Bonneagar Iompair Éireann
Transport Infrastructure Ireland

NTA
Údarás Náisiúnta Iompair
National Transport Authority

Luas Finglas

Environmental Impact Assessment Report 2024

Appendix A11.1: GII Factual Ground Investigation Report

BARRY TRANSPORTATION
egis GROUP
egis

Project Ireland 2040
Building Ireland's Future

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

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Ground Investigations Ireland

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Ground Investigation Report

February 2023

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APPENDICES

1.0 Preamble

On the instructions of Barry Transportation Egis (BTEG), a site investigation was carried out by Ground Investigations Ireland Ltd., between September 2021 to January 2022 at the site of the proposed Luas Line extension. A second round of site investigation works was carried out in October 2023. The proposed extension is to run from the existing Green Line at Broombridge in Dublin 7 to Charlestown in Dublin 11.

2.0 Overview

2.1. Background

It is proposed to construct an extension to the existing green Luas line and parallel cycle track with associated services, access roads and car parking at the proposed sites. Two new bridge structures are also proposed as part of the design. The site extends from Broombridge through Tolka Valley Park, Finglas Village, Mellows Park and terminating at Charlestown. The site is a mixture of industrial residential/commercial and parklands. The proposed alignment will be constructed mostly at grade.

2.2. Purpose and Scope

The purpose of the site investigation was to investigate subsurface conditions utilising a variety of investigative methods in accordance with the project specification. The scope of the work undertaken for this project included the following:

- Visit project site to observe existing conditions
- Carry out 21 No. Trial Pits to a maximum depth of 4.5m BGL
- Carry out 18 No. Soakaways to determine a soil infiltration value to BRE digest 365
- Carry out 9 No. In-situ Plate Bearing tests to determine soil CBR
- Carry out 35 No. Window Sample Boreholes to recover soil samples
- Carry out 35 No. Dynamic Probes to determine soil strength/density characteristics
- Carry out 41 No. Cable Percussion boreholes to a maximum depth of 16.8m BGL
- Carry out 44 No. Rotary Core Boreholes to a maximum depth of 23m BGL
- Installation of 26 No. Groundwater monitoring wells
- Geotechnical & Environmental Laboratory testing
- Factual report

3.0 Subsurface Exploration

3.1. General

During the ground investigation a programme of intrusive investigation specified by the Consulting Engineer was undertaken to determine the sub surface conditions at the proposed site. Regular sampling and in-

situ testing was undertaken in the exploratory holes to facilitate the geotechnical descriptions and to enable laboratory testing to be carried out on the soil samples recovered during excavation and drilling.
The procedures used in this site investigation are in accordance with Eurocode 7 Part 2: Ground Investigation and testing (ISEN 1997 – 2:2007) and B.S. 5930:2015.

3.2. Trial Pits

The trial pits were excavated using a JCB 3CX excavator at the locations shown in the exploratory hole location plan in Appendix 1. The locations were checked using a CAT scan to minimise the potential for encountering services during the excavation. The trial pits were sampled, logged and photographed by a Engineering Geologist prior to backfilling with arisings. Notes were made of any services, inclusions, pit stability, groundwater encountered and the characteristics of the strata encountered and are presented on the trial pit logs which are provided in Appendix 2 of this Report.

3.3. Soakaway Testing

The soakaway testing was carried out at the locations shown in the exploratory hole location plan in Appendix 1. The pits were carefully excavated and filled with water to assess the infiltration characteristics of the proposed site. The pits were allowed to drain and the drop in water level was recorded over time as required by BRE Digest 365. The pits were logged prior to completing the soakaway test and were backfilled with arising's upon completion. The soakaway test results are provided in Appendix 3 of this Report.

3.4. Window Sampling

The window sampling was carried out at the locations shown in the location plan in Appendix 1 using a Tecopsa SPT Tec 10 percussion drilling rig. The window sampling consists of a 1m long steel tube with a cutting edge and an internal plastic liner which is mechanically driven into the ground utilising a 63.5kg weight falling a height of 750mm. Upon completion of the 1m sample, the tube is withdrawn and the plastic liner removed and sealed for logging and sub sampling by an Engineering Geologist. The tube is replaced in the borehole and a subsequent 1m sample can be recovered. Occasionally outer casing or a reduced diameter tube is utilised to enable the window sample to progress in difficult drilling conditions. Geotechnical or environmental soil samples can be recovered from each of the liners following logging. The window sample records are provided in Appendix 4 of this Report.

3.5. Dynamic Probing

The dynamic probe tests (DPSH) were carried out at the locations shown in the location plan in Appendix 1 in accordance with B.S. 1377: Part 9 1990. The test consists of mechanically driving a cone with a 63.5kg weight with a drop height of 750mm in 100mm intervals and monitoring the number of blows required. An approximate Standard Penetration Test (SPT) 'N' value may be calculated by adding the total number of blows over a 300mm drive. The dynamic probe logs are provided in Appendix 5 of this Report.

3.6. Cable Percussion Boreholes

The Cable Percussion Boreholes were drilled using a Dando 2000 drilling rig with regular in-situ testing and sampling undertaken to facilitate the production of geotechnical logs and laboratory testing.
The standard method of boring in soil for site investigation is known as the Cable Percussion method. It consists of using a Shell in non cohesive soils and a clay cutter in cohesive soils, both operated on a wire cable. Very hard soils, boulders and other hard obstructions are broken up by chiselling and the fragments removed with the Shell. Where ground conditions made it necessary, the borehole was lined with 200mm diameter steel casing. While the use of the Cable Percussion method of boring gives the maximum data on soil conditions, some mixing of laminated soil is inevitable. For this reason, thin lenses of granular material may not be noticed. Disturbed samples were taken from the boring tools at suitable depths, so that there is a representative sample at the top of each change in stratum and thereafter at regular intervals down the borehole until the next stratum was encountered. The disturbed samples were then sealed and sent to the laboratory where they were visually examined to confirm the description of the relevant strata.
Standard Penetration Tests were carried out in the boreholes. The results of these tests, together with the depths at which the tests were taken are shown on the accompanying borehole records. The test consists of a thick wall sampler tube, 50mm external diameter, being driven into the soil by a monkey weighing 63.5kg and with a free drop of 760mm. For gravels and glacial till the driving shoe was replaced by a solid 60º cone. The Standard Penetration Test number referred to as the 'N' value is the number of blows required to drive the tube 300mm, after an initial penetration of 150mm. The number gives a guide to the consistency of the soil and can also be used to estimate the relative strength/density at the depth of the test and also to estimate the bearing capacity and compressibility of the soil. The cable percussion borehole logs are provided in Appendix 6 of this Report.

3.7. Rotary Boreholes

The rotary coring was carried out by a track mounted T44 Beretta rig at the locations shown on the location plan in Appendix 1. The rotary boreholes were completed from the ground surface or alternatively, where noted on the individual borehole log, from the base of the cable percussion borehole where a temporary liner was installed to facilitate follow-on rotary coring.
The T44 Beretta is equipped with rubber tracks which allow for short travel on pavement surfaces avoiding any damage to the surface. The T44 Beretta utilises a triple tube core barrel system operated using a wireline drilling process. The outer barrel is rotated by the drill rods and at its lower end, carries the coring bit. The inner barrel is mounted on a swivel so that it does not rotate during the process. The third barrel or liner is placed within the second one to retain the core intact and to preserve as much as possible the fabric of the drilling stratum. The core is cut by the coring bit and passes to the inner liner. The core is brought up to the surface within the inner barrel on a small diameter wire rope or line attached to the "overshoot" recovery tool which is then placed into a core box in order of recovery. A drilling fluid, typically air mist or water flush is passed from the surface through hollow drill rods to the drill bit, and is used to cool the drill bit. Temporary casing is used in some situations to support unstable ground or to seal off fissures or voids.

It should be noted that the rotary coring can only achieve limited recovery in overburden, particularly granular or weakly cemented strata due to the flushing medium washing away the cohesive fraction during coring. The recovery achieved, where required is noted on the borehole logs and core photographs are provided to allow assessment of the core recovered. The rotary borehole logs are provided in Appendix 6of this Report.

3.8. Surveying

The exploratory hole locations have been recorded using a KQ GEO Technologies KQ-M8 System which records the coordinates and elevation of the locations to ITM or Irish National Grid as required by the project specification. The coordinates and elevations are provided on the exploratory hole logs in the appendices of this Report.

3.9. Groundwater/Gas Monitoring Installations

Groundwater and Gas Monitoring Installations were installed upon the completion of selected window samples and boreholes to enable sampling and the determination of the equilibrium groundwater level. The typical groundwater monitoring installation consists of a 50mm uPVC/HDPE slotted pipe with a pea gravel response zone and bentonite seal installed to the Engineers specification. Where required the standpipe is sealed with a gas tap and finished with a durable steel cover fixed in place with a concrete surround. The installation details are provided on the exploratory hole logs in the appendices of this Report.

3.10. Insitu Plate Bearing Test

The plate bearing tests were carried out using a 450mm diameter plate at the locations shown on the site plan in Appendix 1. The plate was loaded in increments using a hydraulic jack and an excavator to provide a reaction and the displacement was monitored in accordance with BS1377 Part 9 using independently mounted digital strain gauges. The constrained modulus and equivalent CBR are calculated in accordance with HD29/75 and are provided on the test reports in Appendix 7 of this Report.

3.11. Variable Head Permeability Testing

Falling head permeability testing was carried out in the standpipes as requested to determine the permeability of the ground. The initial water level was recorded where possible, or the base of the borehole test zone used where no groundwater was encountered. The casing is cleaned out and wither retracted or left flush with the base of the borehole and the hole filled with water from a bowser to ground level and the drop-in water level was recorded at regular intervals. The recorded test data was interpreted to calculate the permeability value based on the methods outlined in B.S. 5930:2015 and IS EN ISO 22282-2:2012. The results of this testing are provided in Appendix 8 of this Report.

3.12. Laboratory Testing

Samples were selected from the exploratory holes for a range of geotechnical and environmental testing to assist in the classification of soils and to provide information for the proposed design.
Environmental & Chemical testing as required by the specification, including the Rilta Suite and Client Suite A, B, C, D, E, F1, F2, G, H, I and pH and sulphate testing was carried out by Element Materials Technology Laboratory in the UK. The Rilta suite testing includes both Solid Waste and Leachate Waste Acceptance Criteria.
Geotechnical testing consisting of moisture content, Atterberg limits, Particle Size Distribution (PSD), hydrometer tests were carried out in Prosoils Geotechnical Laboratory. Specialist shear strength testing consisting of quick undrained, consolidated undrained triaxial and consolidation testing was carried out on undisturbed UT100 or piston samples where recovered.
Rock strength testing including Point Load (Is_{50}) and Unconfined Compressive Strength (UCS) testing was carried out in Prosoils Geotechnical Laboratory
The results of the laboratory testing are included in Appendix 9 of this Report.

3.13. Archaeological Survey

Archaeological monitoring was carried out under licence number 21E0657 during the excavation of selected trial pits and inspection pits. No artefacts were found during the works. The findings from the archaeological are under the cover of a separate Report carried out by Yvonne Whitty Archaeology.

4.0 Ground Conditions

4.1. General

The ground conditions encountered during the investigation are summarised below with reference to insitu and laboratory test results. The full details of the strata encountered during the ground investigation are provided in the exploratory hole logs included in the appendices of this report.

- Topsoil/Surfacing
- Made Ground
- Cohesive Deposits
- Weathered Bedrock
- Bedrock

TOPSOIL: Topsoil was encountered in all the majority of the exploratory holes and was present to a maximum depth of 0.3m BGL. Tarmac/concrete surfacing where present was encountered to a maximum depth of 0.20m BGL.

MADE GROUND: Made Ground deposits were encountered beneath the Topsoil/Surfacing and were present in the Tolka Valley and St. Helena's Road parks locations to a maximum depth of between 3.90m

and 4.50m BGL. Made Ground was present in the locations along the track to a depth of between 0.80m and 1.40m BGL. These deposits were described generally as *brown sandy slightly gravelly Clay with frequent cobbles and boulders and contained occasional fragments of concrete, red brick, glass and plastic .*

COHESIVE DEPOSITS: Cohesive deposits were encountered beneath the Made Ground and were described typically as *grey/brown sandy gravelly CLAY with occasional cobbles and boulders* overlying a *stiff dark grey sandy gravelly CLAY with occasional cobbles and boulders*. The secondary sand and gravel constituents varied across the site and with depth, with granular lenses occasionally present in the glacial till matrix. The strength of the cohesive deposits typically increased with depth and was firm to stiff or stiff below 1.20m BGL in the majority of the exploratory holes. These deposits had some, occasional or frequent cobble and boulder content where noted on the exploratory hole logs.

GRANULAR DEPOSITS: Granular deposits were encountered within/below the cohesive deposits and were typically described as *Grey very clayey gravelly fine to coarse SAND.* The secondary sand/gravel and silt/clay constituents varied across the site and with depth while occasional or frequent cobble and boulder content also present where noted on the exploratory hole logs.

Based on the SPT N values the deposits are typically medium dense and become dense with depth. It should be noted that many of the trial pits where granular deposits or groundwater were encountered, experienced instability. This was described either as side wall spalling or as side wall collapse in the remarks section at the base of the trial pit logs.

WEATHERED BEDROCK: In the majority of exploratory holes weathered rock was encountered which was diggable with the large excavator to a depth of up to 0.70m below the top of the stratum. The trial pits were terminated upon encountering the more competent bedrock, in which further excavation became more difficult. This material was recovered typically as angular gravel and cobbles of Limestone/Mudstone however there was some variability in the fracture spacing and the ease at which the excavator could progress. Some clay and sand were also present with the rock mass either from weathering or as infilling to fractures which were opened upon excavation.

BEDROCK: The rotary core boreholes recovered *Medium strong to very strong grey/dark grey fine to medium grained laminated LIMESTONE interbedded with weak to medium strong black fine grained laminated Mudstone*. Rare visible pyrite veins were noted during logging which are typically present within the Calp Limestone.

The depth to rock varies from 1.30m BGL at LF-CPRC-1006 to a maximum depth 19.0m BGL at the location of LF-CPRC-1010. The total core recovery is good, typically 100% with some of the uppermost runs dropping to 80 or 90%. The SCR and RQD both are relatively poor in the upper weathered zone, often recovered as non-intact, however both indices show an increase with depth in each of the boreholes.

4.2. Insitu Strength Testing

The correlated DPSH blow counts indicate that the overburden deposits are soft or soft to firm to depth of 1.80m to 2.00m BGL and become firm or firm to stiff with depth.

4.3. Groundwater

Groundwater strikes are noted on the exploratory hole logs where they occurred and where possible drilling was suspended for twenty minutes to allow the subsequent rise in groundwater to be recorded. We would point out that these exploratory holes did not remain open for sufficiently long periods of time to establish the hydrogeological regime and groundwater levels would be expected to vary with the time of year, rainfall, nearby construction and other factors. For this reason, standpipes were installed in selected window samples and boreholes to allow the equilibrium groundwater level to be determined. The groundwater monitoring is included in Appendix 9 of this Report.

APPENDICES

Due to the extensive size of the appendices attached to this report and in the interest of promoting environmental sustainability, the Luas Team has decided not to produce printed copies of the full report. However, the report is available for review on the Luas Finglas website at www.luasfinglasro.ie."

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