Percussion	Dando Terrier	0.00	2.00	726001.49 E 719163.98 N

Final Depth:	Start Date:	Driller:	Sheet 1 of 1
2.00 m	19/10/2020	JC	Scale: 1:50
Elevation: 13.64 mOD	**End Date:** 19/10/2020	**Logger:**	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
								TOPSOIL		
0.50	ES1				13.14	0.50				
0.50 - 1.30	B2							Soft to firm brown sandy gravelly SILT. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.		
1.00	ES3									
1.20	D4									
1.20 - 1.65	SPT (C)	N=13 (3,4/3,3,3,4) Hammer SN = 0696	0.00	Dry	12.34	1.30		Medium dense light brown very sandy silty subangular to subrounded fine to coarse GRAVEL of mixed lithologies. Sand is fine to coarse.		
1.30 - 1.60	B5									
1.60 - 2.00	B6									
2.00	ES7				11.64	2.00		End of Borehole at 2.00m		
2.00 - 2.44	SPT (C)	N=50 (8,10/50 for 285mm) Hammer SN = 0696	0.00	Dry						

Water Strikes				Casing Details	
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	To (m)	Diameter

Remarks

Hand dug inspection pit excavated to 1.20m.
No groundwater encountered.

Termination Reason	Last Updated
Terminated on refusal.	17/12/2020

AGS

APPENDIX C

SLIT TRENCH LOGS AND DRAWINGS

CAUSEWAY GEOTECH

Project No. 20-0399E	**Project Name:** Bus Connects Route 13 Bray to City Centre		**Trial Pit ID** R13-SLT01
Coordinates 720141.85 E 728273.13 N	**Client:** National Transport Authority (NTA)		
Method: Slit Trenching	**Client's Representative:** Jacobs		Sheet 1 of 1 Scale: 1:25
Plant: 3T Tracked Excavator	**Elevation** 48.72 mOD	**Date:** 20/10/2020	**Logger:** MG	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
			48.52	0.20		TOPSOIL	
0.50	B3					MADE GROUND: Soft to firm light brown and brown sandy gravelly CLAY with low cobble content and fragments of brick and concrete. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.	
0.50	ES1		48.12	0.60		MADE GROUND: Soft to firm dark brown and greyish brown sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.	
1.00	B4						
1.00	ES2		47.60	1.12		End of trial pit at 1.12m	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Water Strikes	
Struck at (m)	Remarks

Depth: 1.12
Width: 0.34
Length: 3.05

Remarks:
No groundwater encountered.
Concrete encountered at 0.60m on western side of trench.

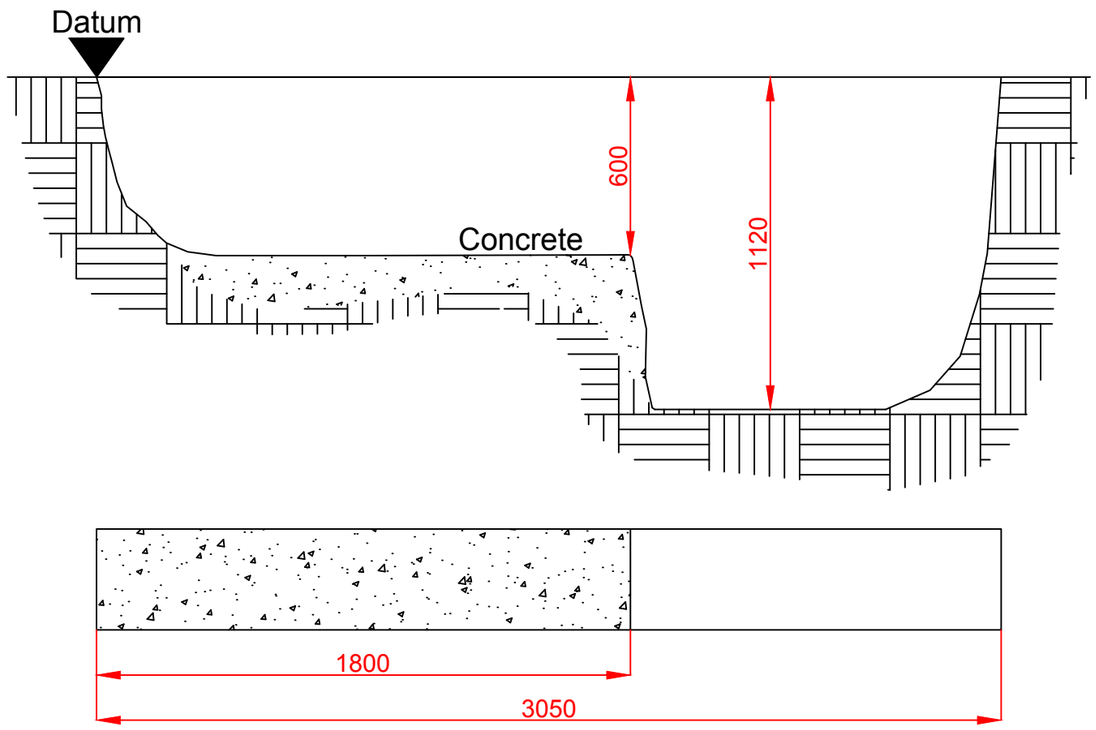
Stability:	Termination Reason:	Last Updated
Stable	Terminated on the instruction of the engineer.	17/12/2020

AGS

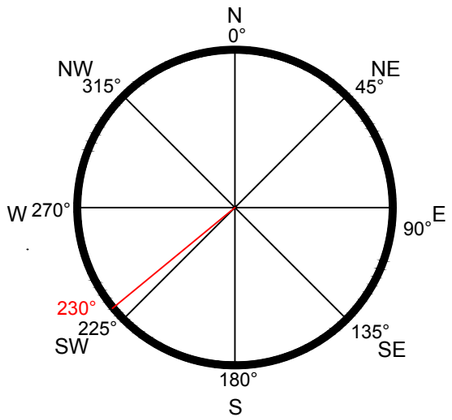
JOB NUMBER: 20-0399E	JOB NAME: Route 13 Bray to City Centre	LOCATION: R13 - SLT01

CLIENT: National Transport Authority (NTA)	CLIENTS REPRESENTATIVE: Jacobs	CREW: MG	PLANT & EQUIPMENT: 3 Tonne Excavator & Hand Tools

TRENCH: (SECTION & PLAN)



TRENCH - ORIENTATION



TRENCH ORIENTATED : 230° FROM NORTH

COORDINATES: DATUM

EASTING: 720141.845

NORTHING: 728273.126

ELEVATION: 48.718mOD

No:	Type of Service:	Diameter (in mm)	Depth to Top of Service (m)	Distance to Centre of Service (m)	Details/Comments
01	Possible ESB	Unknown	0.60	0.90 (assumed)	Lean mix covering ESB
02					
03					
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

TRENCH LENGTH (m) : 3.05

TRENCH DEPTH (m) : 1.12

TRENCH WIDTH (m) : 0.34

STABILITY: Stable

GROUNDWATER: None

SCALE: NTS@A3

DRAWN: BS

CHECKED: CH

DATE EXCAVATED: 20/10/2020

CAUSEWAY GEOTECH

CAUSEWAY GEOTECH

Project No. 20-0399E	**Project Name:** Bus Connects Route 13 Bray to City Centre		**Trial Pit ID** R13-SLT02
Coordinates 720189.26 E 728228.16 N	**Client:** National Transport Authority (NTA)		
Method: Slit Trenching	**Client's Representative:** Jacobs		Sheet 1 of 1 Scale: 1:25
Plant: 3T Tracked Excavator	**Elevation** 48.40 mOD	**Date:** 20/10/2020	**Logger:** MG	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
			48.30	0.10		TOPSOIL	
0.50 0.50	B3 ES1					MADE GROUND: Soft slightly sandy gravelly silty CLAY with medium cobble content and fragments of brick, concrete, tin, and plastic. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of limestone of mixed lithologies. Cobbles are subrounded of mixed lithologies.	
			47.60	0.80		MADE GROUND: Firm to stiff brown and dark greyish brown slightly sandy gravelly CLAY with medium cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subangular of mixed lithologies.	
1.00 1.00	B4 ES2						
			47.20	1.20		End of trial pit at 1.20m	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Water Strikes	
Struck at (m)	Remarks

Depth: 1.20
Width: 0.40
Length: 4.53

Remarks:
No groundwater encountered.
Lean mix concrete encountered at 0.35mbgl on eastern side of trench.

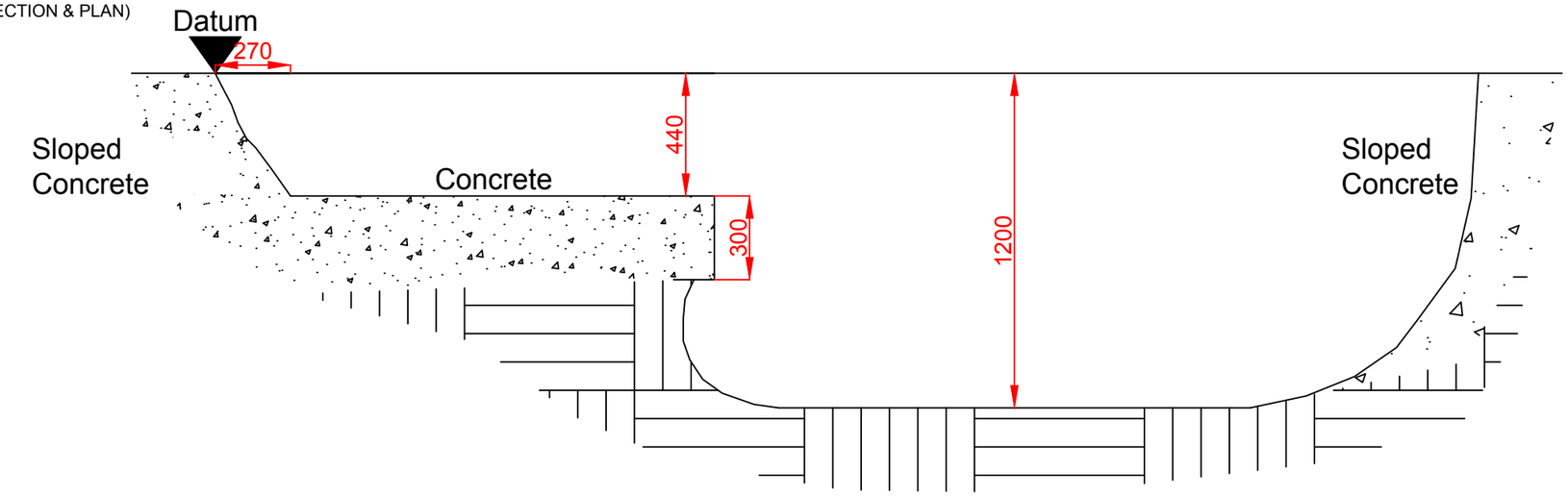
Stability:	**Termination Reason:**	**Last Updated**
Stable	Terminated on the instruction of the engineer.	17/12/2020

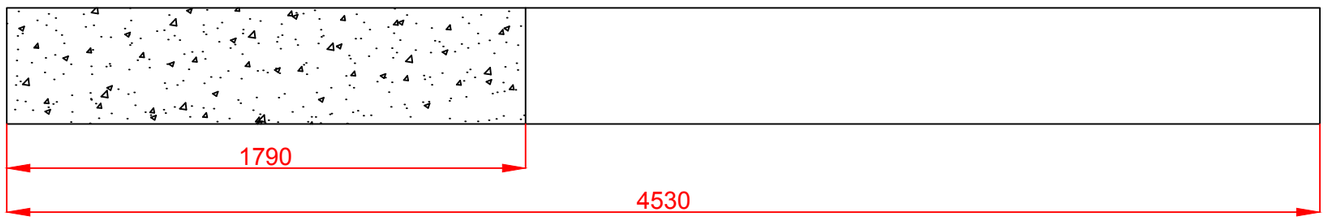
AGS

JOB NUMBER: 20-0399E	JOB NAME: Route 13 Bray to City Centre	LOCATION: R13 - SLT02

CLIENT: National Transport Authority (NTA)	CLIENTS REPRESENTATIVE: Jacobs	CREW: MG	PLANT & EQUIPMENT 3 Tonne Excavator & Hand Tools

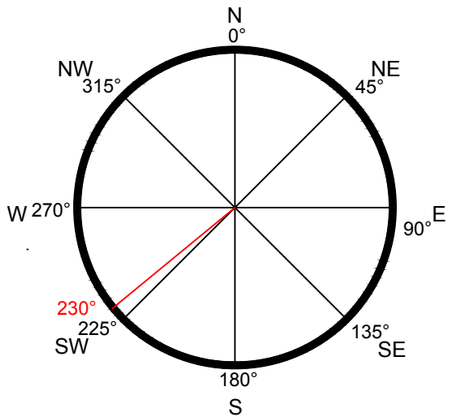
TRENCH: (SECTION & PLAN)





No:	Type of Service:	Diameter (in mm)	Depth to Top of Service (m)	Distance to Centre of Service (m)	Details/Comments
01	Possible ESB	Unknown	0.44	Unknown	Lean mix covering ESB
02					
03					
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

TRENCH - ORIENTATION



TRENCH ORIENTATED : 230° FROM NORTH

COORDINATES: DATUM

EASTING: 720189.258

NORTHING: 728228.155

ELEVATION: 48.397mOD

TRENCH LENGTH (m) : 4.53

TRENCH DEPTH (m) : 1.20

TRENCH WIDTH (m) : 0.40

STABILITY: Stable

GROUNDWATER: None

SCALE: NTS@A3

DRAWN: BS

CHECKED: CH

DATE EXCAVATED: 20/10/2020

CAUSEWAY GEOTECH

CAUSEWAY GEOTECH

Project No. 20-0399E	**Project Name:** Bus Connects Route 13 Bray to City Centre		**Trial Pit ID** R13-SLT03
Coordinates 720237.46 E 728181.97 N	**Client:** National Transport Authority (NTA)		
Method: Slit Trenching	**Client's Representative:** Jacobs		Sheet 1 of 1 Scale: 1:25
Plant: 3T Tracked Excavator	**Elevation** 47.86 mOD	**Date:** 20/10/2020	**Logger:** MG	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
						TOPSOIL	
0.20 - 0.40	B2		47.66	0.20		MADE GROUND: Soft slightly sandy gravelly silty CLAY with medium cobble content and fragments of brick, concrete, tin, and plastic. Sand is fine to coarse. Gravel is angular to subangular fine to coarse of limestone. Cobbles are subangular of limestone.	
0.40	ES		47.51	0.35		CONCRETE	
0.40	ES1		47.38	0.48		End of trial pit at 0.48m	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Water Strikes	
Struck at (m)	Remarks

Depth: 0.48
Width: 0.44
Length: 4.65

Remarks: No groundwater encountered.

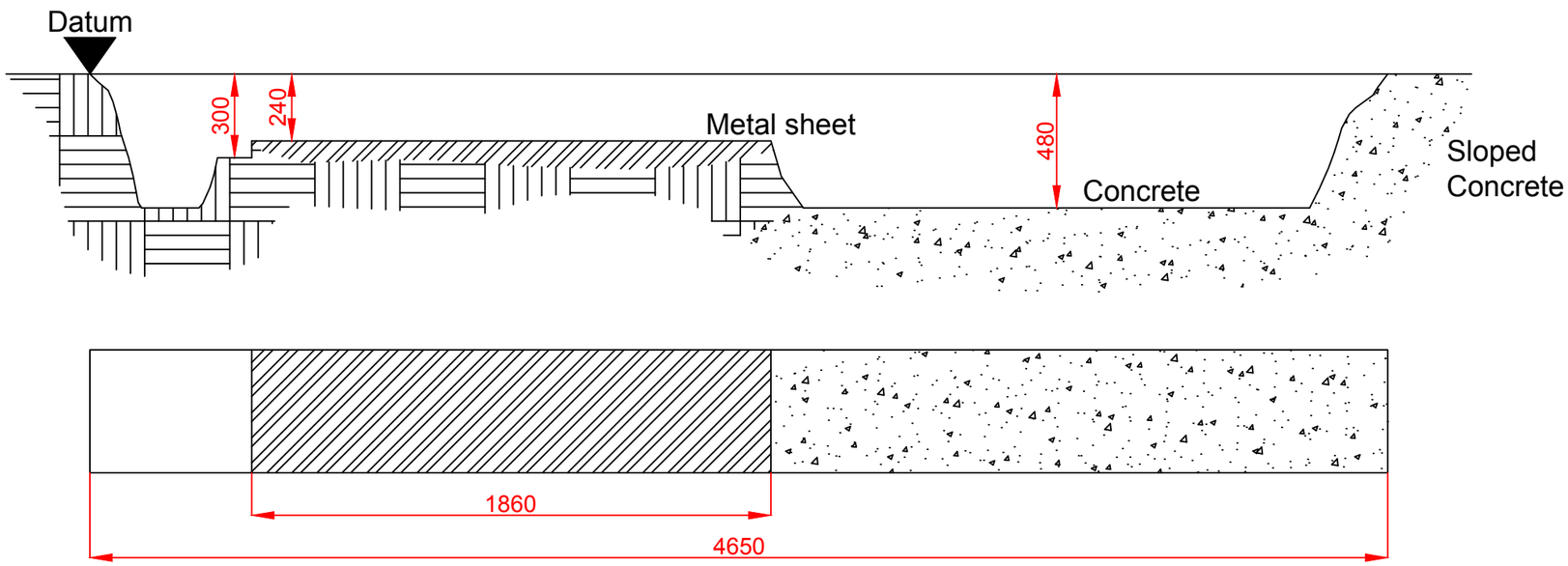
Stability:	Termination Reason:	Last Updated
Stable	Terminated on concrete obstruction	17/12/2020

AGS

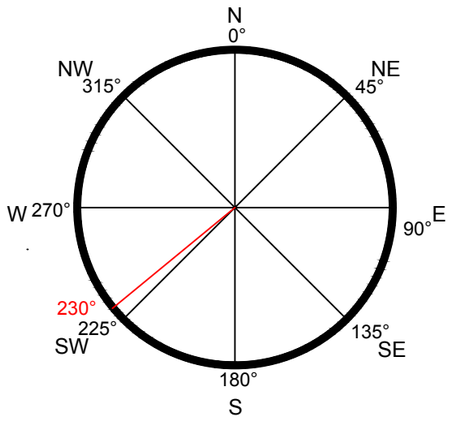
JOB NUMBER: 20-0399E	JOB NAME: Route 13 Bray to City Centre	LOCATION: R13 - SLT03

CLIENT: National Transport Authority (NTA)	CLIENTS REPRESENTATIVE: Jacobs	CREW: MG	PLANT & EQUIPMENT 3 Tonne Excavator & Hand Tools

TRENCH: (SECTION & PLAN)



TRENCH - ORIENTATION



TRENCH ORIENTATED : 230° FROM NORTH

COORDINATES: DATUM

EASTING: 720237.458

NORTHING: 728181.966

ELEVATION: 47.858mOD

No:	Type of Service:	Diameter (in mm)	Depth to Top of Service (m)	Distance to Centre of Service (m)	Details/Comments
01	Possible ESB	Unknown	0.24	Unknown	Metal sheet covering ESB
02					
03					
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

TRENCH LENGTH (m) : 4.65

TRENCH DEPTH (m) : 0.48

TRENCH WIDTH (m) : 0.44

STABILITY: Stable

GROUNDWATER: None

SCALE: NTS@A3

DRAWN: BS

CHECKED: CH

DATE EXCAVATED: 20/10/2020

CAUSEWAY GEOTECH

CAUSEWAY GEOTECH

Project No. 20-0399E	**Project Name:** Bus Connects Route 13 Bray to City Centre		**Trial Pit ID** R13-SLT03A
Coordinates 720236.49 E 728180.61 N	**Client:** National Transport Authority (NTA)		
Method: Slit Trenching	**Client's Representative:** Jacobs		Sheet 1 of 1 Scale: 1:25
Plant: 3T Tracked Excavator	**Elevation** 47.93 mOD	**Date:** 20/10/2020	**Logger:** MG	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
			47.73	0.20		TOPSOIL	
						MADE GROUND: Soft slightly sandy slightly silty CLAY with medium cobble content, fragments of brick, concrete, tin, and plastic. Sand is fine to coarse. Gravel is angular to subangular fine to coarse of mixed lithologies. Cobbles are subangular of limestone.	
			47.11	0.82		End of trial pit at 0.82m	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Water Strikes	
Struck at (m)	Remarks

Depth: 0.82
Width: 0.58
Length: 3.78

Remarks:
No groundwater encountered.
Old road level encountered at 0.27mbgl.
Manhole cover encountered at 0.34mbgl.
Old road curbs/pavers encountered at 0.60-0.82mbgl.

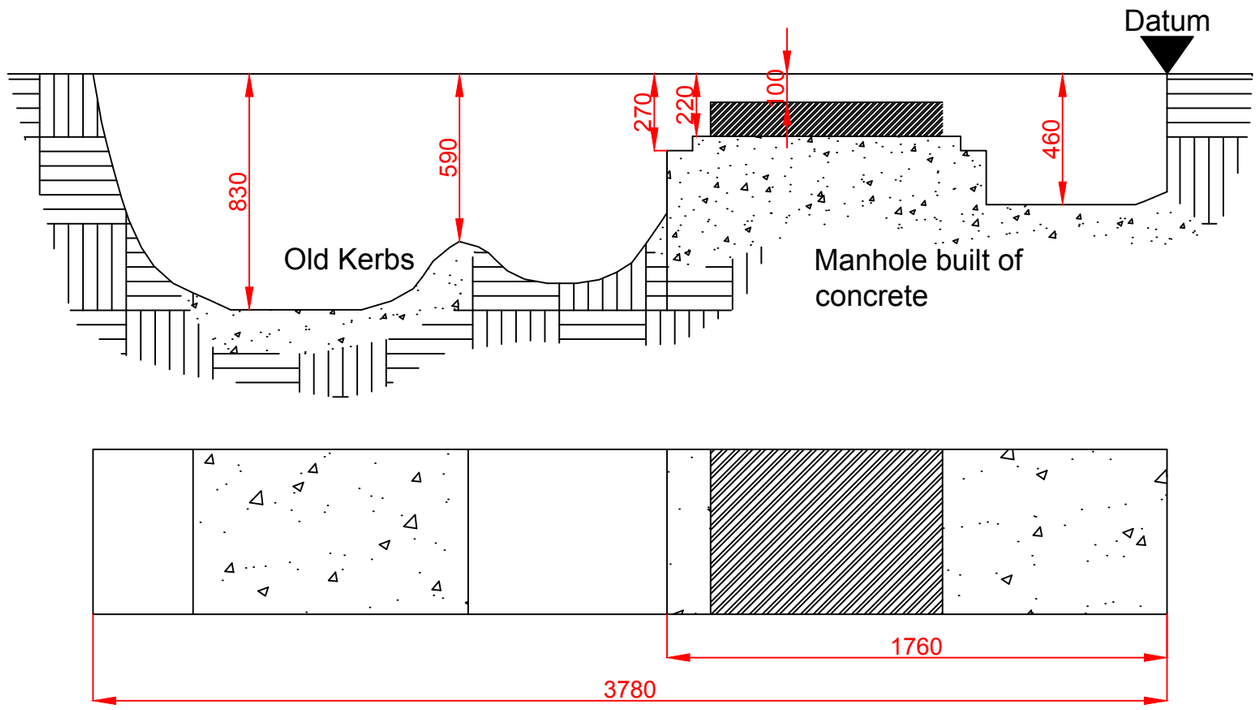
Stability:	**Termination Reason:**	**Last Updated**
Stable	Terminated on the instruction of the engineer.	17/12/2020

AGS

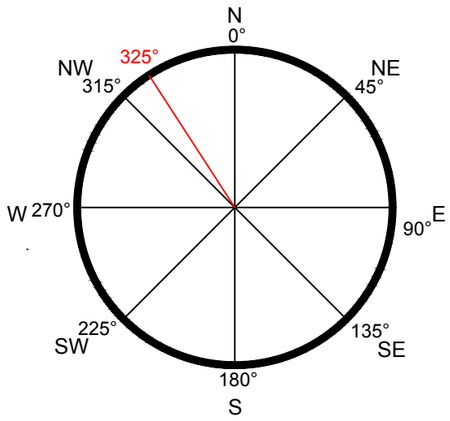
JOB NUMBER: 20-0399E	JOB NAME: Route 13 Bray to City Centre	LOCATION: R13 - SLT03A

CLIENT: National Transport Authority (NTA)	CLIENTS REPRESENTATIVE: Jacobs	CREW: MG	PLANT & EQUIPMENT 3 Tonne Excavator & Hand Tools

TRENCH: (SECTION & PLAN)



TRENCH - ORIENTATION



TRENCH ORIENTATED : 325° FROM NORTH

COORDINATES: DATUM

EASTING: 720236.490

NORTHING: 728180.613

ELEVATION: 47.927mOD

No:	Type of Service:	Diameter (in mm)	Depth to Top of Service (m)	Distance to Centre of Service (m)	Details/Comments
01					No services found
02					
03					
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

TRENCH LENGTH (m) : 3.78

TRENCH DEPTH (m) : 0.82

TRENCH WIDTH (m) : 0.58

STABILITY: Stable

GROUNDWATER: None

SCALE: NTS@A3

DRAWN: BS

CHECKED: CH

DATE EXCAVATED: 20/10/2020

CAUSEWAY GEOTECH

CAUSEWAY GEOTECH

Project No. 20-0399E	**Project Name:** Bus Connects Route 13 Bray to City Centre		**Trial Pit ID** R13-SLT04
Coordinates 720387.00 E 727759.17 N	**Client:** National Transport Authority (NTA)		
Method: Slit Trenching	**Client's Representative:** Jacobs		Sheet 1 of 1 Scale: 1:25
Plant: 3T Tracked Excavator	**Elevation** 53.67 mOD	**Date:** 02/11/2020	**Logger:** GH	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
			53.47	0.20		TOPSOIL	
0.50 0.50	B1 B2					MADE GROUND: Firm brown slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.	
			52.77	0.90		MADE GROUND: Brown fine to coarse SAND.	
			52.27	1.40		End of trial pit at 1.40m	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Water Strikes	
Struck at (m)	Remarks

Depth: 1.40
Width: 0.60
Length: 4.30

Remarks:
No groundwater encountered.

Stability:
Stable

Termination Reason:
Terminated on the instruction of the engineer.

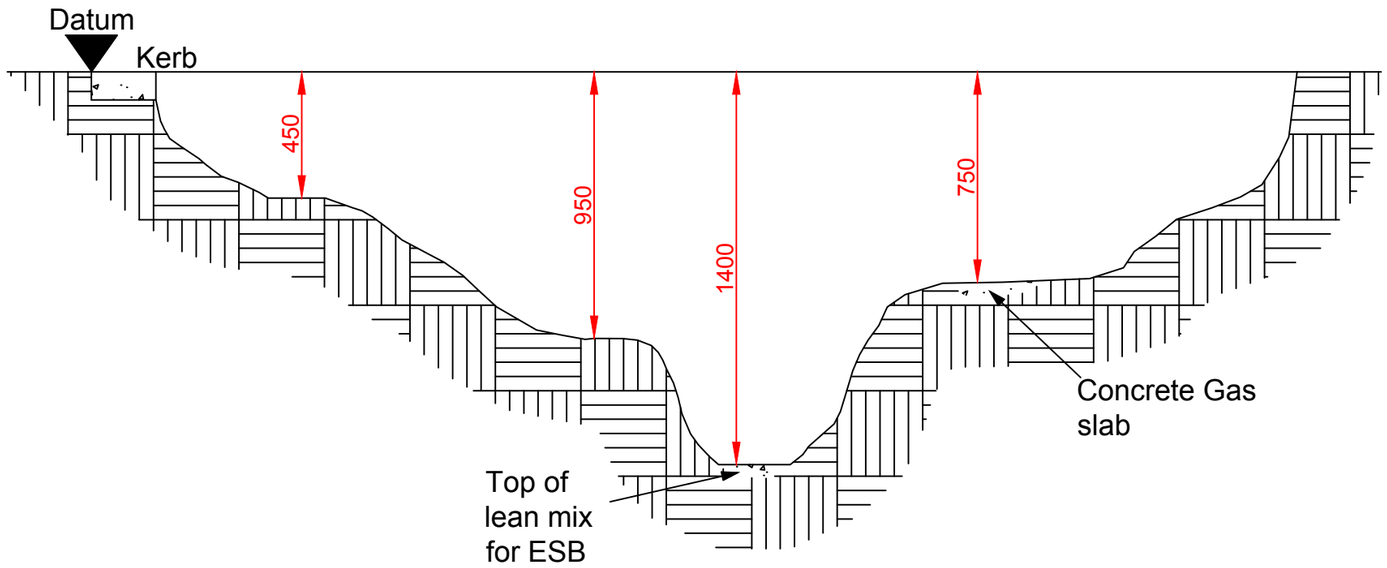
Last Updated
17/12/2020

AGS

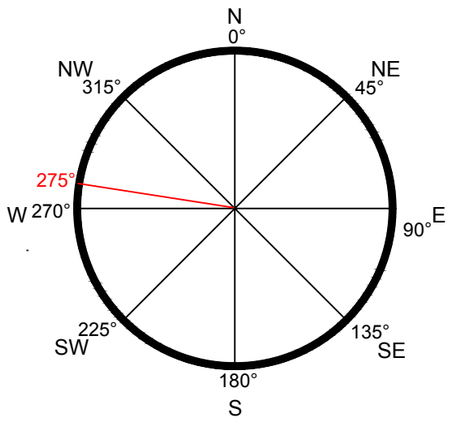
JOB NUMBER: 20-0399E	JOB NAME: Route 13 Bray to City Centre	LOCATION: R13 - SLT04

CLIENT: National Transport Authority (NTA)	CLIENTS REPRESENTATIVE: Jacobs	CREW: GH	PLANT & EQUIPMENT 3 Tonne Excavator & Hand Tools

TRENCH: (SECTION & PLAN)



TRENCH - ORIENTATION



TRENCH ORIENTATED : 275° FROM NORTH

COORDINATES: DATUM

EASTING: 720386.999

NORTHING: 727759.170

ELEVATION: 53.671MOD

No:	Type of Service:	Diameter (in mm)	Depth to Top of Service (m)	Distance to Centre of Service (m)	Details/Comments
01	ESB	Unknown	1.40	2.30	Lean mix covering ESB
02	Gas	160	0.75	3.00	Lean mix covering Gas
03					
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

TRENCH LENGTH (m) : 4.30

TRENCH DEPTH (m) : 1.40

TRENCH WIDTH (m) : 0.60

STABILITY: Stable

GROUNDWATER: None

SCALE: NTS@A3

DRAWN: BS

CHECKED: CH

DATE EXCAVATED: 02/11/2020

CAUSEWAY GEOTECH

CAUSEWAY GEOTECH

Project No. 20-0399E	**Project Name:** Bus Connects Route 13 Bray to City Centre		**Trial Pit ID** R13-SLT05
Coordinates 720377.30 E 727669.68 N	**Client:** National Transport Authority (NTA)		
Method: Slit Trenching	**Client's Representative:** Jacobs		Sheet 1 of 1 Scale: 1:25
Plant: 3T Tracked Excavator	**Elevation** 54.38 mOD	**Date:** 02/11/2020	**Logger:** GH	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
			54.18	0.20		TOPSOIL	
						MADE GROUND: Firm brown slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.	
			53.78	0.60		MADE GROUND: Brown fine to coarse SAND.	
			53.53	0.85		End of trial pit at 0.85m	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Water Strikes	
Struck at (m)	Remarks

Depth: 0.85
Width: 0.60
Length: 4.90

Remarks:
No groundwater encountered.

Stability:
Stable

Termination Reason:
Terminated on the instruction of the engineer.

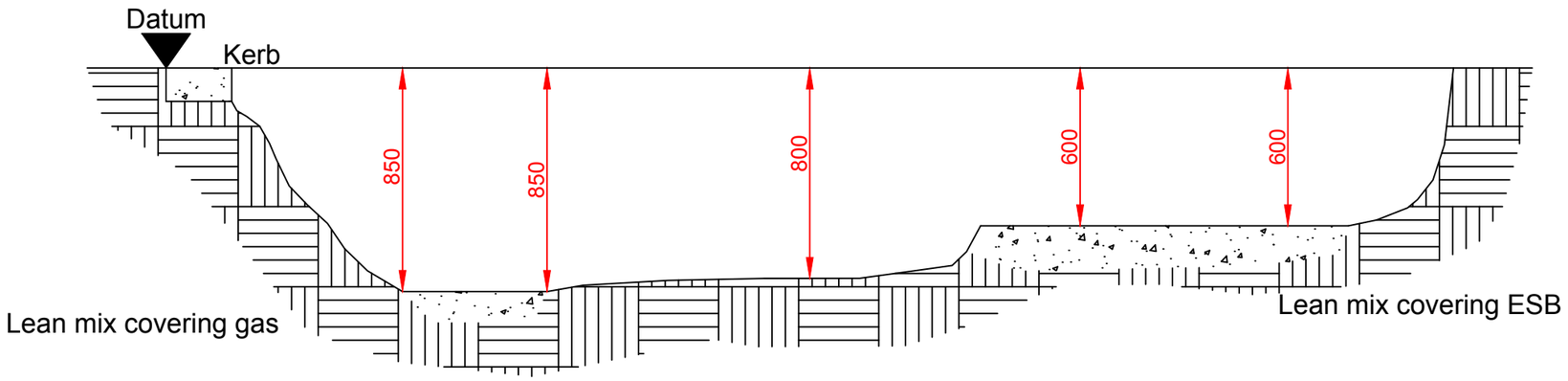
Last Updated
17/12/2020

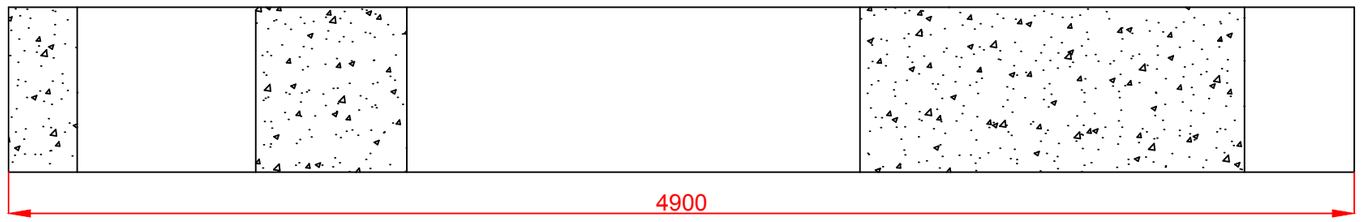
AGS

JOB NUMBER: 20-0399E	JOB NAME: Route 13 Bray to City Centre	LOCATION: R13 - SLT05

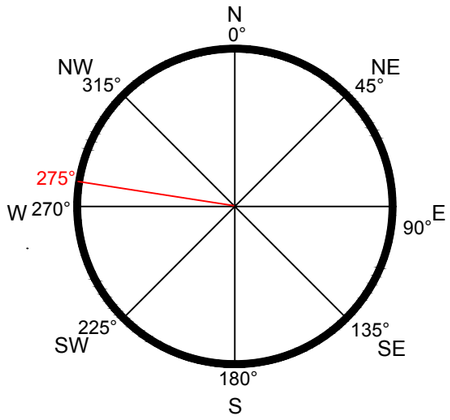
CLIENT: National Transport Authority (NTA)	CLIENTS REPRESENTATIVE: Jacobs	CREW: GH	PLANT & EQUIPMENT 3 Tonne Excavator & Hand Tools

TRENCH: (SECTION & PLAN)





TRENCH - ORIENTATION



TRENCH ORIENTATED : 275° FROM NORTH

COORDINATES: DATUM

EASTING: 720377.295

NORTHING: 727669.677

ELEVATION: 54.381mOD

No:	Type of Service:	Diameter (in mm)	Depth to Top of Service (m)	Distance to Centre of Service (m)	Details/Comments
01	Gas	550	0.85	0.90 - 1.45	Lean mix covering Gas
02	ESB	1700	0.60	3.10 - 4.50	Lean mix covering ESB
03					
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

TRENCH LENGTH (m) : 4.90

TRENCH DEPTH (m) : 0.85

TRENCH WIDTH (m) : 0.60

STABILITY: Stable

GROUNDWATER: None

SCALE: NTS@A3

DRAWN: BS

CHECKED: CH

DATE EXCAVATED: 02/11/2020

CAUSEWAY GEOTECH

APPENDIX D
SLIT TRENCH PHOTOGRAPHS

R13-SLT01

R13-SLT01

R13-SLT01

R13-SLT01

R13-SLT01

R13-SLT01

R13-SLT01

R13-SLT02

R13-SLT02

R13-SLT02

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R13-SLT05

R13-SLT05

APPENDIX E
GEOTECHNICAL LABORATORY TEST RESULTS

CAUSEWAY GEOTECH

HEAD OFFICE
Causeway Geotech Ltd
8 Drumahiskey Road, Ballymoney
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NI: +44 (0)28 276 66640
Registered in Northern Ireland.
Company Number: NI610756

REGIONAL OFFICE
Causeway Geotech (IRL) Ltd
Unit 3 Balbriggan Business Park, Balbriggan
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Registered in Ireland.
Company Number: 633786

www.causewaygeotech.com

SOIL AND ROCK SAMPLE ANALYSIS
LABORATORY TEST REPORT

19 November 2020

Project Name:	Bus Connects - Route 13 – Bray to City Centre
Project No.:	20-0399E
Client:	National Transport Authority (NTA)
Engineer:	AECOM

We are pleased to attach the results of laboratory testing carried out for the above project. This memo and its attachments constitute a report of the results of tests as detailed in the Contents page(s).

The attached results complete the testing requested and we would therefore wish to confirm that samples will be retained without charge for a period of 28 days from the above date after which they will be appropriately disposed of unless we receive written instructions to the contrary prior to that date.

We trust our report meets with your approval but if you have any queries or require additional information, please do not hesitate to contact the undersigned.

Stephen Watson

Laboratory Manager

Signed for and on behalf of Causeway Geotech Ltd

Project Name: Bus Connects - Route 13 – Bray to City Centre

Report Reference: Schedule 1

The table below details the tests carried out, the specifications used, and the number of tests included in this report.

Tests marked with* in this report are not United Kingdom Accreditation Service (UKAS) accredited and are not included in Causeway Geotech Limited's scope of UKAS Accreditation Schedule of Tests. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL	Moisture Content of Soil	BS 1377-2: 1990: Cl 3.2	9
SOIL	Liquid and Plastic Limits of soil-1 point cone penetrometer method	BS 1377-2: 1990: Cl 4.4, 5.3 & 5.4	2
SOIL	Particle size distribution - wet sieving	BS 1377-2: 1990: Cl 9.2	9
SOIL	Particle size distribution - sedimentation hydrometer method	BS 1377-2: 1990: Cl 9.5	6

SUB-CONTRACTED TESTS

In agreement with Client, the following tests were conducted by an approved sub-contractor. All sub-contracting laboratories used are UKAS accredited.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL – Subcontracted to Eurofins Chemtest Ltd *(UKAS 2183)*	BRE Test – Suite B		4

Summary of Classification Test Results

Project No.	Project Name
20-0399E	Bus Connects Route 13 Bray to City Centre

Hole No.	Sample				Soil Description	Density bulk	Density dry	w	Passing 425µm	LL	PL	PI	Particle density	Casagrande Classification
	Ref	Top	Base	Type		Mg/m3		%	%	%	%	%	Mg/m3	
R13-CP01	3	2.00		B	Brown sandy gravelly silty CLAY.			14.0	64	32 -1pt	17	15		CL
R13-CP01	13	3.00		D	Brown sandy gravelly silty CLAY.			14.0						
R13-CP01	14	4.50		D	Brown sandy gravelly silty CLAY.			16.0						
R13-CP02	9	1.20		D	Grey gravelly clayey subangular fine to coarse GRAVEL.			7.5						
R13-CP02	3	2.00		B	Brown sandy very gravelly silty CLAY.			7.6						
R13-CP03	16	2.00		D	Brown sandy gravelly silty CLAY.			22.0	58	36 -1pt	22	14		CI
R13-CP03	17	4.00		D	Brown sandy silty CLAY.			17.0						
R13-CP03	7	6.00		B	Brown gravelly slightly clayey fine to coarse SAND.			7.3						
R13-WS01	5	1.30		B	Brown gravelly clayey fine to coarse SAND.			6.4						

All tests performed in accordance with BS1377:1990 unless specified otherwise

LAB 01R Version 4

Key

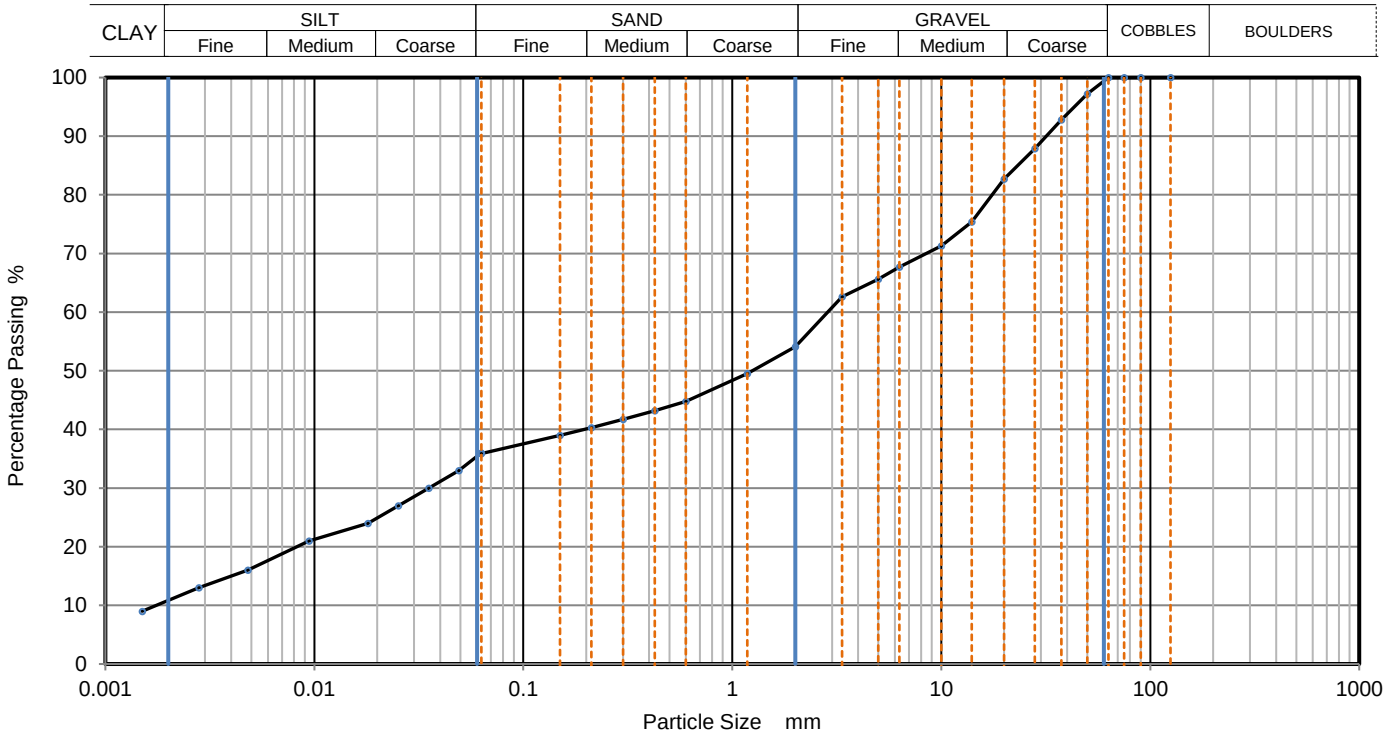
Density test	Liquid Limit	Particle density
Linear measurement unless :	4pt cone unless :	sp - small pyknometer
wd - water displacement	cas - Casagrande method	gj - gas jar
wi - immersion in water	1pt - single point test	

Date Printed: 19/11/2020

Approved By: Stephen.Watson

UKAS TESTING 10122

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**20-0399E**
				Borehole/Pit No.	R13-CP01
Site Name	Bus Connects Route 13 Bray to City Centre			Sample No.	4
Soil Description	Brown sandy gravelly silty CLAY.			Depth, m	3.00
Specimen Reference	2	Specimen Depth	3 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2020110347



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	36
90	100	0.04921	33
75	100	0.03524	30
63	100	0.02523	27
50	97	0.01806	24
37.5	93	0.00944	21
28	88	0.00480	16
20	83	0.00280	13
14	75	0.00150	9
10	71		
6.3	68		
5	66		
3.35	63		
2	54		
1.18	50		
0.6	45	Particle density	(assumed)
0.425	43	2.65	Mg/m3
0.3	42		
0.212	40		
0.15	39		
0.063	36		

Dry Mass of sample, g	6625

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	45.9
Sand	18.1
Silt	25.0
Clay	11.0

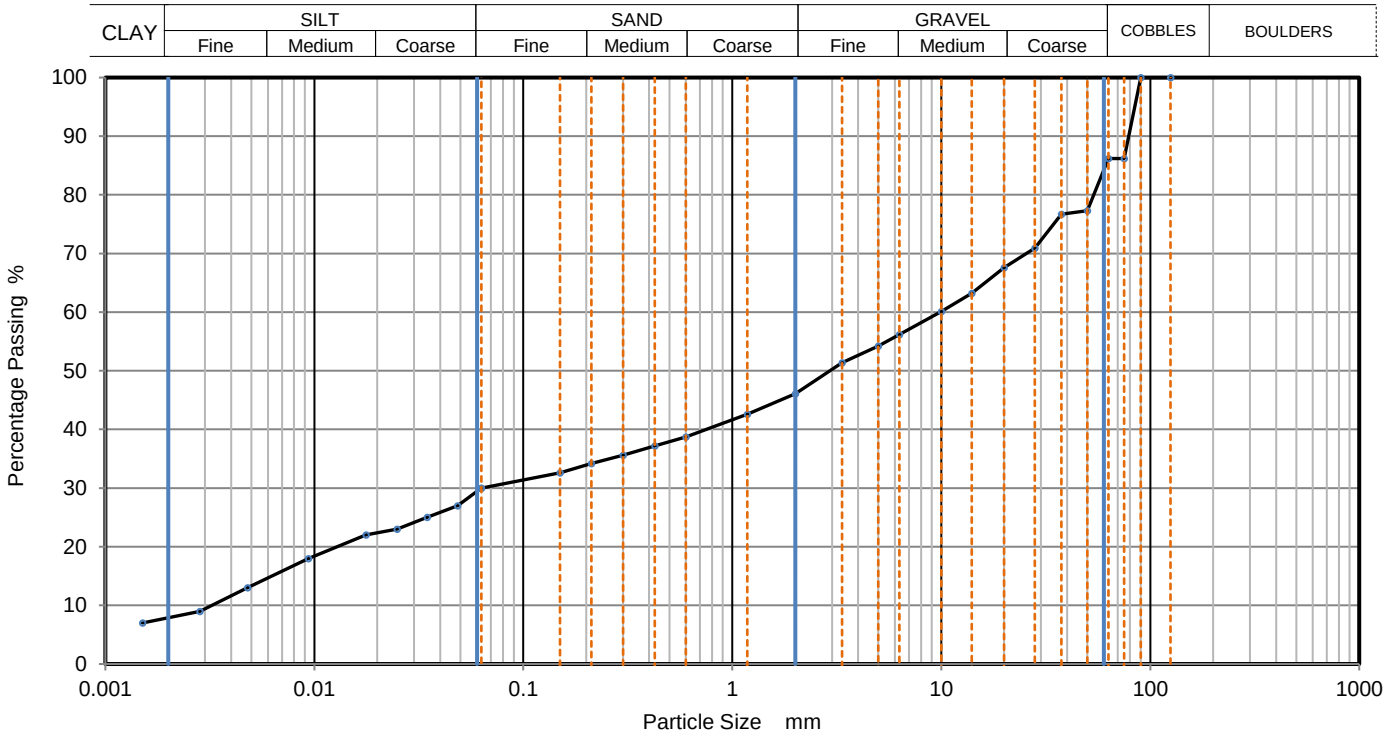
Grading Analysis		
D100	mm	
D60	mm	2.86
D30	mm	0.0356
D10	mm	0.00173
Uniformity Coefficient		1700
Curvature Coefficient		0.26

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**20-0399E**
				Borehole/Pit No.	R13-CP01
Site Name	Bus Connects Route 13 Bray to City Centre			Sample No.	6
Soil Description	Brown sandy gravelly silty CLAY.			Depth, m	4.50
Specimen Reference	2	Specimen Depth	4.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2020110349



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	30
90	100	0.04843	27
75	86	0.03470	25
63	86	0.02485	23
50	77	0.01769	22
37.5	77	0.00936	18
28	71	0.00479	13
20	68	0.00283	9
14	63	0.00150	7
10	60		
6.3	56		
5	54		
3.35	51		
2	46		
1.18	43		
0.6	39	Particle density	(assumed)
0.425	37	2.65	Mg/m3
0.3	36		
0.212	34		
0.15	33		
0.063	30		

Dry Mass of sample, g	14073

Sample Proportions	% dry mass
Cobbles	13.8
Gravel	40.1
Sand	16.1
Silt	21.8
Clay	8.2

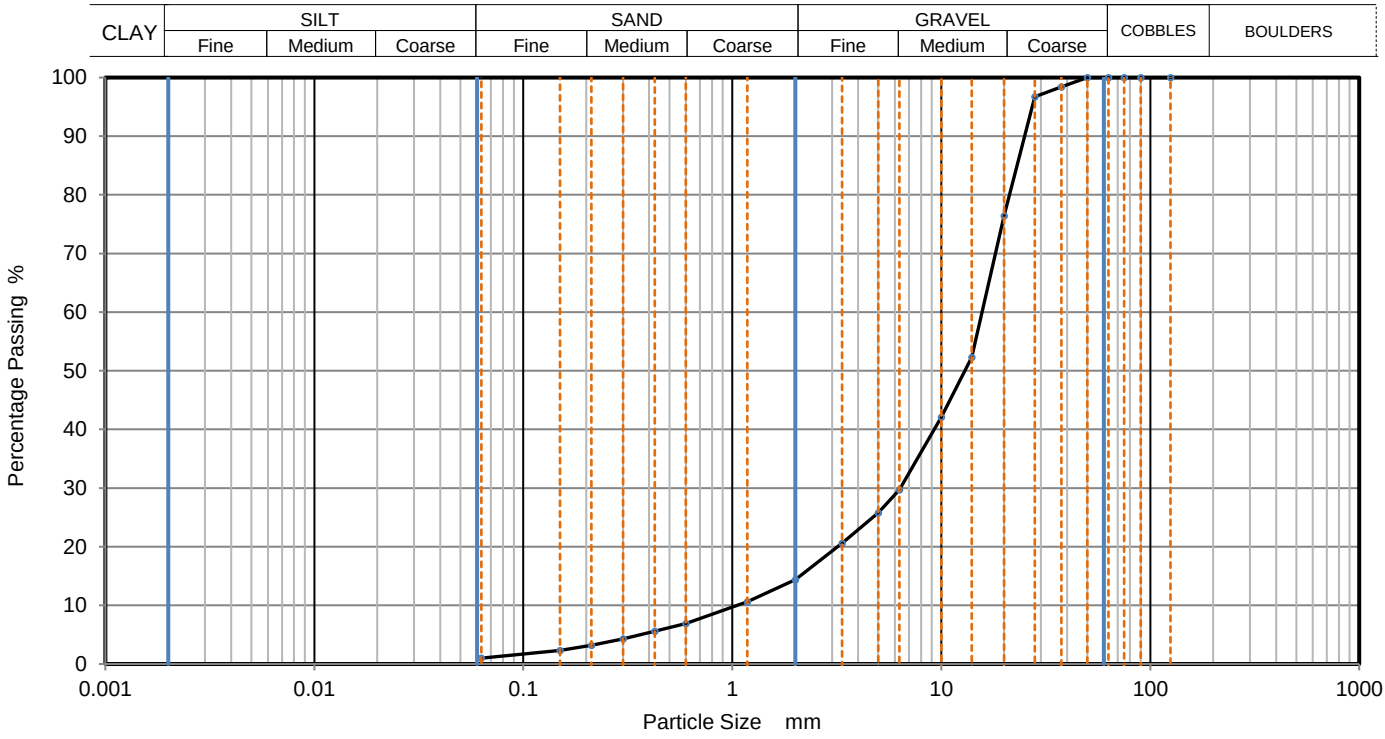
Grading Analysis		
D100	mm	
D60	mm	9.93
D30	mm	
D10	mm	0.00309
Uniformity Coefficient		3200
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**20-0399E**
				Borehole/Pit No.	R13-CP02
Site Name	Bus Connects Route 13 Bray to City Centre			Sample No.	2
Soil Description	Grey slightly sandy subangular fine to coarse GRAVEL.			Depth, m	1.00
Specimen Reference	2	Specimen Depth	1 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2020110351



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	98		
28	97		
20	76		
14	52		
10	42		
6.3	30		
5	26		
3.35	21		
2	14		
1.18	11		
0.6	7		
0.425	6		
0.3	4		
0.212	3		
0.15	2		
0.063	1		

Dry Mass of sample, g	9965

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	85.6
Sand	13.4
Fines <0.063mm	1.0

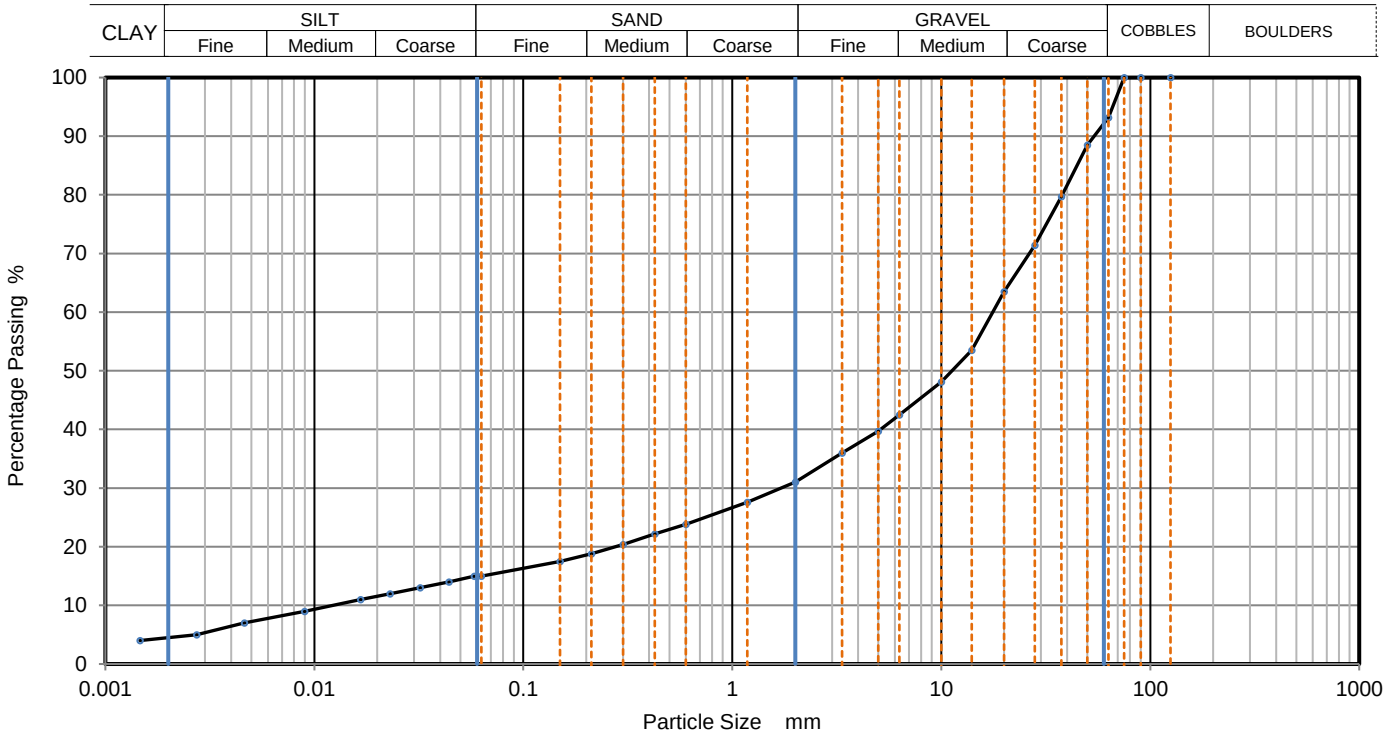
Grading Analysis		
D100	mm	
D60	mm	15.7
D30	mm	6.38
D10	mm	1.06
Uniformity Coefficient		15
Curvature Coefficient		2.5

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**20-0399E**
				Borehole/Pit No.	R13-CP02
Site Name	Bus Connects Route 13 Bray to City Centre			Sample No.	3
Soil Description	Brown sandy very gravelly silty CLAY.			Depth, m	2.00
Specimen Reference	4	Specimen Depth	2 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2020110353



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.05820	15
90	100	0.04400	14
75	100	0.03211	13
63	93	0.02305	12
50	89	0.01666	11
37.5	80	0.00896	9
28	71	0.00462	7
20	64	0.00273	5
14	54	0.00146	4
10	48		
6.3	43		
5	40		
3.35	36		
2	31		
1.18	28		
0.6	24	Particle density	(assumed)
0.425	22	2.65	Mg/m3
0.3	20		
0.212	19		
0.15	18		
0.063	15		

Dry Mass of sample, g	6718

Sample Proportions	% dry mass
Cobbles	6.8
Gravel	62.1
Sand	16.1
Silt	10.1
Clay	4.9

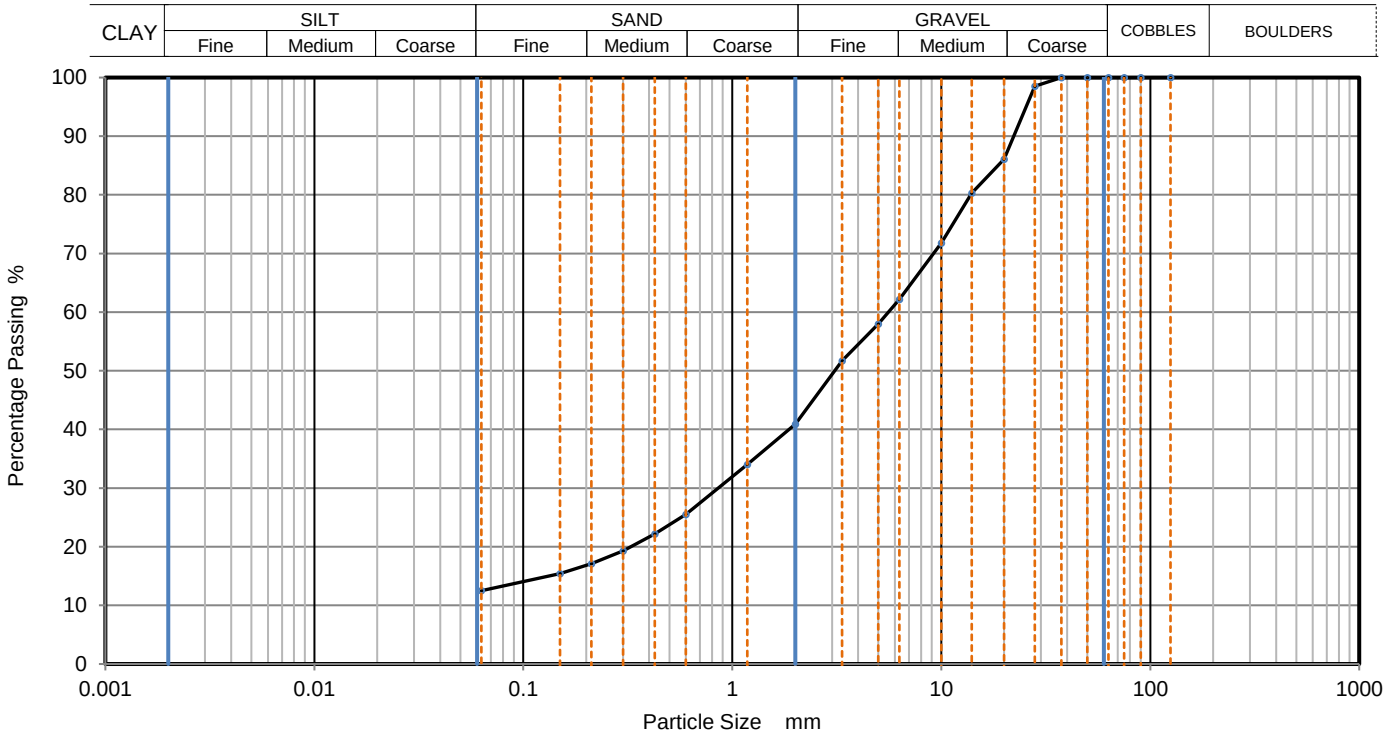
Grading Analysis		
D100	mm	
D60	mm	17.7
D30	mm	1.71
D10	mm	0.0126
Uniformity Coefficient		1400
Curvature Coefficient		13

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**20-0399E**
				Borehole/Pit No.	R13-CP03
Site Name	Bus Connects Route 13 Bray to City Centre			Sample No.	2
Soil Description	Brown gravelly clayey fine to coarse SAND.			Depth, m	1.00
Specimen Reference	2	Specimen Depth	1 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2020110354



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	99		
20	86		
14	80		
10	72		
6.3	62		
5	58		
3.35	52		
2	41		
1.18	34		
0.6	26		
0.425	22		
0.3	19		
0.212	17		
0.15	15		
0.063	13		

Dry Mass of sample, g	2531

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	59.1
Sand	28.4
Fines <0.063mm	12.0

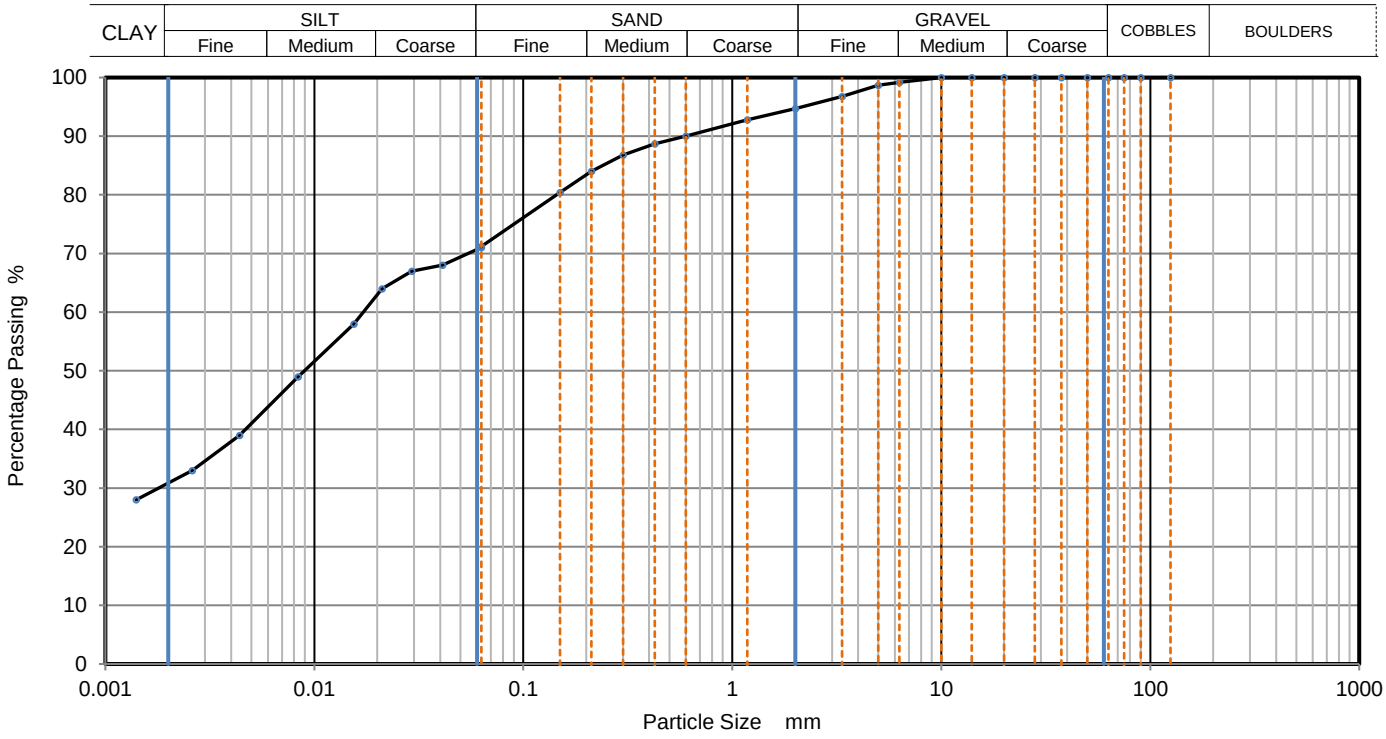
Grading Analysis		
D100	mm	
D60	mm	5.58
D30	mm	0.859
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**20-0399E**
				Borehole/Pit No.	R13-CP03
Site Name	Bus Connects Route 13 Bray to City Centre			Sample No.	5
Soil Description	Brown sandy silty CLAY.			Depth, m	4.00
Specimen Reference	2	Specimen Depth	4 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2020110356



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	71
90	100	0.04104	68
75	100	0.02929	67
63	100	0.02109	64
50	100	0.01543	58
37.5	100	0.00835	49
28	100	0.00439	39
20	100	0.00260	33
14	100	0.00140	28
10	100		
6.3	99		
5	99		
3.35	97		
2	95		
1.18	93		
0.6	90	Particle density	(assumed)
0.425	89	2.65	Mg/m3
0.3	87		
0.212	84		
0.15	80		
0.063	71		

Dry Mass of sample, g	216

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	5.3
Sand	23.5
Silt	40.3
Clay	30.9

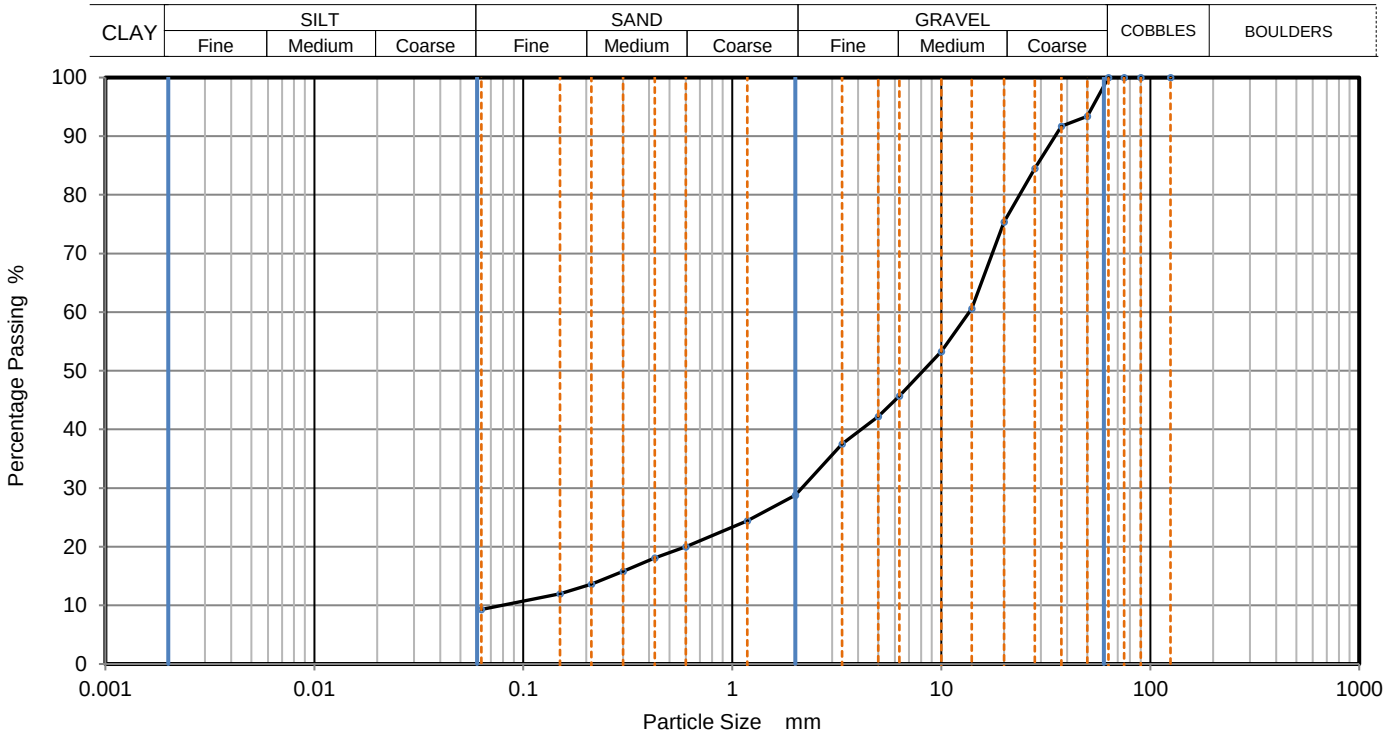
Grading Analysis		
D100	mm	
D60	mm	0.0171
D30	mm	0.00181
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**20-0399E**
				Borehole/Pit No.	R13-CP03
Site Name	Bus Connects Route 13 Bray to City Centre			Sample No.	7
Soil Description	Brown gravelly slightly clayey fine to coarse SAND.			Depth, m	6.00
Specimen Reference	4	Specimen Depth	6 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2020110358



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	93		
37.5	92		
28	85		
20	75		
14	61		
10	53		
6.3	46		
5	42		
3.35	38		
2	29		
1.18	24		
0.6	20		
0.425	18		
0.3	16		
0.212	14		
0.15	12		
0.063	9		

Dry Mass of sample, g	6501

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	71.2
Sand	19.5
Fines <0.063mm	9.0

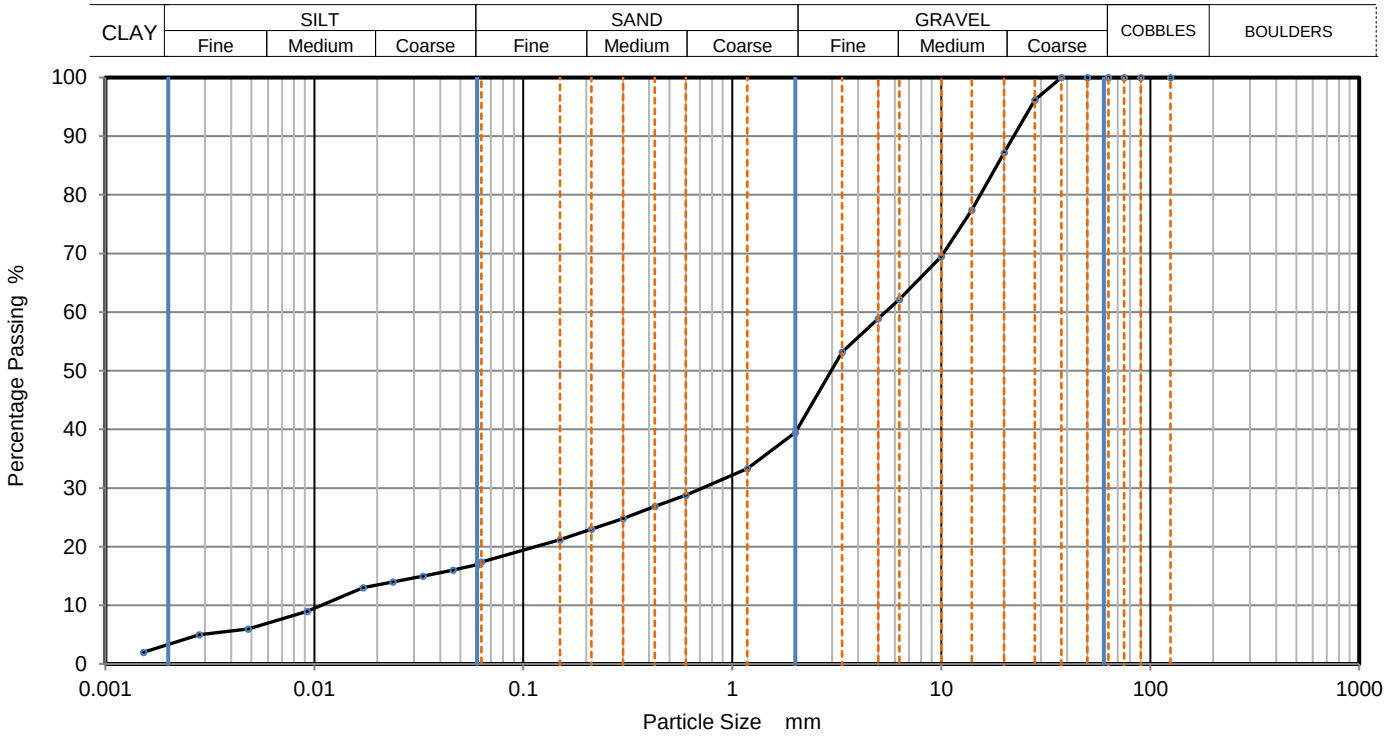
Grading Analysis		
D100	mm	
D60	mm	13.6
D30	mm	2.15
D10	mm	0.0794
Uniformity Coefficient		170
Curvature Coefficient		4.3

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**20-0399E**
				Borehole/Pit No.	R13-WS01
Site Name	Bus Connects Route 13 Bray to City Centre			Sample No.	5
Soil Description	Brown gravelly clayey fine to coarse SAND.			Depth, m	1.30
Specimen Reference	4	Specimen Depth	1.3 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2020110359



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06107	17
90	100	0.04609	16
75	100	0.03307	15
63	100	0.02372	14
50	100	0.01712	13
37.5	100	0.00925	9
28	96	0.00482	6
20	87	0.00281	5
14	77	0.00152	2
10	70		
6.3	62		
5	59		
3.35	53		
2	40		
1.18	33		
0.6	29	Particle density	(assumed)
0.425	27	2.65	Mg/m3
0.3	25		
0.212	23		
0.15	21		
0.063	17		

Dry Mass of sample, g: 3435

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	60.5
Sand	22.0
Silt	13.9
Clay	3.6

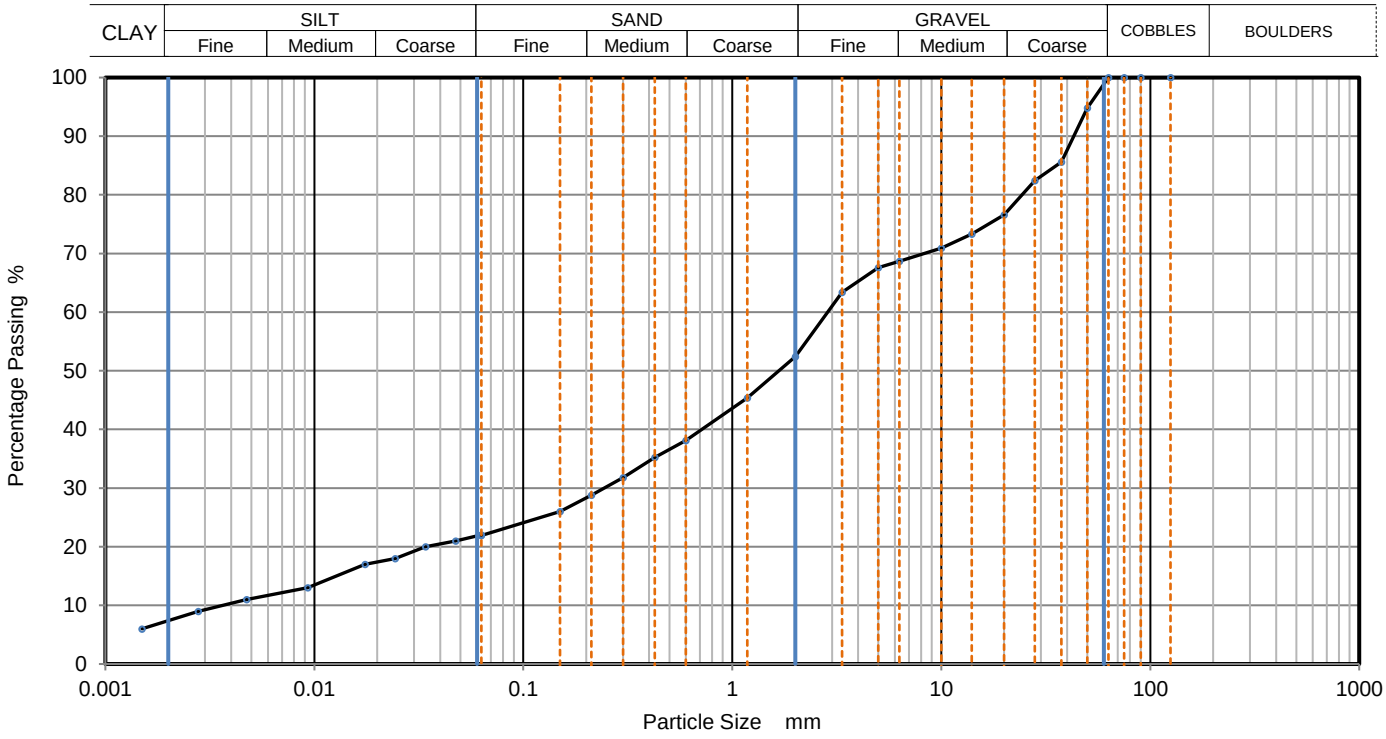
Grading Analysis		
D100	mm	
D60	mm	5.41
D30	mm	0.721
D10	mm	0.0102
Uniformity Coefficient		530
Curvature Coefficient		9.4

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**20-0399E**
				Borehole/Pit No.	R13-WS01
Site Name	Bus Connects Route 13 Bray to City Centre			Sample No.	6
Soil Description	Brown sandy clayey subangular fine to coarse GRAVEL.			Depth, m	1.60
Specimen Reference	2	Specimen Depth	1.6 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2020110360



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	22
90	100	0.04744	21
75	100	0.03401	20
63	100	0.02437	18
50	95	0.01746	17
37.5	86	0.00930	13
28	82	0.00474	11
20	77	0.00278	9
14	73	0.00150	6
10	71		
6.3	69		
5	68		
3.35	63		
2	52		
1.18	45		
0.6	38	Particle density	(assumed)
0.425	35	2.65	Mg/m3
0.3	32		
0.212	29		
0.15	26		
0.063	22		

Dry Mass of sample, g	5323

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	47.6
Sand	30.5
Silt	14.7
Clay	7.2

Grading Analysis		
D100	mm	
D60	mm	2.86
D30	mm	0.243
D10	mm	0.00376
Uniformity Coefficient		760
Curvature Coefficient		5.5

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

UKAS TESTING

10122

eurofins | Chemtest
Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING 2183

Final Report

Report No.:	20-30179-1
Initial Date of Issue:	11-Nov-2020
Client	Causeway Geotech Ltd
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL
Contact(s):	Carin Cornwall Colm Hurley Darren O'Mahony Gabriella Horan Joe Gervin John Cameron Lucy Newland Martin Gardiner Matthew Gilbert Neil Haggan Paul Dunlop Sean Ross Stephen Franey Stephen McCracken Stephen Watson Stuart Abraham Thomas McAllis
Project	20-0399E Route 13 Bray to City Centre

Quotation No.:		**Date Received:**	06-Nov-2020
Order No.:		**Date Instructed:**	06-Nov-2020
No. of Samples:	4		
Turnaround (Wkdays):	5	**Results Due:**	12-Nov-2020
Date Approved:	11-Nov-2020		

Approved By:

Details: Glynn Harvey, Technical Manager

Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Results - Soil

Project: 20-0399E Route 13 Bray to City Centre

Client: Causeway Geotech Ltd			**Chemtest Job No.:**		20-30179	20-30179	20-30179	20-30179
Quotation No.:			**Chemtest Sample ID.:**		1092939	1092940	1092941	1092942
Order No.:			Client Sample Ref.:		9	14	2	20
			Sample Location:		R13-CP01	R13-CP01	R13-CP02	R13-CP03
			Sample Type:		SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		2.00	4.50	1.00	3.00
			Date Sampled:		05-Nov-2020	05-Nov-2020	05-Nov-2020	05-Nov-2020
Determinand	**Accred.**	**SOP**	**Units**	**LOD**				
Moisture	N	2030	%	0.020	13	10	6.9	14
pH (2.5:1)	N	2010		4.0	8.7	8.8	10.8	8.8
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	< 0.010	0.025	0.51	< 0.010
Total Sulphur	U	2175	%	0.010	< 0.010	0.046	0.14	
Sulphate (Acid Soluble)	U	2430	%	0.010	0.035	0.030	0.25	

Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2175	Total Sulphur in Soils	Total Sulphur	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
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I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied

B - Sample age exceeds stability time (sampling to extraction)

C - Sample not received in appropriate containers

D - Broken Container

E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

customerservices@chemtest.com

LABORATORY RESTRICTION REPORT

Project Reference	20-0399E	To	Sean Ross
Project Name	Bus Connects Route 9 - Bray to City Centre	Position	Project Manager
TR reference	20-0399E / G01	From	Joseph Nicholl
		Position	Laboratory Quality Manager

The following sample(s) and test(s) are restricted as detailed below. Could you please complete the "Required Action" column and return the completed form to the laboratory.

Hole Number	Sample			Test Type	Reason for Restriction	Required Action
	Number	Depth (m)	Type			
R13 CP01	15	3.00	U	UU Triaxial Oedometer	Unable to obtain specimen for test - coarse gravel content too high	CANCEL

For electronic reporting a form of electronic signature or printed name is acceptable

Laboratory Signature	Project Manager Signature
Joseph Nicholl	Sean Ross
Date	Date
13 November 2020	

APPENDIX F

ENVIRONMENTAL LABORATORY TEST RESULTS

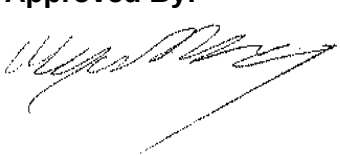
eurofins | Chemtest
Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Final Report

Report No.:	20-28443-1
Initial Date of Issue:	26-Oct-2020
Client	Causeway Geotech Ltd
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL
Contact(s):	Carin Cornwall Colm Hurley Darren O'Mahony Gabriella Horan Joe Gervin John Cameron Lucy Newland Martin Gardiner Matthew Gilbert Neil Haggan Paul Dunlop Sean Ross Stephen Franey Stephen McCracken Stephen Watson Stuart Abraham Thomas McAllis
Project	20-0399E Bus Connects Route 13

Quotation No.:		**Date Received:**	21-Oct-2020
Order No.:		**Date Instructed:**	21-Oct-2020
No. of Samples:	1		
Turnaround (Wkdays):	5	**Results Due:**	27-Oct-2020
Date Approved:	26-Oct-2020		

Approved By:



Details: Glynn Harvey, Technical Manager

Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Results - Soil

Project: 20-0399E Bus Connects Route 13

Client: Causeway Geotech Ltd			**Chemtest Job No.:**		20-28443
Quotation No.:			**Chemtest Sample ID.:**		1084161
			Sample Location:		R13-CP03
			Sample Type:		SOIL
			Top Depth (m):		1.0
			Date Sampled:		19-Oct-2020
			Asbestos Lab:		DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-
Moisture	N	2030	%	0.020	10
pH	M	2010		4.0	9.5
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40	0.78
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	< 0.010
Cyanide (Total)	M	2300	mg/kg	0.50	< 0.50
Arsenic	M	2450	mg/kg	1.0	21
Cadmium	M	2450	mg/kg	0.10	0.47
Chromium	M	2450	mg/kg	1.0	13
Copper	M	2450	mg/kg	0.50	12
Mercury	M	2450	mg/kg	0.10	< 0.10
Nickel	M	2450	mg/kg	0.50	17
Lead	M	2450	mg/kg	0.50	42
Zinc	M	2450	mg/kg	0.50	34
Organic Matter	M	2625	%	0.40	1.3
Total TPH >C6-C40	M	2670	mg/kg	10	< 10
Naphthalene	M	2700	mg/kg	0.10	< 0.10
Acenaphthylene	M	2700	mg/kg	0.10	< 0.10
Acenaphthene	M	2700	mg/kg	0.10	< 0.10
Fluorene	M	2700	mg/kg	0.10	< 0.10
Phenanthrene	M	2700	mg/kg	0.10	< 0.10
Anthracene	M	2700	mg/kg	0.10	< 0.10
Fluoranthene	M	2700	mg/kg	0.10	< 0.10
Pyrene	M	2700	mg/kg	0.10	< 0.10
Benzo[a]anthracene	M	2700	mg/kg	0.10	< 0.10
Chrysene	M	2700	mg/kg	0.10	< 0.10
Benzo[b]fluoranthene	M	2700	mg/kg	0.10	< 0.10
Benzo[k]fluoranthene	M	2700	mg/kg	0.10	< 0.10
Benzo[a]pyrene	M	2700	mg/kg	0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.10	< 0.10
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.10	< 0.10
Benzo[g,h,i]perylene	M	2700	mg/kg	0.10	< 0.10
Coronene	N	2700	mg/kg	0.10	< 0.10
Total Of 17 PAH's	N	2700	mg/kg	2.0	< 2.0
Total Phenols	M	2920	mg/kg	0.30	< 0.30

Results - Single Stage WAC

Project: 20-0399E Bus Connects Route 13

					Landfill Waste Acceptance Criteria Limits		
Chemtest Job No:	20-28443						
Chemtest Sample ID:	1084161						
Sample Ref:							
Sample ID:							
Sample Location:	R13-CP03						
Top Depth(m):	1.0						
Bottom Depth(m):							
Sampling Date:	19-Oct-2020						
Determinand	**SOP**	**Accred.**	**Units**		**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Total Organic Carbon	2625	M	%	0.75	3	5	6
Loss on Ignition					--	--	10
Total BTEX	2760	M	mg/kg	< 0.010	6	--	--
Total PCBs (7 Congeners)	2815	M	mg/kg	< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	M	mg/kg	< 10	500	--	--
Total (Of 17) PAH's	2700	N	mg/kg	< 2.0	100	--	--
pH					--	>6	--
Acid Neutralisation Capacity					--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457 at L/S 10 l/kg**		
Arsenic	1450	U	0.0038	< 0.050	0.5	2	25
Barium	1450	U	0.0017	< 0.50	20	100	300
Cadmium	1450	U	< 0.00010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.0010	< 0.050	0.5	10	70
Copper	1450	U	0.0018	< 0.050	2	50	100
Mercury	1450	U	< 0.00050	< 0.0050	0.01	0.2	2
Molybdenum	1450	U	< 0.0010	< 0.050	0.5	10	30
Nickel	1450	U	< 0.0010	< 0.050	0.4	10	40
Lead	1450	U	< 0.0010	< 0.010	0.5	10	50
Antimony	1450	U	< 0.0010	< 0.010	0.06	0.7	5
Selenium	1450	U	< 0.0010	< 0.010	0.1	0.5	7
Zinc	1450	U	< 0.0010	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.14	1.4	10	150	500
Sulphate	1220	U	2.1	21	1000	20000	50000
Total Dissolved Solids	1020	N	57	570	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	4.9	< 50	500	800	1000

Solid Information	
Dry mass of test portion/kg	0.090
Moisture (%)	10

Waste Acceptance Criteria

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes. This analysis is only applicable for hazardous waste landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Test Methods

SOP	Title	Parameters included	Method summary
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1610	Total/Dissolved Organic Carbon in Waters	Organic Carbon	TOC Analyser using Catalytic Oxidation
1920	Phenols in Waters by HPLC	Phenolic compounds including: Phenol, Cresols, Xylenols, Trimethylphenols Note: Chlorophenols are excluded.	Determination by High Performance Liquid Chromatography (HPLC) using electrochemical detection.
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Allkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2670	Total Petroleum Hydrocarbons (TPH) in Soils by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO*TPH C8–C40	Dichloromethane extraction / GC-FID
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.
2815	Polychlorinated Biphenyls (PCB) ICES7Congeners in Soils by GC-MS	ICES7 PCB congeners	Acetone/Hexane extraction / GC-MS
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.
640	Characterisation of Waste (Leaching C10)	Waste material including soil, sludges and granular waste	ComplianceTest for Leaching of Granular Waste Material and Sludge

Report Information

Key

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N	Unaccredited
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SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
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I/S	Insufficient Sample
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<	"less than"
>	"greater than"

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The results relate only to the items tested

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None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied

B - Sample age exceeds stability time (sampling to extraction)

C - Sample not received in appropriate containers

D - Broken Container

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eurofins | Chemtest
Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING 2183

Final Report

Report No.:	20-28569-1
Initial Date of Issue:	27-Oct-2020
Client	Causeway Geotech Ltd
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL
Contact(s):	Carin Cornwall Colm Hurley Darren O'Mahony Gabriella Horan Joe Gervin John Cameron Lucy Newland Martin Gardiner Matthew Gilbert Neil Haggan Paul Dunlop Sean Ross Stephen Franey Stephen McCracken Stephen Watson Stuart Abraham Thomas McAllis
Project	20-0399E Bus Connects Route 13

Quotation No.:	Q20-21063	**Date Received:**	22-Oct-2020
Order No.:		**Date Instructed:**	22-Oct-2020
No. of Samples:	1		
Turnaround (Wkdays):	5	**Results Due:**	28-Oct-2020
Date Approved:	27-Oct-2020		

Approved By:

Details: Glynn Harvey, Technical Manager

Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Results - Soil

Project: 20-0399E Bus Connects Route 13

Client: Causeway Geotech Ltd			**Chemtest Job No.:**		20-28569
Quotation No.: Q20-21063			**Chemtest Sample ID.:**		1084750
			Sample Location:		R13-SLT03
			Sample Type:		SOIL
			Top Depth (m):		0.40
			Date Sampled:		20-Oct-2020
			Asbestos Lab:		COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-
Moisture	N	2030	%	0.020	11
pH	U	2010		4.0	8.9
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	0.43
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	< 0.010
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50
Arsenic	U	2450	mg/kg	1.0	15
Cadmium	U	2450	mg/kg	0.10	1.6
Chromium	U	2450	mg/kg	1.0	12
Copper	U	2450	mg/kg	0.50	24
Mercury	U	2450	mg/kg	0.10	< 0.10
Nickel	U	2450	mg/kg	0.50	35
Lead	U	2450	mg/kg	0.50	69
Zinc	U	2450	mg/kg	0.50	77
Organic Matter	U	2625	%	0.40	3.1
Total TPH >C6-C40	U	2670	mg/kg	10	< 10
Naphthalene	U	2700	mg/kg	0.10	< 0.10
Acenaphthylene	U	2700	mg/kg	0.10	< 0.10
Acenaphthene	U	2700	mg/kg	0.10	< 0.10
Fluorene	U	2700	mg/kg	0.10	< 0.10
Phenanthrene	U	2700	mg/kg	0.10	< 0.10
Anthracene	U	2700	mg/kg	0.10	< 0.10
Fluoranthene	U	2700	mg/kg	0.10	< 0.10
Pyrene	U	2700	mg/kg	0.10	< 0.10
Benzo[a]anthracene	U	2700	mg/kg	0.10	< 0.10
Chrysene	U	2700	mg/kg	0.10	< 0.10
Benzo[b]fluoranthene	U	2700	mg/kg	0.10	< 0.10
Benzo[k]fluoranthene	U	2700	mg/kg	0.10	< 0.10
Benzo[a]pyrene	U	2700	mg/kg	0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2700	mg/kg	0.10	< 0.10
Dibenz(a,h)Anthracene	U	2700	mg/kg	0.10	< 0.10
Benzo[g,h,i]perylene	U	2700	mg/kg	0.10	< 0.10
Coronene	N	2700	mg/kg	0.10	< 0.10
Total Of 17 PAH's	N	2700	mg/kg	2.0	< 2.0
Total Phenols	U	2920	mg/kg	0.30	< 0.30

Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
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2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Allkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2670	Total Petroleum Hydrocarbons (TPH) in Soils by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO*TPH C8–C40	Dichloromethane extraction / GC-FID
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.

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customerservices@chemtest.com

APPENDIX G

SPT HAMMER ENERGY MEASUREMENT REPORT

Southern Testing
Environmental & Geotechnical

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Southern Testing
Keeble House
Stuart Way
East Grinstead
West Sussex
RH19 4QA

SPT Hammer Ref: .0643
Test Date: 22/02/2020
Report Date: 03/03/2020
File Name: .0643.spt
Test Operator: NPB

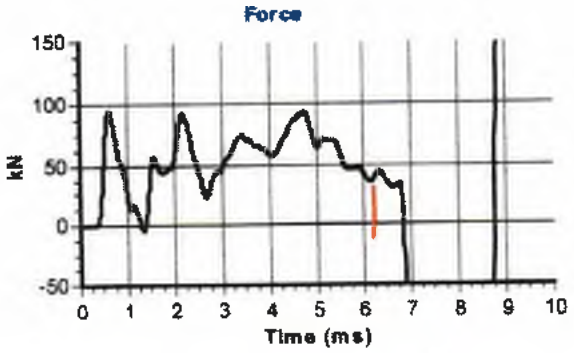
Instrumented Rod Data

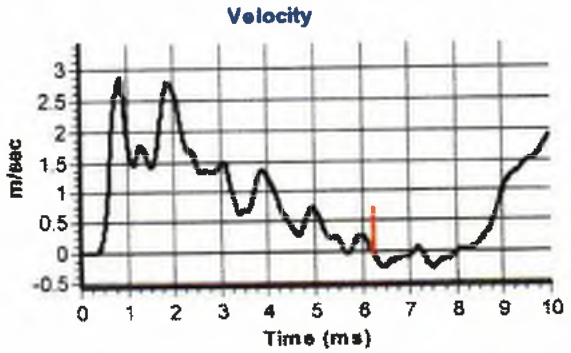
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.0
Assumed Modulus E_a (GPa):	200
Accelerometer No.1:	6458
Accelerometer No.2:	9607

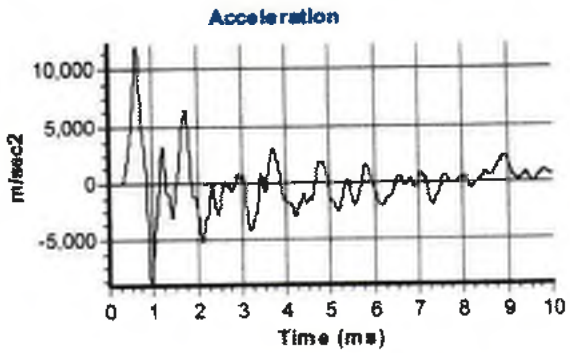
SPT Hammer Information

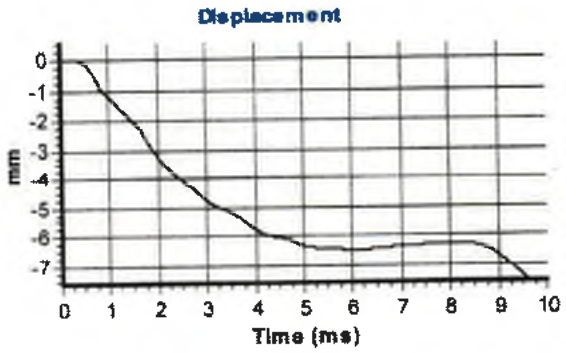
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	10.0

Comments / Location
BALLEYMONEY









Calculations

Area of Rod A (mm2):	905
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	400

Energy Ratio E_r (%): 85

NPBurrows

Signed: Neil Burrows
Title: Field Operations Manager

The recommended calibration interval is 12 months

Southern Testing
Environmental & Geotechnical

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Southern Testing
Keeble House
Stuart Way
East Grinstead
West Sussex
RH19 4QA

SPT Hammer Ref: .T7
Test Date: 22/02/2020
Report Date: 03/03/2020
File Name: .T7.spt
Test Operator: NPB

Instrumented Rod Data

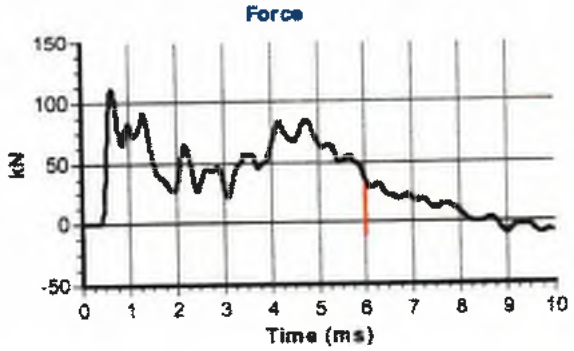
Diameter d_r (mm): 54
Wall Thickness t_r (mm): 6.0
Assumed Modulus E_a (GPa): 200
Accelerometer No.1: 6458
Accelerometer No.2: 9607

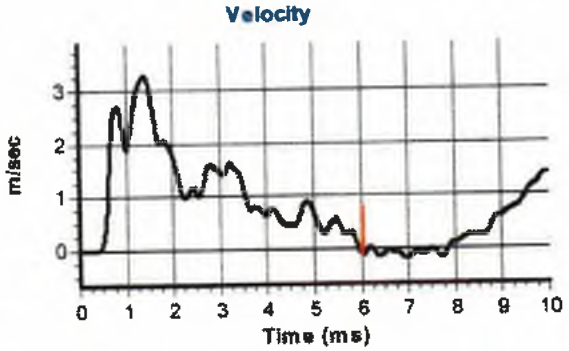
SPT Hammer Information

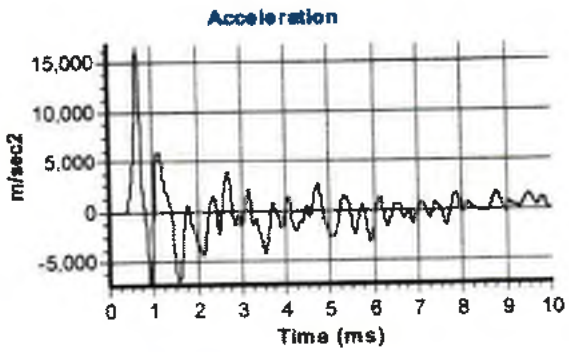
Hammer Mass m (kg): 63.5
Falling Height h (mm): 760
SPT String Length L (m): 10.0

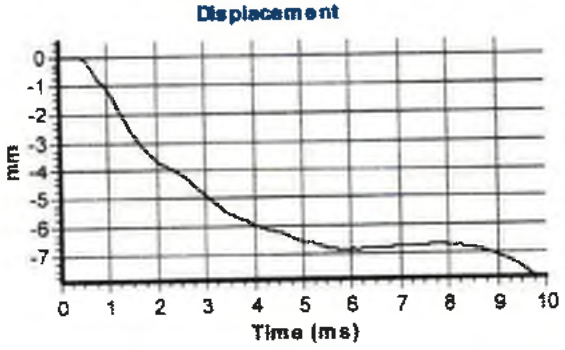
Comments / Location

BALLEYMONEY









Calculations

Area of Rod A (mm2): 905
Theoretical Energy E_{theor} (J): 473
Measured Energy E_{meas} (J): 399

Energy Ratio E_r (%): 84

Signed: Neil Burrows
Title: Field Operations Manager

The recommended calibration interval is 12 months