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Technical Appendix 11.3: Biodiversity Management Plan

Biodiversity Management Plan

Profile Park Data Centre

13/12/2021

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EXECUTIVE SUMMARY

1.1. Objectives have been established to enhance and maintain the biodiversity of the land at the proposed data centre lands within Profile Park, Clondalkin, Dublin.

1.2. These include planting of species-rich hedgerows to provide a plentiful source of food and shelter for a range of fauna species. Other enhancement measures include development of a wetland wildflower mix, wildflower meadow mix, berms and woodland on site. This would be in addition to a riparian planting along the Baldonnel stream, as well as creating a herptile hibernaculum and adding bird and bat boxes to the site.

1.3. A Fossitt habitat survey of the site was conducted in June 2021 to assess the current baseline of the Application Site. An Ecological Impact Assessment (EcIA)[1] was then conducted to assess the local area and its ability to support a range of wildlife, as part of the full planning application.

1.4. The enhancements and management measures set out in this document have been developed in accordance with the findings of the above habitat survey. This will enable the Proposed Development to deliver biodiversity gain.

[1] A Blom, D Dunlop (2021) Profile Park Data Center. Ecological Impact Assessment. Neo Environmental.

INTRODUCTION

Background

1.6. Neo Environmental Ltd has been appointed by Ramboll on behalf of Vantage Data Centers Dub 11 Limited (the "Applicant") to undertake a Biodiversity Management to inform a planning application for a proposed data centre (the "Proposed Development") located on lands within Profile Park, Clondalkin, Dublin (the "Application Site").

Development Description

1.7. The development will consist of the demolition of the abandoned single storey dwelling and associated buildings (206 sqm), and the construction of 2 no. two storey data centers with plant at roof level of each facility and associated ancillary development that will have a gross floor area of 41,105sqm. The proposed development will include a range of SuDs features and enhancements to the Baldonnel Stream.

Site Description

1.8. The proposed site consists of agricultural land with mature treelines, hedgerow, building and a stream. These habitats have potential to support breeding birds, bats badgers and other protected species.

OBJECTIVE OF THE BIODIVERSITY MANAGEMENT PLAN

1.9. The objective of this BMP is to minimise any potential negative impacts, arising from the Proposed Development, while increasing the habitat diversity. The enhancement of the land within the Application Site boundary will increase the sites capability of supporting wildlife.

1.10. This will be achieved by

- Providing enhancements to the Baldonnel Stream;
- Creating and maintaining a wetland specific species-rich diverse grassland with a varied sward structure;
- Creating and maintaining a wildflower meadow;
- Creating and maintaining species-rich hedgerows;
- Creating and maintaining wildlife shelters for priority and locally important species;
- Ensure no net loss of biodiversity within the Application Site as a result of the habitat creation scheme; and
- Maximise the floral and faunal biodiversity of the created and retained habitats.

CURRENT CONSERVATION & BIODIVERSITY

National Conservation

Ireland's National Biodiversity Action Plan 2017 - 2021[2]

1.11. The National Biodiversity Action Plan[3] sets out a vision and seven strategic objectives to halt the decline of biodiversity across Ireland.

"Objective 1 - Mainstream biodiversity into decision-making across all sectors.

Objective 2 - Strengthen the knowledge base for conservation, management, and sustainable use of biodiversity.

Objective 3 - Increase awareness and appreciation of biodiversity and ecosystem services.

[2] Department of Culture, Heritage, and the Gaeltach (2017) National Biodiversity Action Plan 2017-2021

[3] Department of Arts, Heritage and the Gaeltacht (2011) Actions for Biodiversity 2011 – 2016 Ireland's National Biodiversity Action Plan. Available at: http://www.npws.ie/sites/default/files/general/national-biodiversity-plan-english.pdf

Objective 4 - conserve and restore biodiversity and ecosystem services in the wider countryside.

Objective 5 - conserve and restore biodiversity and ecosystem services in the marine environment.

Objective 6 - Expand and improve management of protected areas and species.

Objective 7 - Strengthen international governance for biodiversity and ecosystem services."

1.12. This document outlines that special protection to sites of highest nature value and species most at risk, including designated sites should be afforded. However, effective conservation and sustainable use of biodiversity should also occur within the wider countryside, as this is where much of the biodiversity lies.

1.13. The primary threat to biodiversity both within and outside protected areas is from habitat degradation, fragmentation and loss due to changes in agricultural practices (such as intensification), commercial forestry, fisheries over exploitation, peat extraction, air and water pollution, invasive alien species, land clearance and development, tourism and recreational activities and climate change.

All Ireland Pollinator Plan 2021-2025[4]

1.14. On the 17th of September 2015, Ireland joined a small number of countries in Europe who have developed a strategy to address pollinator decline and protect pollination services. In March 2021, a new Plan was released.

1.15. This new Plan has six objectives and has identified 186 actions in order to achieve its objectives. The six objectives are as follows:

- **Making farmland pollinator friendly**. Working together with the farming community, increase awareness of pollinators and the resources they need in order to survive on farmland.
- **Making public land pollinator friendly**. Working with Councils, Transport Authorities, Local Communities and others, to strengthen links between this plan and other initiatives and to increase shelter and food resources for pollinators.
- **Making private plan pollinator friendly**. Work together with the public and community groups to create networks of biodiversity-friendly habitat across the landscape.

[4] National Biodiversity Data Centre (2015) All Ireland Pollinator Plan 2021-2025. Available at: https://pollinators.ie/wp-content/uploads/2021/03/All-Ireland-Pollinator-Plan-2021-2025-WEB.pdf

- **All-Ireland honeybee strategy**. Working with beekeepers, achieve healthy, sustainable populations, and for honeybees to be part of a cohesive pollinator message that balances managed and wild pollinator populations.

- **Conserving rare pollinators**. Improving our knowledge on rare pollinators, and raising awareness through dedicated initiatives, achieve a Plan that protects as much wild pollinator diversity as possible.

- **Strategic coordination of the Plan**. Continually raising awareness; addressing gaps in knowledge through research, tracking where pollinators occur and how populations are changing, work from an evidence base that enables us to coordinate a dynamic plan that is targeted and effective.

1.16. The enhancements set out within this BMP will create areas of flower-rich habitat that will support Ireland's pollinator species, including bees and flies.

South Dublin Development Plan 2016–2022 [5]

1.17. The Plan sets out an overall strategy for the proper planning and sustainable development of the County and consists of a written statement and accompanying plans and maps

1.18. Chapter 9 of the Plan refers to the county's natural heritage and contains a number of key policies (outlined below), which aim to protect and enhance biodiversity and designated sites within the county:

HCL1: Objective 1: To protect, conserve and enhance natural, built and cultural heritage features and restrict development that would have a significant negative impact on these assets.

HCL1 Objective 2: To support the objectives and actions of the County Heritage Plan, including the preparation of a County Biodiversity Plan.

HCL12 Objective 1: To prevent development that would adversely affect the integrity of any Natura 2000 site located within and immediately adjacent to the County and promote favourable conservation status of habitats and protected species including those listed under the Birds Directive, the Wildlife Acts and the Habitats Directive.

HCL12 Objective 2 To ensure that projects that give rise to significant direct, indirect or secondary impacts on Natura 2000 sites, either individually or in combination with other plans or projects, will not be permitted unless the following is robustly demonstrated in accordance with Article 6(4) of the Habitats Directive and S.177AA of the Planning and Development Act (2000 – 2010) or any superseding legislation:

[5] Available from : https://sdcc.ie/en/services/planning/development-plan/plan-2016-2022/plan-2016-2022.html

1. There are no less damaging alternative solutions available; and

2. There are imperative reasons of overriding public interest (as defined in the Habitats Directive) requiring the project to proceed; and

3. Adequate compensatory measures have been identified that can be put in place.

HCL13 Objective 1 To ensure that any proposal for development within or adjacent to a proposed Natural Heritage Area (pNHA) is designed and sited to minimise its impact on the biodiversity, ecological, geological and landscape value of the pNHA particularly plant and animal species listed under the Wildlife Acts and the Habitats and Birds Directive including their habitats.

HCL13 Objective 2 To restrict development within a proposed Natural Heritage Area to development that is directly related to the area's amenity potential subject to the protection and enhancement of natural heritage and visual amenities including biodiversity and landscapes.

HCL15 Objective 1 To ensure that development does not have a significant adverse impact on rare and threatened species, including those protected under the Wildlife Acts 1976 and 2000, the Birds Directive 1979 and the Habitats Directive 1992.

HCL15 Objective 2 To ensure that, where evidence of species that are protected under the Wildlife Acts 1976 and 2000, the Birds Directive 1979 and the Habitats Directive 1992 exists, appropriate avoidance and mitigation measures are incorporated into development proposals as part of any ecological impact assessment

HCL15 Objective 3 To protect existing trees, hedgerows, and woodlands which are of amenity or biodiversity value and/ or contribute to landscape character and ensure that proper provision is made for their protection and management in accordance with Living with Trees: South Dublin County Council's Tree Management Policy 2015-2020.

1.19. The South Dublin County Council Development Plan for the period 2022 – 2028 is still under review.

South Dublin County Council Draft Biodiversity Action Plan 2015-2020[6]

1.20. The preparation of this Biodiversity Action Plan is an objective of the South Dublin County Heritage Plan and the South Dublin County Council Development Plan 2016-2022 The South Dublin County Biodiversity Plan was prepared in the context of a range of national and international plans for biodiversity protection and enhancement

1.21. The National Biodiversity Plan lists a range of actions for biodiversity that aim to achieve this vision, arranged under a series of 7 Strategic Objectives. These objectives are:

- the mainstreaming of biodiversity issues across the decision-making in all sectors;

[6]https://www.meath.ie/system/files/media/file-uploads/2019-06/County%20Meath%20Biodiversity%20Plan%202015-2020.pdf

- the strengthening of the knowledge base for conservation, management and sustainable use of biodiversity;
- increasing public awareness and appreciation of biodiversity and ecosystem services;
- the conservation and restoration of biodiversity and ecosystem services in the wider countryside;
- the conservation and restoration of biodiversity and ecosystem services in the marine environment;
- the expansion and improved management of protected areas and species; and
- the strengthening of international governance for biodiversity and ecosystem services.

Local Conservation

1.22. The Proposed Development does not lie within or directly adjacent to any statutory or non-statutory designated environmental sites. Within 15km of the Application Site boundary there are seven Natura 2000 designated sites, four Special Areas of Conservation (SACs) and three Special Protection Areas (SPA)

1.23. Please refer to the supporting Appropriate Assessment (AA) Screening report (**Appendix 11.2**) for details of all Natura 2000 sites within 15km of the Application Boundary.

1.24. From the findings of the EcIA and AA it is considered that with the implementation of design, best practice and mitigation measures the Proposed Development will not significantly impact upon any of the designated and non-designated sites located within 15km of the Proposed Development.

HABITATS & SPECIES PRESENT

1.25. An extended habitat survey of the Proposed Development was undertaken on the 17th June 2021. The following habitat types were identified:

- Improved agricultural grassland (GA1)
- Amenity grassland (improved) (GA2)
- Dry meadows and grassy verges (GS2)
- Hedgerows (WL1)
- Treelines (WL2)
- Depositing/lowland rivers (FW2)
- Recolonising bare ground (ED3)
- Buildings and artificial surfaces (BL3)

(Note: Fossitt classification within brackets).

Fauna

1.26. The potential presence of protected species within the study area was assessed though a data search conducted through the NBDC. This identified records of invasive, rare, scarce and protected species within 2km of the Proposed Development location.

1.27. The Application Site is located within the 1km grid squares O03F and O03K. A database search was also carried out for adjacent grid squares to ensure a full assessment of the 2km radius.

1.28. Additional information on the suitability of habitat in the surrounding area for bats was also obtained from the NBDC in the form of a habitat suitability map. The map provided enhanced information on the recorded distribution of bats and broad-scale geographic patterns of occurrence and local roosting habitat requirements for Irish bat species.

1.29. In addition, the extended habitat survey included a species scoping survey in order to assess the potential of the site to support protected species.

1.30. The Application Site and adjacent areas offer suitable habitat for badger, bat, bird and herptile species which are known to be present in the local area.

POTENTIAL IMPACTS

1.31. Potential impacts which could arise from a Development include:

- Potential habitat loss and fragmentation;
- Disturbance during construction and decommissioning; and
- Potential contamination of surface waters.

1.32. Each of these potential impacts have been considered below in relation to the Proposed Development.

Potential Habitat Loss and Fragmentation

1.33. The overall ground-level Proposed Development footprint take up 41,105m^2.

1.34. Currently the habitat present under the Proposed Development footprint is primarily improved agricultural grassland, considered to be of low ecological value. As the surrounding landscape is of a similar nature, the loss of these small areas will not be significant and the alteration of this habitat will not result in fragmentation.

1.35. Post-construction, with the implementation of this BMP, existing habitats are to be enhanced, with new habitats created. This document sets out how the habitats including hedgerows, trees and grasslands within the Application Site will be sensitively managed to ensure the maximum potential of these habitats are maintained throughout the lifetime of the development.

1.36. It is therefore demonstrated that the Proposed Development will have a positive significant impact on local habitats and will indeed deliver biodiversity enhancements to the benefit of the site and wider area.

Disturbance During Construction and Operation

1.37. The construction and decommissioning phases of the Proposed Development have the greatest potential to impact upon local wildlife.

1.38. Measures will be implemented prior to construction and decommission work taking place to minimise any potential disturbance to wildlife. Mitigation measures recommended within the Ecological Impact Assessment (**Appendix 11.1**) include:

- Pre-construction bird surveys, if works commence between March and August inclusive;
- Pre-construction badger survey;
- Pre-construction otter survey;

- Securely covering all excavations at the end of each working day to prevent accidental trapping of badger, otter or other small mammals.

1.39. With the creation of the wildflower meadow, along with the introduction of hibernacula, bat and bird boxes and the enhancement of existing hedgerows and sensitive management, the sites potential for supporting local wildlife could be greatly increased post-construction.

Potential Disturbance and Contamination of Surface Waters

1.40. The construction phase of a development has the potential for contamination of surface waters, if appropriate measures are not implemented.

1.41. An Outline Construction and Environmental Management Plan has been produced by Pinnacle Consulting Engineers. During the construction phase, stream protection measures outlined will be adhered to.

1.42. Species diversity within the stream has been characterised using kick sampling and has been identified to be low and dominated by freshwater shrimp and stone clingers (see Appendix B of **Appendix 11.1: Ecological Impact Assessment**). Given the low species diversity of invertebrates within the stream, and its small size, the stream would be classified as being of local importance higher value (as this is not a common habitat within the local area).

1.43. Existing riparian vegetation and trees will be retained, and the stream is to be enhanced with proposed native riparian planting.

1.44. The Proposed Development will have a positive significant impact on local habitats and will indeed deliver biodiversity enhancements to the benefit of the site and wider area.

MANAGEMENT & RECOMMENDATIONS

1.45. The following management recommendations have been made:

- to maintain and improve the biodiversity of species within the site;
- to enhance the quality of habitats present;
- increase the sites potential for supporting wildlife; and
- to avoid any potential negative impacts arising from the Proposed Development of the site.

1.46. The alignment of the Baldonnel stream course will be retained. The incorporation of wetland specific planting would be designed to attract a wider range of species and create a diverse habitat which benefits invertebrates, bats, amphibians, and birds. This would be achieved through new and retained trees, planted sustainable urban drainage systems, species rich specific planting, and maintenance of the created habitats and the addition of artificial habitats such as hibernacula, bat and bird boxes and insect hotels, which would be of benefit to a wide range of species

Recommended Management

1.47. Currently the agricultural land of which the majority of the Application Site comprises offer limited benefit to wildlife. The potential of the site to support wildlife will be significantly increased by the habitat creation measures set out below.

Stream Enhancement

1.48. A wetland corridor, consisting of the enhanced existing Baldonnel stream, flood attenuation basins and bioswale attenuation areas is proposed to the north and east of the site. It has been designed as a landscape feature, providing an aesthetic view, but has the added benefit of providing habitats.

1.49. A living willow wall is included within the design. This feature has been added as stabilises the modified banks of the stream and provides visual benefits, banks of willow trees offer further biodiversity benefits.

1.50. Bioswales have been located at the upper level of the stream. Riparian edges composed of native wetland species have been proposed to all of the bioswales and attenuation ponds around the site. The stream corridor and flood attenuation basins establish will provide unique habitats for a wider range of species. The habitats created will not only benefit the aquatic species, through the creation of microhabitats but the additional planting will create species rich foraging grounds for a variety of species.

Habitat Enhancement

1.51. Various options exist to enhance the biodiversity value of a site, including the creation of different habitats, such as: hedgerows, woodland and wildflower meadows.

1.52. Habitats that will be created at the development site will include:

- Wetland wildflower meadow;
- Standard wildflower meadow;
- Hibernaculum;
- Bird and bat boxes;
- Bee and beetle banks.

1.53. These habitats individually offer shelter and a food source for supporting a variety of wildlife. The mosaic of these new habitats combined with the existing hedgerows, will support the existing wildlife within the site. They also have excellent potential to allow the biodiversity of the site to increase, by offering a wider range of habitats that benefit local wildlife.

General Considerations

Obligations

1.54. During each of the Proposed Development phases there are a number of legal obligations that should be considered by all those involved in site work:

- Ensure obligations of the European Communities (Birds and Natural Habitats) Regulations 2011 are met by all involved with the site.
- Ensure obligations of the Wildlife Act 1976 and Wildlife (Amendment) Act 2000 are met by all involved with the site.
- Ensure all relevant Health & Safety at Work Act obligations.

Good Ecological Practice

1.55. Whilst management practices should only be altered if there is a good ecological reason for doing so, they should not be rigidly adhered to if they are obviously detrimental.

Invasive Non-Native Species

1.56. During the extended habitat survey no field signs or evidence of invasive non-native species were observed.

MANAGEMENT OBJECTIVES AND ACTION PLAN

Table 1-1: Recommended Management

Objective	Action Plan Task	Timescale	Notes
Improving the Baldonnel Stream	Ledges and shallow banks to create a high quality riparian edge to the stream. A mix of riparian species will be planted along the banks of the stream, containing: Fool's watercress (*Apium nodiflorum*), Marsh-marigold (*Caltha paulaustris*), Yellow iris (*Iris pseudacorus*), Myosotis scorioides Water forget-me-not (*Myosotis scorioides*), Watermilfoil (*Myriophyllum spicatum*), Sparganium spp. Bur-reed (*Sparganium spp.*), Snow rush (*Luzula nivea*) Soft shield fern (*Polystichum setiferum*), Common fern (*Dryopteris filix-mas*).	Year 1 (early within the construction phase)	Riparian vegetation will provide food and shelter for aquatic species. Water features provide a diverse range of habitats, favoured by wading birds, amphibians and dragonflies, and provide an important source of food for bats and reptiles.
Creating a diversity of habitats within the site	Wetland wildflower mix to contain: Ragged robin (*Lychnis flos-cuculi*), cuckoo flower (*Cardamine pratensis*), meadowsweet (*Filipendula ulmaria*), selfheal (*Prunella vulgaris*), sainfoin (*Onobrychis viciifolia*), ox-eye daisy (*Leucanthemum vulgare*), black medic (*Medicago lupulina*), common vetch (*Vicia sativa*), lady's bedstraw (*Galium verum*), meadow vetchling (*Lathyrus pratensis*), meadow buttercup (*Ranunculus acris*), musk mallow	Year 1 (early within the construction phase)	Wildflower mix will also provide habitat for small mammals and larvae of pollinating insects, including butterflies and moths.

	(*Malva moschata*), yellow rattle (*Rhinanthus minor*) and yarrow (*achillea milliefolium*).		
To enhance the quality of habitats present	<u>Enhance existing hedgerow boundary</u> Gap existing hedgerows with blackthorn (*Prunus spinosa)*, hawthorn (*Crataegus monogyna)*, ash (*Fraxinus excelsior)*, alder (*Alnus glutinosa)*, hazel (*Corylus avellana)* and holly (*Ilex aquifolium)*. These corridors will allow the movement of small mammals and herptile species. To ensure a diverse hedgerow with a good structure it is important to plant and maintain ground flora along the hedgerow.	Year 1 (early within the construction phase)	A hedgerow provides shelter and a source of food for a variety of species including birds, small mammals, amphibians, reptiles and butterflies. If the correct species are planted and maintained correctly, a hedgerow's potential can be maximised, providing food and shelter throughout the year.
Ensure fencing does not inhibit the movement of wildlife	To allow movement of badgers, small mammals and herptiles across the Proposed Development area the fence will be above ground level, with at least a 10cm gap at the base, allowing access for these species where required.	Year 1 (during construction phase)	Although badgers will not pass through a 10cm gap, they will dig a depression into the ground at the required areas.
Creating a diversity of habitats within the site	<u>Creation of hibernaculum, stone piles and log piles</u>	Year 1	See appendix A The hibernaculum comprise log, rock and stone piles, which are aimed at providing shelter for herptile species to hibernate. However, the hibernaculum and

			log pile may also be used by a variety of insects and small mammals.
Creating a diversity of habitats within the site	Creation of bat roosting habitat Bat boxes will be placed on a few of the mature trees within the site.	Year 1	The creation of roosting habitat, along with the creation of species-rich habitat that will encourage an abundance of invertebrate life (a potential food source) will be beneficial to local bats.
Creating a diversity of habitats within the site	Creation of bird nesting habitat Bird boxes will be placed on a few of the mature trees within the site.	Year 1	The creation of nesting habitat, along with the creation of species rich habitat that will encourage an abundance of invertebrate life (a potential food source) and the wild bird seed mix areas will be beneficial to local birds. Boxes installed should include a mixture of single hole, and open fronted bird boxes.
Creating a diversity of habitats within the site	Creation of invertebrate banks and insect hotels Several earth banks shall be created across the site to support invertebrates.	Year 1	See Appendix B Some banks should be left bare, and south facing for insects such as solitary bees, while

			others should be sown with grass for beetles etc.
Maintaining the hedgerows	Section of hedgerow to be cut	Each year between January and February	Cutting on a rotational basis, following standard advice[7], to ensure the optimal availability of berry and blossom for wildlife throughout the year, as a potential food source. Management will also ensure a good base is maintained within the hedgerow, to provide suitable habitat for a range of wildlife.

HABITAT CREATION

1.57. The existing groundcover (currently primarily improved agricultural grassland) will be replaced by a mix of wet grassland, wildflower meads and native woodland. Existing hedgerows will be enhanced, with a new hedgerow created within the Proposed Development boundary. Native coniferous trees and medium or large deciduous trees have been proposed to give visual screening.

1.58. These habitats will be in place and managed for the duration of the Proposed Development.

[7] Hedgelink UK, The Complete Hedge Good Management Guide, Available at www.hedgelink.org.uk

Stream Enhancement

1.59. The stream enhancement will provide microhabitats and providing more habitats for a wider range of species. The general flow, and stream profile proposed in general will be similar to the current habitat, but will benefit from the flood basin, and microhabitats within the stream and selected areas would have shallower banks to provide additional surface roughness, pools, and riffles to provide enhanced microhabitats.

1.60. The habitats created will not only benefit the aquatic species, through the creation of microhabitats, but the additional planting will create species rich foraging grounds for a variety of species, such as otter, bats and birds.

1.61. An assessment of benthic macroinvertebrates was completed on the stream within the site, the results of which are detailed in **Appendix B** of **Appendix 11.1: Ecological Impact Assessment**. No notable species were identified during this stream assessment, the dominate species were Freshwater shrimp (*Gammerus sp.*) and Stone clingers (*Baetidae sp.*), biodiversity was considered to be **low**.

1.62. Currently the stream is considered to be of **low ecological value**. It is considered that the stream enhancement works will provide enhanced habitats for benthic macroinvertebrates, and the value of the stream will increase to at least **moderate ecological value**.

Management

1.63. As a design measure a buffer has been included around the Baldonnel Stream. Landscaping embankment proposals would be undertaken in line with an appropriate method statement and would be carried out in line with the Irish Fisheries Guidelines.

Riparian Planting

1.64. A riparian planting mix (**Table 1-2**) has been proposed to be planted along the banks of the stream.

1.65. They are an important source of food and shelter for aquatic species and support many terrestrial organisms, including bats and a wide range of bird species.

Table 1-2: Native Riparian Planting Mix

SCIENTIFIC NAME	ENGLISH NAME
Apium nodiflorum	Fool's watercress
Caltha paulaustris	Marsh-marigold
Iris pseudacorus	Yellow iris
Myosotis scorioides	Water forget-me-not

Myriophyllum spicatum	Watermilfoil
Sparganium spp.	Bur-reed
Luzula nivea	Snow rush
Polystichum setiferum	Soft shield fern
Dryopteris filix-mas	Common fern

Management

1.66. Within the first year the main aim is to control weeds and to reduce competition from grasses. Where appropriate, this may include hand pulling of weeds.

1.67. After the wildflower mix has established, no specific management is required for the riparian strip

Wetland Wildflower Meadow

1.68. A wetland wildflower meadow has been proposed to be planted adjacent to the Baldonnel stream. These species will attract a wider range of species and create a diverse habitat which benefits invertebrates, bats, amphibians, and birds.

1.69. The species mixture is set out in **Table 1-2** below.

Table 2-2: Wetland wildflower meadow mix

SCIENTIFIC NAME	ENGLISH NAME
Succisa pratensis	Devils Bit Scabious
Rumex acetosa	Common Sorrel
Cardamine pratensis	Cuckoo Flower
Primula veris	Cowslip
Erigeron	Fleabane*
Lotus pedunculatus	Greater Trefoil*
Eupatorium cannabinum	Hemp Agrimony
Centaurea nigra	Lesser Knapweed
Comarum palustre	Marsh Cinquefoil
Caltha palustris	Marsh Marigold
Ranunculus acris	Meadow Buttercup
Filipendula ulmaria	Meadowsweet
Thalictrum	Meadow Rue
Leucanthemum vulgare	Oxeye Daisy
Lythrum salicaria	Purple Loosestrife
Lychnis flos-cuculi	Ragged Robin

Trifolium pratense	Red Clover

Wildflower Meadow

1.70. The wildflower meadow, as shown within the landscape masterplan (by KFLA Architects) accompanying the application, is a species-rich grassland comprised of 85% grass species and 15% perennial species. This will create an insect-rich habitat and support a range of birds, mammals and invertebrates.

1.71. The species mixture is set out in **Table 1-3** below.

Table 1-3: Wildflower meadow mix

SCIENTIFIC NAME	ENGLISH NAME
Agrostis capillaris	Browntop Bent
Cynosurus cristatus	Crested Dogstail
Festuca ovina	Sheeps Fescue
Festuca rubra subsp. commutata	Chewings Fescue
Festuca rubra	Slender Creeping Red Fescue
Trisetum flavescens	Yellow Oat Grass
Anthoxanthum odoratum	Sweet Vernal Grass
Lotus Corniculatus	Birdsfoot Trefoil
Hypochaeris Radicata	Common Cat's Ear
Primula Veris	Cowslip
Knautia Arvensis	Field Scabious
Galium Verum	Lady's Bedstraw
Centaurea Nigra	Lesser knapweed
Ranunculus Acris	Meadow Buttercup
Lathyrus pratensis	Meadow Vetchling
Malva Moschata	Musk Mallow
Leucanthemum Vulgare	Ox Eye Daisy
Lychnis Flos Cuculi	Ragged Robin
Silene Dioica	Red Campion
Planatago Lanceolata	Ribwort Plantain
Leontodon hispidus	Rough Hawkbit
Sanguisorba Minor	Salad Burnet
Prunella Vulgaris	Self Heal
Scabiosa columbaria	Small Scabious
Rumex Acetosa	Common Sorrel
Silene Alba	White Campion
Daucus carota	Wild Carrot
Torilis Japonica	Upright Hedge Parsley
Achillea millefolium	Yarrow

Rhinanathus Minor	Yellow Rattle
Salvia Verbenaca	Wild Clary

Management

1.72. The wildflower mix will be sown in September or March/April, after the completion of the construction phase.

1.73. Within the first year the main aim is to control weeds and to reduce competition from grasses. The sward will be kept short in the first year until the end of June to reduce competition and then allowed to grow in July and August to permit any wildflowers to seed. All cuttings should be removed from site several days after cutting to avoid smothering the sward, but allowing any seeds to disperse.

1.74. After the wildflower mix has established, this area should only require one cutting in late summer (August – September), allowing flowering species to seed with an additional cut in October. Cuttings should be left on site for several days to disperse any seeds, then removed from site.

Hedgerow

1.75. Existing hedgerow boundaries will be enhanced in line with the arborist report.

1.76. Enhancing native hedgerows will benefit a range of local species including BAP Priority Species such as badgers, herptiles, invertebrates and birds. If the correct species are planted and maintained correctly, a hedgerow's potential can be maximised, providing food and shelter throughout the year, as well as connecting corridors.

Table 1-4: Hedgerow Species Mix

SCIENTIFIC NAME	ENGLISH NAME
Corylus avellana	Hazel
Crategus monogyna	Hawthorn
Euonymus Europaeus	Spindle
Ilex aquifolium	Holly
Lonicera periclymenum	Honeysuckle
Prunus spinosa	Blackthorn
Rosa canina	Dog Rose
Viburnum opulus	Guelder Rose

1.77. It is also important to plant and maintain ground flora along the hedgerow to provide suitable commuting corridors for small mammals and herptiles.

Management

1.78. New hedgerows will be planted within the first available planting season (November – March).

1.79. Any pruning or cutting should be done outside of the breeding bird season (March to August inclusive) to minimise disturbance to nesting birds.

Tree planting

1.80. Triple staggered rows of native trees have been proposed to screen the Proposed Development from the surrounding area. A woodland planting mix (**Table 1-5**) has been proposed to enhance habitats around the perimeter and throughout the site.

1.81. Planting trees will provide potential new habitat for roosting bats and birds, providing food and shelter for other BAP Priority Species.

1.82. Native woodland planting is proposed around the perimeter and throughout the site to create a biodiverse native habitat as shown within the landscape masterplan (by KFLA Architects).

Table 1-5: Woodland planting mix

SCIENTIFIC NAME	ENGLISH NAME
Alnus glutinosa	Alder
Betula pendula	Silver birch
Corylus avellana	Hazel
Crataegus monogyna	Hawthorn
Ilex aquifolium	Holly
Larix decidua	Larch
Pinus sylvestris	Scots pine
Prunus avium	Wild cherry
Prunus padus	Bird cherry
Quercus petraea	Sessile oak

Wildlife Shelters

1.83. The creation of wildlife shelters strategically placed throughout the Application Site, will provide shelter to a wide range of species

Bat boxes

1.84. Providing bat boxes will increase opportunities for roosting bats within the local area. Bat boxes should be erected in suitable locations throughout the site. It can however take bats a long time to make use of artificial roosts, therefore a number of factors must be considered when installing a new bat box.

1.85. Microclimate within a new roost is a very important factor in terms of increasing the chance of successful uptake by bats. In line with Bat Conservation Trust guidelines8 bat boxes should be draught-proof and made from a thermally stable material. They should be located where they will receive full/partial sunlight (southerly orientation). The boxes should also be positioned a minimum of 2m above the ground. Access points should also be clear of any obstructions.

1.86. To allow a choice of roosting, bat boxes should be installed in more than one aspect. Bat boxes located on a shady side will be cooler and may be suitable as a hibernation roost or used by male bats throughout the entire year.

1.87. There is a wide range of bat boxes currently available, some which are more suitable for certain species. A variety of bat boxes are recommended in **Table 1-7**. It is recommended that three of each box detailed below be installed on site.

Table 1-7: Details of Bat Boxes

BAT BOX	DETAILS	IMAGE
Schwegler 1FF[9]	Can be used as a summer roost or nursery site. Is open at the bottom and does not require cleaning.	
Schwegler 2F[10]	Standard box and most popular. Simple entrance role. Used as summer roosting space.	

[8] Bat Conservation Trust – Bat Box Information Pack – Available at: http://www.bats.org.uk/data/files/publications/Bat_Box_Information_Pack_FINAL.pdf

[9] Full specification available at: http://www.nhbs.com/title/158636/1ff-schwegler-bat-box-with-built-in-wooden-rear-panel

[10] Full specification available at: http://www.nhbs.com/title/158629

Schwegler 1FD[11]	Specific for smaller bats such as common pipistrelle, nathusius pipistrlle, daubenton's bat and brown long-eared.	

Bird boxes

1.88. In order to enhance the site for nesting birds, a number of bird boxes shall be placed throughout the site. Several types of nest boxes will be installed at suitable locations to favour a variety of bird species.

1.89. Open-fronted boxes will provide enhanced nesting opportunities for species such as robins, pied wagtails and spotted flycatchers. Boxes with entrance holes are suitable for tits, wren and tree sparrows.

1.90. Bird boxes should be mounted so that they face between the south-east and north to avoid direct sunlight. They should be tilted forwards so that rain is directed away from the entrance.

1.91. A variety of bird boxes are recommended in the table below.

[11] Full specification available at: http://www.nhbs.com/title/177076/1fd-schwegler-bat-box

Table 1-8: Details of Bird Boxes

BIRD BOX	DETAILS	IMAGE
1B Schwegler Nest Box[12]	This nest box will attract a wide range of species and is available with different entrance hole sizes to prevent birds from competing with each other for the boxes. The 32mm entrance hole will attract Great, Blue, Marsh, Coal and Crested Tit, Redstart, Nuthatch, Collared and Pied Flycatcher, Wryneck, Tree and House Sparrow and bats. The 26mm entrance hole suits Blue, Marsh, Coal and Crested Tit and possibly Wren. All other species are prevented from using the nest box due to the smaller entrance hole.	
2H Schwegler Robin Box[13]	This traditional design has proved to be highly effective in attracting robins, as well as other small species such as black redstart, spotted flycatcher and wren.	

1.92. It is recommended that 1B Schwegler nest boxes (three 32mm and three 26mm holes) and 2H Schwegler robin boxes are installed.

Hibernacula

1.93. The hibernacula comprise of log, rock and stone piles and is aimed at providing shelter for reptile and amphibians to hibernate. It may also be used by a variety of insects and small mammals. The hibernacula will follow the instructions laid out within Appendix B below.

Management

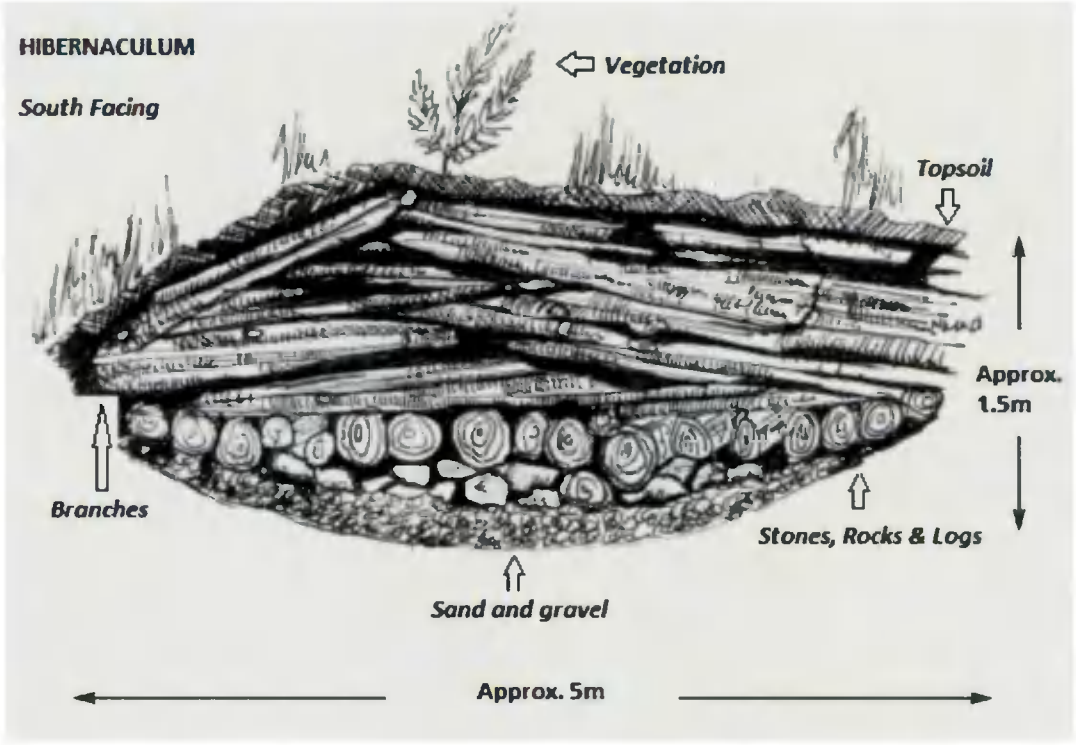
1.94. Final location and number of bird nest boxes and bat boxes to be determined on site by an ecologist.

[12] Full specification available at: http://www.nhbs.com/title/158587/1b-schwegler-nest-box
[13] Full specification available at: http://www.nhbs.com/title/161277/2h-schwegler-robin-box

APPENDICES

Appendix A - Hibernaculum Construction

1.95. The hibernaculum will follow the basic construction set out below, with the log and stone piles situated to the north of the hibernaculum.



- A 5m long east-west running ditch 1m deep and 1m wide will be dug.
- The base will be lined with sand and gravel.
- This will be followed with layers of stones, rocks and logs.
- Smaller branches will then be placed on top, and covered soil from the excavation will be placed over the pile, leaving gaps for access.
- The soil will be shaped into a mound.
- North facing side of the mound will be seeded / planted with species that will attract insects and will also provide extra shelter.
- South facing side will be maintained with a sparse vegetation cover to provide an area to bask.
- A log pile of approximately 2m by 1m will be placed to the north of the hibernaculum.

Appendix B – Invertebrate Bank Creation

Beetle Bank

- September is the best month to establish the grass sward that forms a beetle bank.
- Create a raised bank of about 0.4 metres.
- The grass mix should include up to 60% of tussock-forming species such as cocksfoot or Scots timothy grass. For the rest of the mix choose native species and include fescues.
- Up to three cuts may be needed in the first summer (when the sward reaches 10 cm in height) to encourage the grasses to tiller and to help control invasive annual weeds.
- Once established, the grass strips should be cut typically no more than once every three years.

Bee Bank

- Material (such as aggregate and sand) will be shaped into a mound with various slopes, hollows and angles that may be utilised and favoured by different species.
- Vertical banks created on bee banks take much longer to vegetate and this makes them attractive to many species. Over time a bee bank will be vegetated over through succession.
- Planting vegetation in an open structure in front of a bee bank will provide extra habitat 0for invertebrates that are attracted to the bee bank.
- These banks should be created close to flower-rich areas which will provide important foraging areas for pollinators.

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Technical Appendix 12.1: Ground Investigation and Geotechnical Report

IGSL Ltd

Project Apollo

Ground Investigation & Geotechnical Report

Project No. 23300

July 2021

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FOREWORD

The following conditions and notes on the geotechnical site investigation procedures should be read in conjunction with this report.

Standards

The ground investigation works for this project have been carried out by IGSL in accordance with Eurocode 7 - Part 2: Ground Investigation & Testing (EN 1997-2:2007). This has been used together with complementary documents such as Engineers Ireland Specification for Ground Investigation (2nd Ed, 2016), BS 5930 (2015) and BS 1377 (Parts 1 to 9) and the following European Norms:

- EN 1997-2 Eurocode 7: 2007 – Geotechnical Design – Part 2: Ground Investigation & Testing
- EN ISO 22475-1:2006 Geotechnical Investigation and Sampling – Sampling Methods & Groundwater Measurements
- EN ISO 14688-1:2002 Geotechnical Investigation and Testing – Identification and Classification of Soil, Part 1: Identification and Description
- EN ISO 14688-2:2004 Geotechnical Investigation and Testing – Identification and Classification of Soil, Part 2: Classification Principles
- EN ISO 14689-1:2004 Geotechnical Investigation and Testing - Identification & Classification of Rock, Part 1: Identification & Description

Reporting

No responsibility can be held by IGSL Ltd for ground conditions between exploratory hole locations. The engineering logs provide ground profiles and configuration of strata relevant to the investigation depths achieved and caution should be taken when extrapolating between exploratory points. No liability is accepted for ground conditions extraneous to the investigation points. Unless specifically stated, no account has been taken of possible subsidence due to mineral extraction, mining works or karstification below or close to the site.

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Boring Procedures

Where required, 'shell and auger' or cable percussive boring technique is employed as defined by Section 6.3 of IS EN ISO 22475-1:2006. The boring operations, sampling and in-situ testing meet with the recommendations set out in IS EN 1997-2:2007 and BS 1377:1990 and EN ISO 22476-3:2005. The shell and auger boring technique allows for continuous sampling in clay and silt above the water table and sand and gravel below the water table (Table 2 of IS EN ISO 22475-1:2006).

It is highlighted that some disturbance and variation is unavoidable in particular ground (e.g. blowing sands, gravel / cobble dominant glacial deposits etc). Attention is drawn to this condition, whenever it is suspected. Where cobbles and boulders are recorded, no conclusion should be drawn concerning the size, presence, lithological nature, or numbers per unit volume of ground.

In-Situ Testing

Where required, Standard Penetration Tests (SPT's) are conducted strictly in accordance with Section 4.6 of IS EN 1997-2:2007. The SPT equipment (hammer energy test) has been calibrated in accordance with EN ISO 22476-3:2005 and the Energy Ratio (E_r). A calibration certificate is available upon request. The E_r is defined as the ratio of the actual energy E_{meas} (measured energy during calibration) delivered to the drive weight assembly into the drive rod below the anvil, to the theoretical energy (E_{theor}) as calculated from the drive weight assembly. The measured number of blows (N) reported on the engineering logs are uncorrected. In sands, the energy losses due to rod

length and the effect of the overburden pressure should be taken into account (see IS EN ISO 22476-3:2005).

Soil Sampling

Three categories of sampling methods are outlined in EN ISO 22475-1:2006. The categories are referenced A, B and C for any given ground conditions and are shown in Tables 1 and 2 of EN ISO 22475-1:2006. Reference should be made to EN 1997-2:2002 for guidelines on sample class and quality for strength and compressibility testing. Samples of quality classes 1 or 2 can only be obtained by using Category A sampling methods.

Class 1 thin wall undisturbed tube samples (UT100) were obtained in fine grained soils and strictly meet the requirements of EN 1997-2:2002 and EN ISO 22475-1:2006. Soil samples for laboratory tests are divided into five classes with respect to the soil properties that are assumed to remain unchanged during sampling, handling transport and storage. The minimum sample quality required for testing purposes to Eurocode 7 compatibility (EN 1997-2:2002) is shown in Table A.

Table A – Details of Sample Quality Requirements

EN 1997 Clause	Test	Minimum Sample Quality Class
5.5.3	Water Content	3
5.5.4	Bulk Density	2
5.5.5	Particle Density	N/S
5.5.6	Particle Size Analysis	N/S
5.5.7	Consistency Limits	4
5.5.8	Density Index	N/S
5.5.9	Soil Dispersivity	N/S
5.5.10	Frost Susceptibility	N/S
5.6.2	Organic Content	4
5.6.3	Carbonate Content	3
5.6.4	Sulphate Content	3
5.6.5	pH	3
5.6.6	Chloride Content	3
5.7	Strength Index	1
5.8	Strength Tests	1
5.9	Compressibility Tests	1
5.10	Compaction Tests	N/S
5.11	Permeability	2

N/S – not stated. Presume a representative sample of appropriate size.

Samples recovered from trial pits or trenches meet the requirements of IS EN ISO 22475-1. It is highlighted that unforeseen circumstances such as variations in geological strata may lead to lower quality sample classes being obtained.

Groundwater

The depth of entry of any influx of groundwater is recorded during the course of boring operations. However, the normal rate of boring does not usually permit the recording of an equilibrium level for any one water strike. Where possible, drilling is suspended for a period of twenty minutes to monitor the subsequent rise in water level. Groundwater conditions observed in the borings or pits are those appertaining to the period of investigation. It should be noted however, that groundwater levels are subject to diurnal, seasonal and climatic variations and can also be affected by drainage conditions, tidal variations etc.

Engineering Logging

Soil and rock identification has been based on the examination of the samples recovered and conforms with IS EN ISO 14688-1:2002 and IS EN ISO 14689-1:2004. Rock weathering classification conforms to IS EN ISO 14689-1:2003 while discontinuities (bedding planes, joints, cleavages, faults etc) are classified in accordance with 4.3.3 of IS EN ISO 14689-1:2003. Rock mechanical indices (TCR, SCR, RQD) are defined in accordance with IS EN ISO 22475-1:2006.

Where peat has been encountered, samples have been logged in accordance with the Von Post Classification (ref. Von Post, L. 1992. Sveriges Gologiska Undersoknings torvinventering och nogra av dess hittils vunna resultat (SGU peat inventory and some preliminary results) Svenska Mosskulturforeningens Tidskrift, Jonkoping, Swedden, 36, 1-37 and Hobbs N. B. Mire morphology and the properties of some British and foreign peats. QJEG, Vol. 19, 1986.

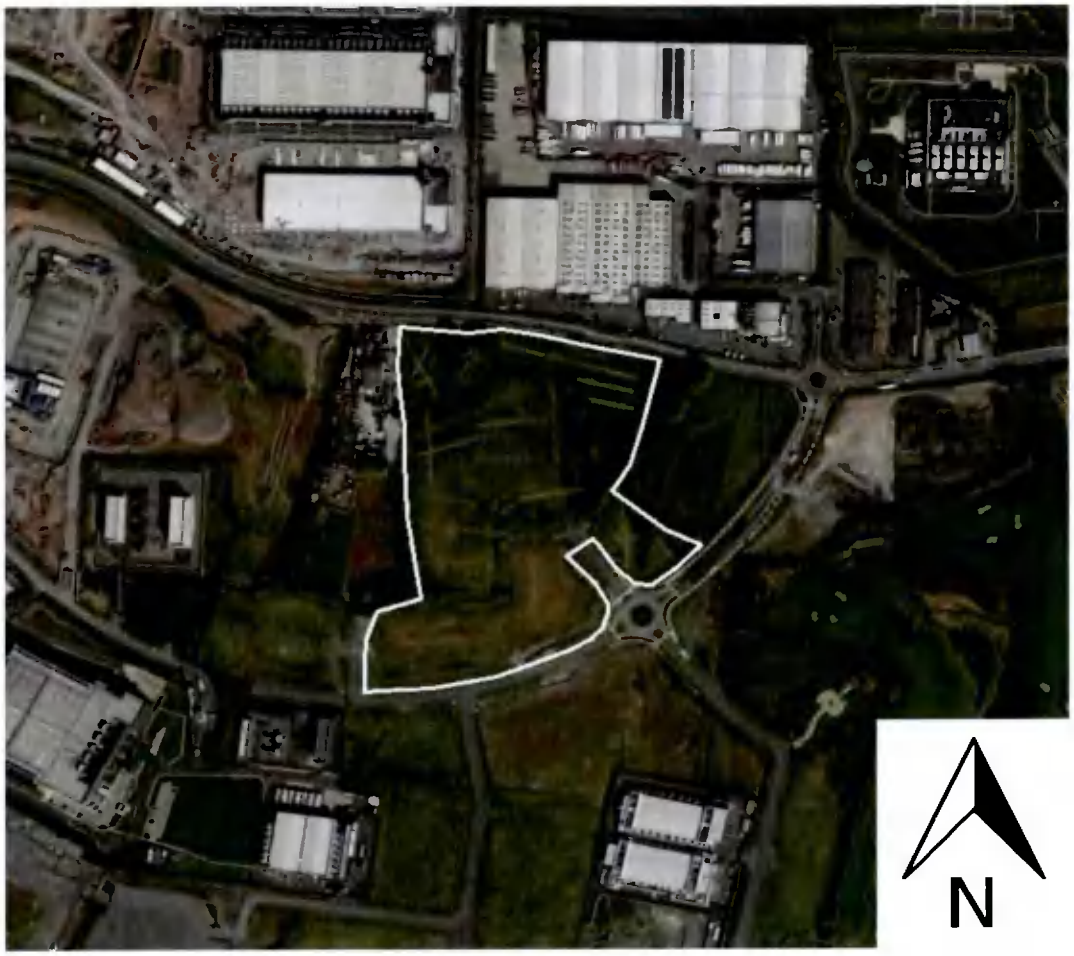
Retention of Samples

After satisfactory completion of all the scheduled laboratory tests on any sample, the remaining material will be discarded. Unless a period of retention of samples is agreed, it is our normal practice to discard all soil samples one month after submission of our final report.

1. INTRODUCTION

IGSL has undertaken a programme of ground investigation works at a greenfield site at Grangecastle, Dublin 22. The Project Apollo site is located between the New Nangor road (R134) and Profile Park as shown in Figure 1. The investigations were executed in accordance with BS 5930, Code of Practice for Site Investigations (2015) and EN 1997-2 Eurocode 7 Part 2 Ground Investigation & Testing and supervised by an IGSL engineering geologist.

Figure 1 – Site Location Plan (area outlined in white denotes the site)



Reproduced from Google Maps

The investigations were conducted at locations determined by Ramboll and included trial pits, cable percussive boreholes, rotary core drillhoiles, plate load tests and soakaway / infiltration tests. Geophysical surveying was carried out to measure in-situ soil resistivities. Groundwater monitoring standpipes were installled in the three rotary holes.

Laboratory tests were performed on a selection of samples and included classification (grading, Atterberg Limits), thermal resistivity, earthworks (MCV, CBR, Compaction) and soil stabilization trial mix testing using lime (calcium oxide). Chemical analyses tests included pH, sullphate, sulphur and derivation of equivalent pyrite contents. Specialist environmental testing ('Rilta Suite') was also undertaken on trial pit samples and groundwater samples.

This report presents the findings from the ground investigation and includes an evaluation of the field and laboratory test data. A discussion of the ground conditions and engineering recommendations (Ground Assessment) are presented. The locations of the exploratory points are shown in Appendix 13.

2. FIELDWORKS

2.1 General

The ground investigations were carried out in May 2021 and comprised the following:

- Trial pits (13 No.)
- Cable percussive boreholes (17 No.)
- Rotary core drillholes (3 No.)
- Plate load tests (13 No.)
- Soakaway / infiltration tests (3 No.)
- Geophysical survey (in-situ resistivity)
- Groundwater monitoring
- Surveying of exploratory locations

2.2 Trial Pits

Trial pitting was undertaken using an 8T tracked excavator. The trial pits are denoted TP 01 to TP13 and extended to depths of between 1.40 and 2.60m. The pits were logged and sampled by an IGSL engineering geologist in accordance with BS 5930 (2015) and Eurocode 7 Part 1. Bulk disturbed samples (typically 25 to 30 kg) were taken as the pits progressed. These were placed in heavy-duty polyethylene bags and sealed before being transported to Naas for laboratory testing. The trial pits were backfilled with the as-dug arisings and reinstated to the satisfaction of IGSL's site engineering geologist. The trial pit logs and photographs are presented in Appendix 1 and include descriptions of the soils encountered, groundwater conditions and stability of the pit sidewalls.

2.3 Cable Percussive Boreholes

Cable percussive boring (200mm diameter) was conducted at seventeen locations using a Dando 2000 rig. The boreholes are denoted BH01 to BH17 and terminated at depths of 1.70 to 2.90m. Boring commenced after scanning (CAT & Jenny) to verify the presence or absence of service ducts. Disturbed bulk samples were recovered at 1m intervals or change of strata during boring and these are denoted 'B' on the engineering logs.

Standard Penetration Tests (SPT's) were performed in the boreholes and given the nature of the soils, a solid cone was used. It is noted that the SPT N-Values reported are the number of blows for 300mm increment penetration (e.g. BH01 at 1.0m where N=12). These exclude the seating blow values, which represent the initial 150mm depth of penetration. Where partial penetration was achieved during testing, the number of blows is shown for the actual penetration depth achieved (e.g. BH03 at 2.00m where N=60/75mm). In accordance with Eurocode 7, the SPT hammer has been calibrated and the energy ratio (Er) value is incorporated on the engineering logs. It is highlighted that the SPT N-Values reported on the engineering logs are uncorrected for energy ratio.

Descriptions of the soils encountered, in-situ tests undertaken and samples recovered are presented on the borehole records in Appendix 2. Details of groundwater strikes and hard strata boring (i.e. chiselling) are also presented on the aforementioned records.

2.4 Rotary Core Drillholes

Rotary core drilling (holes denoted RC01, 02 and 03) was carried out using a tracked Beretta BT44 top-drive rig. The hydraulic rig utilised symmetrex drilling within the superficial deposits with coring techniques deployed in the underlying bedrock. The holes extended to depths of 10.0m and produced 78mm diameter cores using air mist flush. The cores were placed in 3m capacity timber boxes and logged in Naas, Co. Kildare by an IGSL engineering geologist. This included photography of the cores with a digital camera. Where rock core was recovered, a graphic fracture log is also presented alongside the mechanical indices. This illustrates the fracture state of the rock cores and allows easy identification of highly fractured / non-intact zones and discontinuity spacings. It should be noted that no correction for dip of the joints has been made and that the spacings shown are successive joint / core intersections within the core.

Groundwater monitoring standpipes were installed in each of the three rotary holes. The standpipes consisted of 50mm diameter HDPE pipework with proprietary 1mm slots and incorporated a pea gravel filter pack and cement / bentonite grout seal. Protective headwork covers were concreted in place at each monitoring point. The core log records are presented in Appendix 3 and this includes engineering geological descriptions, details of the bedding / discontinuities and mechanical indices (TCR, SCR and RQD's) for each core run. Core photographs are also presented in Appendix 3 and illustrate the structure and fracture state of the bedrock.

2.5 Plate Load Tests

Thirteen plate load tests were undertaken on the shallow or near surface sub-soils (0.4 to 0.6m). The tests determined modulus of sub-grade reaction (Ks) and equivalent CBR value. A 450mm diameter plate was used for the tests with kentledge provided by an 8T tracked excavator. Two load cycle tests were performed and the load / settlement plots, Ks and equivalent CBR values are presented in Appendix 4.

2.6 Soakaway Tests

Three infiltration tests were undertaken to assess the capability of the sub-soils for dispersion of storm water through a soakaway system. The infiltration testing was performed in accordance with BRE Digest 365 'Soakaway Design'. To obtain a measure of the infiltration rate of the sub-soils, water is poured into each test pit, and records taken of the fall in water level against time. This procedure is repeated to ensure saturation of the sub-soils. The infiltration rate is the volume of water dispersed per unit of exposed area per unit of time, and is generally expressed as metres / minute or metres / second. Designs are based on the slowest infiltration rate, which is generally calculated from the final cycle. The soakaway records are presented in Appendix 5.

2.7 Groundwater Monitoring

Groundwater monitoring was caried out following the fieldworks period. Groundwater levels were measured using an electric dipmeter and the findings are shown in Appendix 6. Groundwater samples were taken from the standpipes installed in the three rotary holes while surface water samples were collected from two locations (denoted Ws1 and WS 2 on the laboratory test records in Appendix 11).

2.8 Geophysical Survey

APEX Geophysics Limited carried out in-situ resistivity surveying at the site. The Wenner Constant Separation technique was used to determine soil resistivity values. The Apex report is presented in Appendix 7.

2.9 Surveying of Exploratory Hole Locations

Following completion of the exploratory works, surveying was carried out using GPS techniques. Co-ordinates (x, y) were measured to Irish Transverse Mercator and ground levels (z) established to a Malin Head. The co-ordinates and ground levels are shown on the exploratory hole logs with the approximate locations plotted on the exploratory hole plan in Appendix 13.

3. LABORATORY TESTING

Geotechnical laboratory testing was carried out on selected trial pit samples and on rock core specimens. The soils testing focused on classification (particle size grading, Liquid / Plastic Limits), thermal resistivity and earthworks assessment (Moisture Condition Value (MCV), California Bearing Ratio (CBR), Proctor compaction (2.5kg rammer).

In addition, trial mix testing for ground improvement (soil stabilization) was undertaken to evaluate the potential re-use of the soils using lime or a combination of lime and cement to produce a high strength engineering fill. Samples were tested in the MCV apparatus and CBR moulds after mixing with 1,2 and 3% lime and lime (1!%) and cement (2%). The lime (calcium oxide) was provided by Clogrennane, CRH Group. The geotechnical testing was undertaken in accordance with BS 1377 (1990) and the test results are contained in Appendix 8.

Point load strength index (PLSI) tests and uniaxial compressive strength [UCS] tests were conducted on rock core specimens and the results presented in Appendix 9.

Soil samples from the trial pits were selected for Waste Acceptance Criteria (WAC) analysis. The results are contained in Appendix 10 and can be used to classify the material with regard to disposal off-site to landfill.

Groundwater and surface water samples were retrieved and the test results are presented in Appendix 11. Chemical analysis tests (i.e. total sulphur, acid soluble sulphate & water soluble sulphate) were performed on rock core specimens and results are incorporated in Appendix 12. Finally, chemical analysis tests (pH, sulphate & sulphur) were carried out on soil samples treated lime or a combination of lime and cement after curing for 7 days.

4. GROUND CONDITIONS

4.1 Ground Profile

The investigations have revealed the ground conditions at the Grangecastle site to comprise:

- TOPSOIL consisting of brown slightly sandy silty CLAY / SILT with occasional rootlets
- Glacial Till - firm mottled grey and brown sandy gravelly CLAY / SILT with a medium cobble content
- Glacial Till - stiff to very stiff dark grey very gravelly SILT/CLAY with a medium cobble content
- Variably weathered rockhead recovered as dark grey clayey silty GRAVEL shy of trial pit termination. Gravel and cobbles range from medium strong limestone to weak mudstone or shale
- Bedrock consisting of dark grey and black LIMESTONE with thin horizons of fissile SHALE or MUDSTONE

4.2 Superficial Deposits

4.2.1 TOPSOIL

Topsoil mantles the site and typically extends to depths of between 0.3 and 0.50m bgl. As the field was formerly worked as tillage the thickness of topsoil is not unexpected given the annual ploughing of the upper soils.

4.2.2 Glacial Deposits

Beneath the topsoil layer, mottled brown sand grey sandy gravelly SILT/CLAY was intercepted. It was noted to contain a low cobble content. The lower till has a distinctive dark grey / black cplour and is referred to as boulder clay or glacial till. This represents a heavily over-consolidated ablation till and is often referred to as 'Dublin Boulder Clay. The upper mottled brown and grey glacial till a glacial weathering product. At depths of c.0.6 to 0.7m bgl the till displayed an increase in strength (typically stiff), becoming increasingly gravelly with cobble-sized clasts. The clasts range from subrounded to subangular and are dominated by limestone derived from the parent bedrock.

A series of index or classification tests were carried out on the trial pit samples and results are presented in Appendix 8. Moisture contents are quite variable with the majority in the 10 to 19% envelope. The particle size distributions show the glacial soils to be well graded with typical 'straight-line' type profiles (refer to Figure 4). Fines contents (<425micron) are largely between 52 and 70%. The Atterberg Limits show the glacial till deposits to be a mixture of low plasticity (CL) and intermediate (CI) CLAY. Plasticity Indices range from 10 to 22% (refer to Figure 3).

Figure 2 – Images Showing Glacial Soils in Trial Pits

TP 1

TP 5

Figure 3 - Atterberg Limit Plot (Liquid & Plastic Limits)

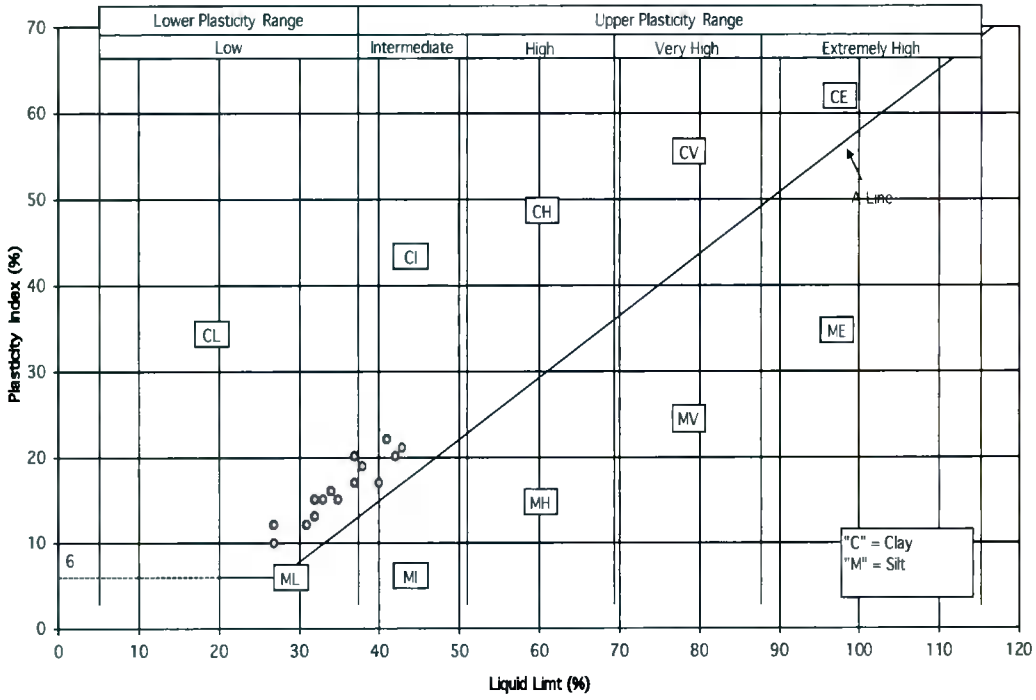
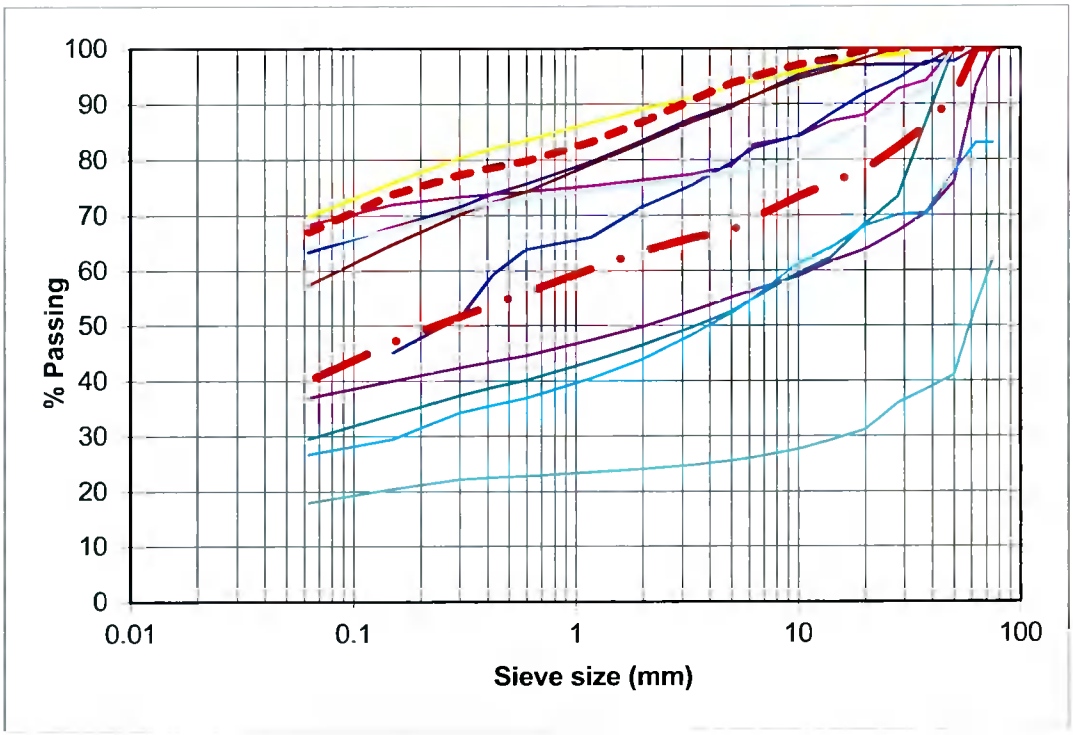


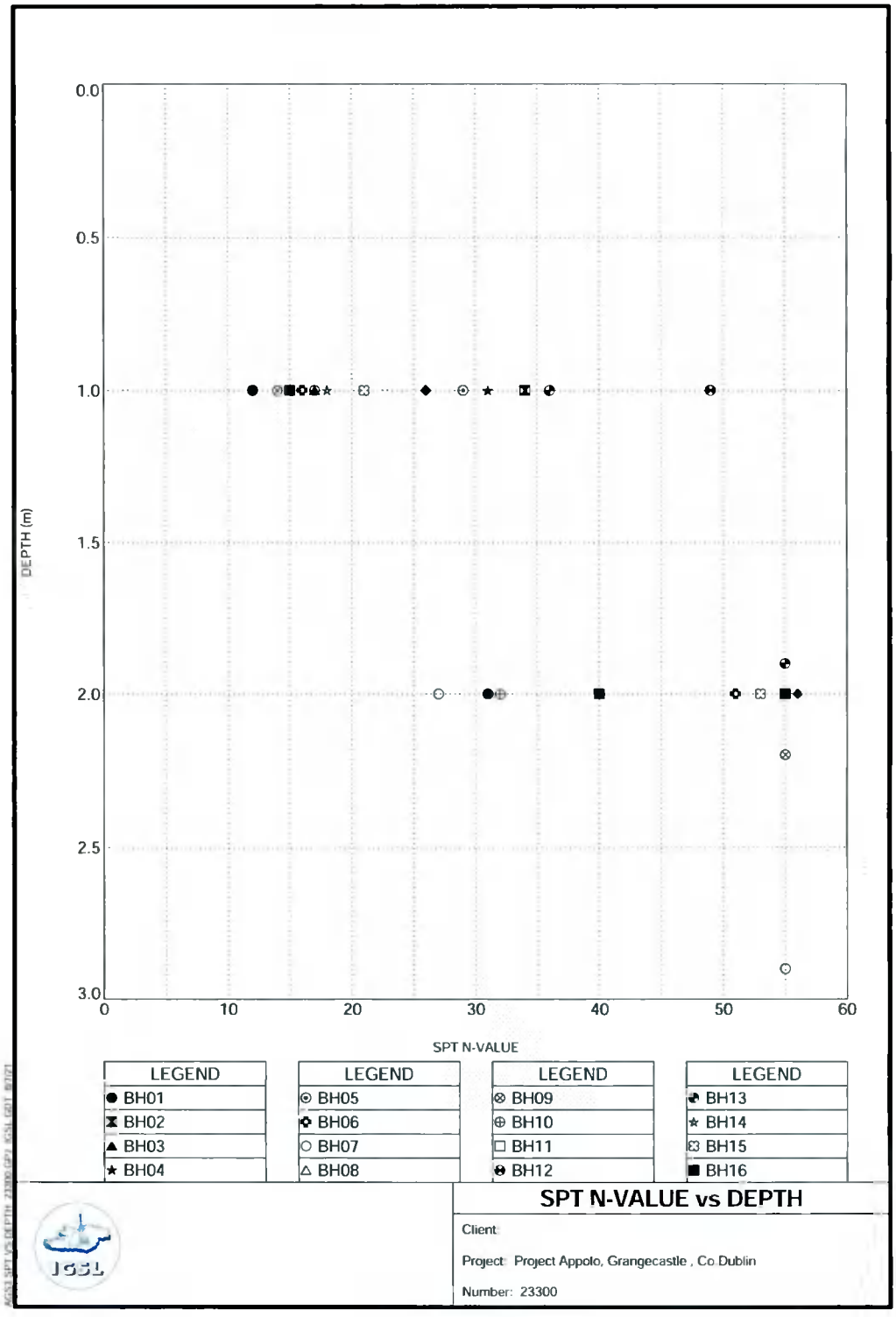
Figure 4 - Particle Size Distribution Envelope



Standard Penetration Tests (SPT's) were conducted in the cable percussive boreholes to establish stiffness or shear strength. An SPT data plot has been prepared and is presented in Figure 5. Using the Stroud & Butler correlation between SPT N-Value and undrained shear strength (where Cu ≈ 4 to 6N) the upper mottled grey brown glacial till is classed as generally medium strength (firm) as

defined in Table 6 of EN 14688-2:2087. It should be noted that N-Values <15 were recorded in some instances and suggest inherent variations in the strength of the upper glacial till. The dark grey / black glacial till is classed as high or very high strength – in some instances this unit can be classed as extremely high strength (>300 kN/m^2) and has the structure of a weakly cemented mudrock.

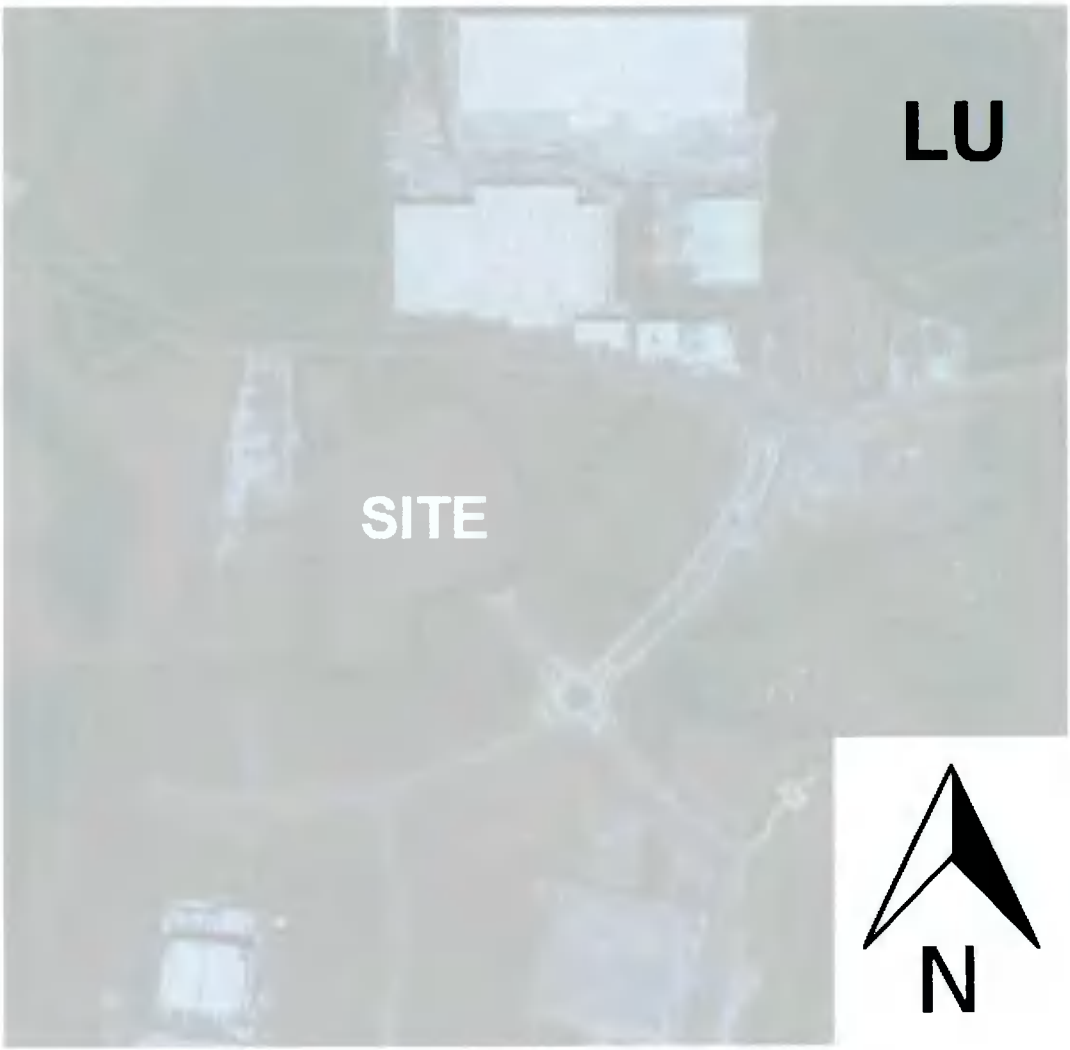
Figure 5 - SPT Data Plot (N-Values v Depth)



4.3 Bedrock

Reference to the GSI map for the area (Figure 6, 1:100,000 Solid Geology series) shows that the site is underlain by the undifferentiated Dublin Calp Limestone which largely comprise the Dublin Basin sequence (McConnell & Philcox, 1994B). Bedrock typically consists of varied dark grey to black basinal limestone with interbeds of mudstone or shale. Stratigraphic sequences in the Calp Limestone comprise gradationally interbedded argillaceous limestone (i.e. impure limestone with clay minerals) with calcisiltite limestone and anoxic calcareous mudstone / black shale which tends to be very closely or very thinly laminated (McConnell & Philcox, 1994B).

Figure 6 - Bedrock Geological Map for Site (Adapted from McConnell & Philcox, 1994A)



The rotary drillholes show that bedrock typically consists of dark grey to black, strong fine grained predominantly argillaceous or muddy LIMESTONE with partings or thin interbeds of shale or mudstone (core specimens illustrated in Figure 7). Rotary coring proved bedrock or 'rockhead' at depths between 2.60m and 3.0m bgl. This correlates well with refusal depths in the cable percussive boreholes which mainly terminated at depths of 2.3 to 2.9m. The mechanical indices show that total core recovery (TCR) was excellent (100% in all instances) while rock quality designation (RQD) values mostly range from 50 to 70% though RQD values in RC03 are noticeably lower reflecting a more closely fractured or jointed cores. This is not uncommon in the Calp formation in West Dublin where rapid changes occur in both composition and fracture state.

Discontinuity spacings in the cores generally range from closely spaced (60 to 200mm) to medium spaced (200 to 600mm) with dips ranging from sub-horizontal, to 45°. The discontinuity surfaces are typically smooth to rough, planar to curviplanar and locally exhibit clay smearing in tight to moderately open apertures. Local iron oxide staining was also remarked during logging and clcite veining was apparent throughout.

Figure 7 – Images showing core recovery

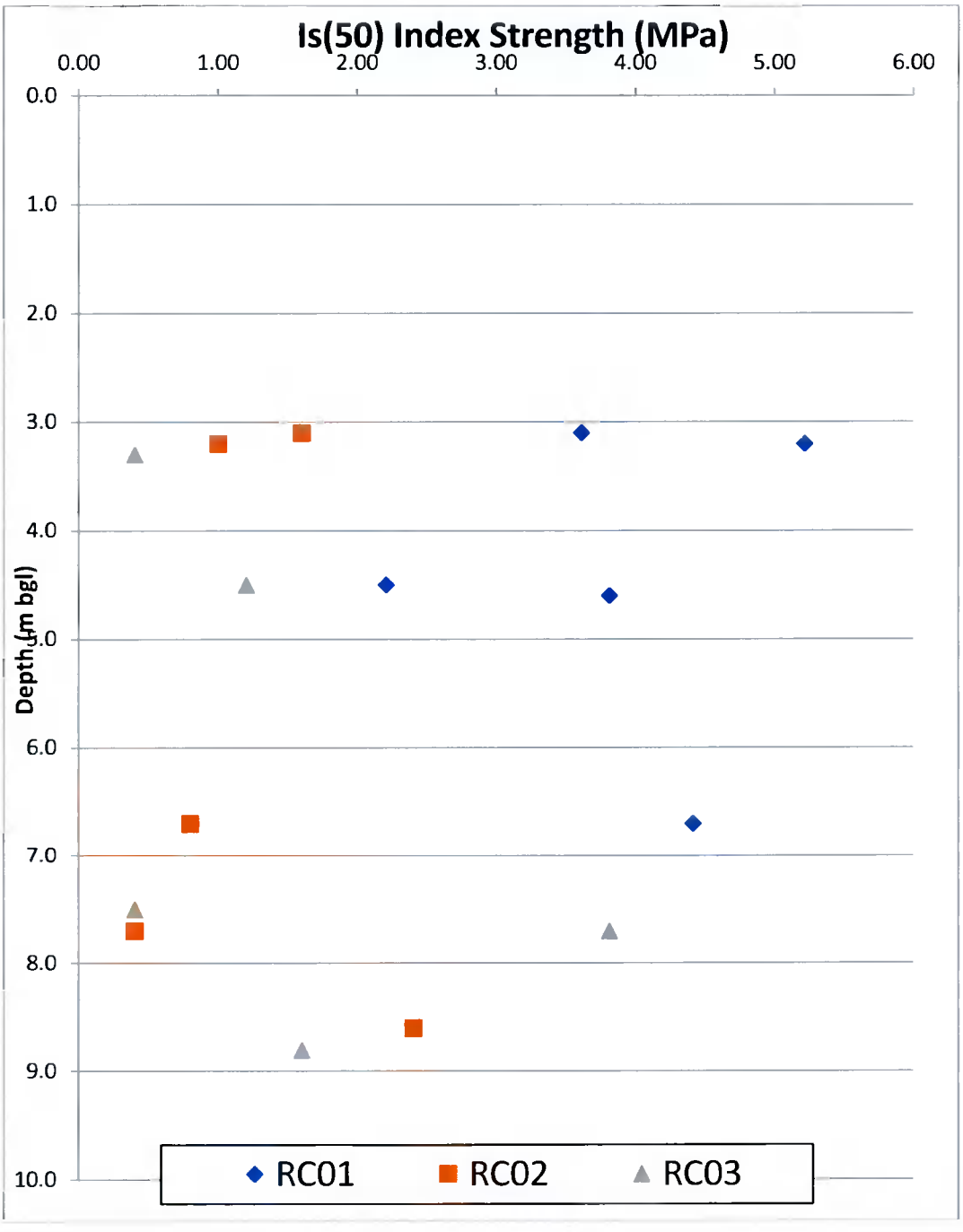
RC 01 (3.0 to 6.0m)

RC02 (3.0 to 6.0m)

RC03 (3.0 to 6.0m)

The point load strength index (PLSI) test data produced $I_s(50)$ values ranging from 0.4 to 5.22 MPa with a mean value of 2.20 MPa (See Figure 6). Using a correlation value (K) of 20 the cores are classed as weak to very strong but mostly strong. The range of strengths obtained from the PLSI testing can be observed by the data scatter in Figure 8.

Figure 8 – Point Load Strength Data Plot



Unconfined Compressive Strength [UCS] tests were undertaken on three core specimens and produced values of 43, 48 and 90 MPa respectively. Given the interbedded nature of the bedrock it would be reasonable to assume some test specimens would comprise mudstone. The reason for the absence of mudstone samples is largely due to the weak strength of this lithology. As the mudstone is not as well cemented as the limestone, it is found in smaller core lengths, i.e., its fracture spacing is generally very close to close (20 – 200mm). Bieniawski & Bernede (1979) state that a height to diameter ratio of 2.5-3.0 is recommended for UCS test specimens. This would require test specimens of at least 220mm in length.

4.4 Groundwater & Infiltration

Groundwater strikes or seepages were encountered in each of the trial pits and in a number of cable percussive boreholes. In the case of the trial pits, groundwater was reported as seepages at depths mainly between 1.2 and 1.9m.

In the cable percussive boreholes groundwater was intercepted at depths of 1.6 to 2.4m in BH's 1, 7, 8, 10, 12 and 17 while the remainder were noted to be dry. Where groundwater was absent this may be attributable to the casing sealing potential seepages. Groundwater was intercepted at depths of 2.50, 2.60 and 3.00m during rotary drilling while the standpipes show groundwater levels of 0.97 to 1.89m in late June 2021.

Table 1 – Summary Details of Groundwater Levels in Rotary Hole Standpipes

BH	Ground Elevation (m OD)	Groundwater Strike during Drilling	Groundwater level End of drilling	Groundwater Level (21.6.21)
RC01	72.50	2.50m	1.70m	0.97m
RC02	73.25	2.60m	1.70m	1.54m
RC03	73.51	3.00m	2.10m	1.89m

Soakaway tests (3 No.) were conducted to evaluate the infiltration characteristics of the upper soils for dispersion of storm water through a soakaway system. The tests demonstrate or confirm low infiltration characteristics in the upper fine grained soils. This is not unexpected given the soil composition and fines contents determined by the particle size distribution tests.

5.0 GROUND ASSESSMENT & ENGINEERING RECOMMENDATIONS

5.1 General

In light of the investigation findings, a ground assessment has been prepared and addresses the following:

- Bearing Capacity & Foundations
- Floor slabs
- Earthworks & Ground Improvement
- Pavement Foundation
- Groundwater
- Slope / Batters
- Buried Concrete & Potential for Pyritic Heave
- Waste Acceptance Criteria [WAC] & Environmental Testing

5.2 Bearing Capacity & Foundations

The investigations show that the stiff to very stiff glacial till has an undrained shear strength of the order of 90 to 100 kN/m^2 and therefore should provide a safe or allowable bearing pressure of 175 to 200 kN/m^2. At a bearing pressure of this magnitude, total settlement (immediate elastic and long-term consolidation) would be expected to be <10mm. Based on the trial pit observations, foundations would need to be placed at depths of at least 0.6 to 0.8m (locally increasing to approximately 1m) to achieve the aforementioned allowable bearing pressure. Variations in excavation depths would not be uncommon in Grangecastle where limestone rafts have been thrust upwards and caused disturbance (often resulting in lower shear strength) to the overlying glacial till or boulder clay.

Depths to bedrock and rock mass quality was established by the three rotary core drillholes which are in good agreement with the 'refusal' depths in the cable percussive boreholes. These confirmed the existence of bedrock at levels varying from 2.60 to 3.0m. The upper bedrock recorded in the trial pits is typically weak to medium strong shaley limestone while the cores shown in Figure 7 demonstrate competent bedrock. Foundations placed on the upper bedrock or rockhead could be sized using a safe or allowable bearing capacity of 750 kN/m^2. This may appear somewhat conservative but is recommended to reflect the inherent variations in rockhead / upper rock mass characteristics, especially the presence of fissile shale or calcareous mudstone. There may be instances where pockets of highly weathered bedrock are encountered (mainly extremely weak mudstone) – this can be quite common in the Grangecaste / Baldonnel area. In these instance, extremely weak or friable mudstone should be removed and replaced with lean mix or low-grade concrete.

With steeply inclined or folded bedding / discontinuities, excavations in the upper Calp Formation tend to produce a saw-tooth profile. All loosened material (due to bucket excavation) should be removed before lean mix concrete is placed. It is important that the upper bedrock is not over-excavated (a common occurrence in the Calp formation) as this leads to excess material being generated and increases in concrete volumes. For this reason, the input of a competent engineering geologist / geotechnical engineer should be considered during foundation construction works. The engineering geologist / geotechnical engineer could advise on adequate or satisfactory excavation depths and prepare foundation inspection records.

5.3 Floor Slabs

The floor slab loadings for the proposed data centre buildings are unknown, however the firm glacial till material which mantles the site is considered suitable for typical industrial floor slab loadings (i.e. 30 to 40 kN/m^2). A minimum formation CBR value of 3% is recommended (as determined by plate load test method) before SR21 hardcore is placed and compacted. If particularly heavily loaded ground bearing floor slabs are required, then an enhanced modulus layer' should be considered

using T0 unbound granular fill. The purpose of this would be to provide a robust foundation layer to support heavily loaded areas. Any low strength soils (i.e. shear strength <50 kN/m^2) should be removed prior to placing granular fill.

Imported granular fill 'hardcore' used in any foundation application or under concrete floor slabs at the site should meet the requirements of Annex E of SR 21;2014+A1;2016. It is recommended that T0 Struc is used in conjunction with T1 Struc. The T0 and T1 hardcore fills should be tested (independent of the quarry source) before delivery to site to ensure that they meet the physical, durability, chemical and mineralogical characteristics as set out in the aforementioned Annex E of SR 21;2014+A1;2016. Independent testing on samples of the proposed source hardcore is strongly recommended in advance of the material being used on the Grangecastle site. As a minimum, particle size gradings, chemical tests and simplified petrology are advised to screen the material and assess compliance with Annex E, SR21;2014+A1;2016.

Compaction / Placement of imported granular fill or hardcore will need to achieve a low air voids (<5%) and ensure that settlement is not an issue for ground bearing floor slabs. In the case of layer thickness, number of roller passes and mass per metre and width of roll should meet the guidelines in IS 888:2016. Layer thickness should not exceed 200mm using a smooth drum roller with a mass per metre of roll of not less than 5400 kg.

5.4 Earthworks & Ground Improvement

Moisture Condition Value (MCV), California Bearing Ratio (CBR) and Proctor compaction tests (2.5kg rammer) were carried out on a selection of samples retrieved from the trial pits. The MCV tests were conducted on samples at their received moisture content and following mixing and curing with lime (calcium oxide). The lime used in the trial mixes was supplied by Clogrennane. For the MCV tests, the lime was mixed with the soil and allowed to air cure in the laboratory (temperature of the order of 15 to 16°C) for a period of 1 hour. The samples were then placed in the MCV apparatus and tested.

Summary details of the MCV tests are presented in Table 2. MCV tests at 'natural moisture content produced values ranging from 9 to 14.2. For general cohesive fill (Class 2) a minimum MCV of 8 is normally required for acceptable Class 2 soils for re-use in earthworks (mainly embankments). The results show that each of the tests satisfy this criterion. There was a notable increase in MCV following the addition of 1, 2 or 3% lime (refer to Table 2). The MCV results show that the upper soils have the capability to produce acceptable Class 2 fill (for use as fill in embankments or make-up under pavement areas).

Table 2 – Summary of Moisture Condition Value (MCV) Tests

Sample Location	Sample Depths (m)	MCV @ NMC	MCV with 1% Lime	MCV with 2% Lime	MCV with 3% Lime
TP01	0.5	9	12.4	13.8	16.8
TP 03	1.00	14.2			
TP 06	0.60	10.6	12.6	17	17.2
TP07	1.00	12			
TP 10	0.50	12.8			
TP12	0.50	10.3	13.2	15	16.4

Notations:
NMC = Natural Moisture Content
MCV = Moisture Condition Value

CBR tests were conducted on samples in their nature state (unsoaked) and on soaked samples (20 degrees in water tank) after mixing with lime or lime-cement and curing for 3, 7 and 14 days respectively. Summary details of the stabilization trial mix CBR tests are presented in Table 3. The CBR values at natural moisture content range from 2.1 to 23.%. Not unexpectedly, the CBR tests after 3, 7 and 14 days of curing (soaked at 20°) showed a significant increase following the addition of lime or a combination of lime and cement binders. The laboratory trial mix results demonstrate that a high strength engineered fill can be obtained by ground improvement techniques. A minimum CBR value of 15% is generally specified for structural applications such as heavily loaded floor slabs or pad foundations. The 3 day test results with 2% lime suggest that this should be achievable. The percentage binder(s) will depend on weather conditions - very wet weather./ heavy rainfall would soften the low plasticity glacial soils and require a higher percentage binder to be applied.

Table 3 – Summary Details of Laboratory CBR Tests

3 Day Tests

Sample Location	Sample Depths (m bgl)	CBR (%) At NMC	CBR (%) 1% lime	CBR (%) 2% Lime	CBR (%) 3% Lime	CBR (%) 1% Lime & 2% Cement
TP 1	0.5	23	27 (3 day)	35 (3 day)	38 (3 day)	49 (3 day)
TP 12	0.50	9	11 (3 day)	15 (3 day)	29 (3 day)	41 (3 day)
TP 6	0.60	2.1	7 (3 day)	13 (3 day)	19 (3 day)	28 (3 day)

7 Day Tests

Sample Location	Sample Depths (m bgl)	CBR (%) At NMC	CBR (%) 1% lime	CBR (%) 2% Lime	CBR (%) 3% Lime	CBR (%) 1% Lime & 2% Cement
TP 1	0.5	23	42	39	45	57
TP 12	0.50	9	15	20	36	42
TP 6	0.60	2.1	10	18	24	34

14 Day Tests

Sample Location	Sample Depths (m bgl)	CBR (%) At NMC	CBR (%) 1% lime	CBR (%) 2% Lime	CBR (%) 3% Lime	CBR (%) 1% Lime & 2% Cement
TP 1	0.5	23	38	41	51	60
TP 12	0.50	9	20	20	40	65
TP 6	0.60	2.1	12	26	29	40

Notations:
NMC (Natural Moisture Content)
CBR value shown is mean of top and bottom result

Proctor compaction tests (2.5kg rammer) were carried out on a number of samples to determine optimum moisture contents and maximum dry densities and summary details are presented in Table 4. Inspection of the data shows that optimum moisture contents (OMC) generally range from 11 to 12% with maximum dry densities (MDD) of 1.87 to 1.97 Mg/m^3. The tests demonstrate the soils tested are at or slightly wet of optimum. This has implications for soil modification and stabilization works in dry warm weather – the soils may need to be scarified (addition of water by spraying) to ensure that excess air voids do not manifest.

Table 4 – Summary Details of Compaction Tests

Sample Location	Sample Depths (m)	% Retained 20mm Sieve	NMC (%)	OMC (%)	MDD (Mg/m^3)
TP 1	1.0	31	15	15	1.62
TP 3	1.0	60	17	11	1.88
TP 6	1.0	26	5	12	1.87
TP 7	1.0	61	13	11	1.93
TP 10	0.5	72	11	11	1.87
TP 12	1.0	7	16	11	1.97

Notations:
NMC = Natural Moisture Content
OMC = Optimum Moisture Content
MDD = Maximum Dry Density

For ground improvement projects the percentage of lime or cement binder(s) to be added would be at the direction of the specialist contractor and governed by MCV at natural moisture content and weather conditions (temperature, moisture and humidity). Based on the trial mix test results at least 2% lime would be anticipated to achieve a high strength engineered fill. Control of air voids in lime or lime-cement engineered fill is critical, especially where structural loads and ground bearing floor slabs are proposed. A maximum air voids content of 5% is recommended and the engineered fill should be compacted to achieve 95% of Proctor optimum (based on the 2.5kg rammer method).

The earthworks contractor should appreciate that the fine-grained glacial soils at the site will be particularly susceptible to degradation under trafficking (rutting) with rubber wheeled dump trucks (e.g. Volvo A25 or similar). Rutting will present a significant challenge for the earthworks contractor as successive layers are placed and compacted. Where the glacial till material (acceptable Class 2 to Series 600 of the NRA SRW) is used without modification, static rolling (without vibration) is advised using a smooth drum roller with a mass per metre width of roll of not less than 5400 kg. If vibration during rolling is proposed, then care must be taken not to induce excess pore water pressures as this would lead to 'cow-bellying' and prominent rutting. A minimum of 6 roller passes is recommended with the aforementioned roller.

Groundwater management will be critical to the success of the earthworks and possible stabilization operations at the Grangecastle site and should be carefully considered by civil engineering contractors. A series of perimeter drains, internal drains (herringbone arrangement) and sump pumping is anticipated. Contractors should seek specialist advice on groundwater control measures (dewatering) and risks associated with bulk excavation to depths of up to 3m followed by ground improvement works. Geotechnical quality assurance testing is a vital component of ground improvement works, especially where structures are to be built or founded on lime or cement engineered fill. Testing during the course of ground improvement / earthworks should include MCV, in-situ density, TRL DCP and plate load. The testing frequency should be agreed with the ground improvement specialist but should be sufficiently detailed to allow sign off on the key properties (CBR, air voids and relative compaction).

5.5 Pavement Foundation

CBR values were established by plate load test method and the results are summmarised in Table 4. Laboratory CBR tests were also conducted (samples re-compacted at their natural moisture content) and summary details are shown in Table 5. The CBR values by plate test method are considered most realistic for the in-situ conditions. Inspection of the data in Table 4 shows CBR values at Cycle 1 (initial load) mostly range from 2.2 to 3.4% with an increase on Cycle 2 (re-load).

Table 5 – Summary Details of Plate Load Tests

Plate Test Location	Test Depth (m bgl)	CBR Cycle 1 (%)	CBR Cycle 2 (%)
PBT 1	0.5	3.5	5.1
PBT 2	0.5	2.4	9.4
PBT 3	0.6	2.2	2.6
PBT 4	0.5	3.1	4.2
PBT 5	0.5	2.8	4.9
PBT 6	0.6	4.9	11.5
PBT 7	0.5	1.3	3.6
PBT 8	0.5	2.3	5.3
PBT 9	0.4	2.6	3.1
PBT 10	0.4	5.3	8.8
PBT 11	0.4	3.4	4.2
PBT 12	0.4	1.6	2.5
PBT 13	0.4	3.3	4.0

In accordance with the Design Guidance for Road Pavement (HD 25), the lower-end equilibrium CBR values should be used to determine appropriate capping layer thickness for roads or pavements. Given the CBR values from the plate load tests, a CBR design value of 2.5 to 3% would not be unreasonable for determination of capping and sub-base pavement thickness. It is highlighted that the CBR value on the indigenous soil formation would depend greatly on the effectiveness of drainage, water management and tome year (seasonality plays a major role). If drainage is not adequate then the sub-grade stiffness would diminish greatly and a greater thickness of capping (or the use of a starter layer) would have to be implemented.

Taking a design CBR value of 2.5 to 3% for the upper glacial till, then a minimum 6F capping thickness of 600mm with a sub-base thickness of 150mm would be advised to support the road pavements. If the roads are to be used for construction traffic or access (e.g. ready mix concrete. hardcore deliveries, steel erection etc) and given the potential for rutting (with rubber wheeled plant or trucks, consideration should be given to using a starter layer (i.e. TII SRW Series 6A/6B granular fill). For heavily trafficked roads (access roads during construction) approximately 500mm of Class 6A / 6B material could be used in conjunction with 300mm of 6F capping. This may appear somewhat conservative but is recommended from our experience of earthworks in the Grangecastle / City West area.

The laboratory trial mix testing shows that the soils when modified and stabilized by lime and cement have the capability to produce a stabilised capping (CBR> 30%) as an alternative to imported Class 6F material. The key issue or concern with stabilized capping is the potential for inclement weather to cause degradation, especially if it is used in roads or pavement areas which act as temporary haul roads. The capping would need to be protected as soon as compaction is completed, otherwise there is a strong likelihood that surface water and trafficking would lead to deterioration / degradation. A field compaction trial is strongly advised to assess the performance of the SSM in a field environment (especially pulverization and air voids). If / when a field compaction trial is completed (suggest 10m x 20m with 3 layers or lifts) a trafficking trial is recommended to evaluate the performance of the SSM under trafficking. A loaded dump truck (Volvo A25 or similar) should be used to stress the SSM and investigate whether rutting or degradation occurs.

5.6 Groundwater

As noted in Section 4.4, groundwater strikes were reported during trial pit excavation with inflows mainly classed as seepages with standing water noted in some instances. The monitoring wells installed in the rotary hole standpipes reported standing groundwater levels of between 0.97 and 1.89m in late June 2021. If deep excavations are required for the project (in bedrock) then provision should be made to design for uplift or buoyancy with a long term equilibrium groundwater level of 1m bgl.

Groundwater levels will fluctuate over the course of the year with seasonality expected to have an influence. Where groundwater is encountered in open excavations, a combination of perimeter drains (open drains) connected to strategic sumps could be used to control groundwater. If the site development or earthworks commence in winter or early summer the standpipes should be monitored to assess the impact of surface water recharge on groundwater levels.

5.7 Slopes / Batters

The fine grained glacial till soils will be susceptible to softening and degradation with surface water and/or groundwater ingress likely to give rise to a reduction in shear strength. This should be considered in risk assessments for excavations (drainage, foundations etc). A maximum slope angle of 1V to 1.5H (33°) is recommended for temporary excavations or batters in the firm / stiff glacial till. Site operatives or personnel should not enter unsupported excavations and should be informed of potential risks.

Where site operatives or engineering staff work in close proximity to temporary slopes or batters, these should be inspected and approved by a suitably experienced civil engineer, preferably with geotechnical experience. Where there is a risk of spalling in excavations, the use of a geogrid or galvanized mesh is recommended. The geogrid or mesh should be anchored at the top and bottom of the ridge face to contain particles such as gravel, cobbles and / or boulders that may become dislodged.

5.8 Prorection of Buried Concrete from Sulphate Attack & Pyrite Oxidation

Chemical analysis tests were carried out on soil and rock core samples. The tests ion the rock cores included total sulphur, acid soluble sulphate and water soluble sulphate determined in acordance with EN 1744 methods. A summary of the chemicall results is presented in Table 6.

Table 6 - Summary Details of Chemical Analysis Tests on Rock Cores

Sample Location	Depth (m)	WSS (mg/l)	TS (%)	ASS (%)	TPS (SO_4 %)	EP (%)
RC01	3.5	254	0.86	0.07	2.58	1.56
RC02	3.1	323	0.59	0.08	1.77	1.05
RC03	3.1	455	0.47	0.08	1.41	0.82

Notations:

WSS – Water Soluble Sulphate, ASS – Acid Soluble Sulphate or Total Sulphate, TS – Total Sulphur, TPS – Total Potential Sulphate EP – Equivalent Pyrite Content

Inspection of Table 6 shows that the total sulphur contents on the rock core specimens range from 0.47 to 0.86% while total sulphates or acid soluble sulphates vary from 0.07 to 0.08%. Equivalent pyrite contents were calculated (% FeS_2 = 0.623 x OS) and range from 0.82 to 1.56%. Assuming mobile groundwater conditions at the site, pH >5.5 and with total potential sulphate SO_4 of up to 2.58%, concrete founded within the upper bedrock will be exposed to sulfate ions. Reference to Section C5 (Box C8) of BRE Special Digest 1 (2005) shows that concrete in pyritic ground which is initially low in soluble sulphate does not have to be designed to withstand high potential sulphate class unless it is exposed to ground which has been disturbed to the extent that pyrite might oxidise and the resultant ions reach the concrete.

The TPS values highlight the potential for sulphates to be generated from oxidation of sulphides (e.g. pyrite) in excavated or disturbed ground. Based on the chemical test results and known composition of the Calp formation,, design sulphate class DS-5 is recommended for concrete placed or buried in the upper bedrock. Where foundations or concrete floor slabs are placed solely on or in the glacial till then DS-1 sulphate class would be appropriate.

To minimize the risk of oxidation, excavations in the upper bedrock should be blinded without delay. In practical terms, this means concrete blinding works should be undertaken within 48 hours of exposure. The guidance given in IS EN 206;2013 (Concrete: Specification, Performance Production and Conformity) states that the most onerous value for a single chemical characteristic determines the class. In terms of concrete manufacture to IS EN 206-1:2002, it would be prudent to have concreted manufactured to Class XA2 where it is placed on or within the upper bedrock.

Bedrock generated from excavations should not be used beneath structures in any form, most especially in areas such as concrete slabs, concrete pavements or ground bearing floor slabs. It could be stockpiled and considered for use as general fill in site compounds, landscape berms and as TII SRW Class 1 fill in embankments. It is highlighted that argillaceous sedimentary rocks (i.e. muddy limestone, calcareous mudstone or shale, etc.) have high potential to give rise to degradation (i.e. poor durability and soundness) and slaking. Imported granular fills (particularly Series 600 and 800 material) should be thoroughly examined, tested and approved in advance of being used in the project.

Chemical analysis tests (pH, sulphate and sulphur) were determined on soil samples cured for 7 days following the addition of lime or lime and cement. The tests produced pH values of 12.5 with acid soluble sulphate contents of 0.08, 0.09 and 0.18% respectively. Total sulphur contents ranged from 0.03 to 0.06% with water soluble sulphate contents <10 mg/l in all instances. The tests demonstrate that Design Sulphate Class DS-1 would be appropriate for buried concrete in lime / cement treated soils.

5.9 Waste Acceptance Criteria [WAC] & Environmental Testing

Soil samples (13 No.) were selected from the trial pits to assess compliance twith the criteria set out in the 2002 European Landfill Directive (2003/33/EC). The samples were acquired from indigenous glacial till horizons. From the resultant testing, each proved compliant with Waste Acceptance Criteria and therefore would be accepted by an inert landfill. No asbestos was detected in screens conducted on the samples.

In relation to sending the analysed sample results to an EPA-licenced Soil Recovery Facility, the limits for acceptance at the nominated facility should be checked against the results listed in the test record sheet - final report. However, in the case of the samples tested, when compared to the published EPA guidelines including those parameters listed in Table 3.3 of the EPA (2020) document (maximum concentrations and / or trigger levels in soil and stone for soil recovery facilities) for Geochemical Domain 2 (Carboniferous Limestone and related rocks), the following samples (*TP01 at 0.30m, TP02 at 0.50m, TP07 at 0.50m & TP11 at 0.40m).*showed exceedances for at least one metal over and above the maximum concentrations / trigger levels permitted in Domain 2 soil and stone

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11.0 S.R. 21:2014+SA1:2016 Guidance on the use of I.S. EN 13242:2002+A1:2007 Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction

12.0 Tomlinson, M.J. Foundation Design & Construction, 7th Edition

Appendix 1

Trial Pit Records & Photographs

TRIAL PIT RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle	**TRIAL PIT NO.**	**TP1**
		SHEET	Sheet 1 of 1
LOGGED BY	AG	**CO-ORDINATES**	703,551.39 E 730,903.17 N
		DATE STARTED	24/05/2021
		DATE COMPLETED	24/05/2021
CLIENT	Ramboll	**GROUND LEVEL (m)**	72.43
ENGINEER		**EXCAVATION METHOD**	8T Tracked

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0 TOPSOIL: Soft brown sandy silt with rootlets.					AA158658	D	0.10		
Firm grey sandy slightly gravelly SILT. Gravel is subangular to subrounded, fine to coarse, limestone.		0.30	72.13		AA143083	B	0.30-0.50		
Very stiff grey sandy gravelly CLAY with low cobble content. Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded, limestone.		0.50	71.93		AA143084 AA143085	B B	0.50-1.00 0.50-1.00		
1.0					AA143086 AA143087	B B	1.50-1.90 1.50-1.90		
Weak grey shaley LIMESTONE. Recovered as angular cobbles in a matrix of silty angular gravel.		1.90	70.53	1 (Seepage)					
2.0 End of Trial Pit at 2.10m		2.10	70.33		AA143088	B	2.00		
3.0									
4.0									

Groundwater Conditions
Seepage at 2m

Stability
Moderate

General Remarks
Stopped on probable bedrock.

IGSL TP LOG 23300A.GPJ IGSL.GDT 8/7/21

TRIAL PIT RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle	**TRIAL PIT NO.**	**TP10**
		SHEET	Sheet 1 of 1
LOGGED BY	AG	**CO-ORDINATES**	703,575.69 E 730,747.43 N
		DATE STARTED	25/05/2021
		DATE COMPLETED	25/05/2021
CLIENT	Ramboll	**GROUND LEVEL (m)**	72.85
ENGINEER		**EXCAVATION METHOD**	8T Tracked

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
TOPSOIL: Soft brown sandy silt with rootlets.					AA158662	D	0.10		
		0.30	72.55						
Very stiff grey mottled orange brown slightly sandy slightly gravelly CLAY/SILT with low cobble content. Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded, limestone.					AA148080 AA148081	B B	0.50-1.00 0.50-1.00		
		1.50	71.35						
Medium strong grey shaley LIMESTONE. Recovered as angular cobbles with occasional tabular cobbles and boulders (<0.3m) in a matrix of silty gravel.				(Slow)					
		2.10	70.75		AA148082	B	2.00		
End of Trial Pit at 2.10m									

0.0 1.0 2.0 3.0 4.0

Groundwater Conditions
Seepage at 1.5 & 2m

Stability
Good

General Remarks
Stopped on probable bedrock.

IGSL TP LOG 23300A.GPJ IGSL.GDT 8/7/21

TRIAL PIT RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle	TRIAL PIT NO.	TP11
		SHEET	Sheet 1 of 1
LOGGED BY	AG	CO-ORDINATES	703,711.46 E 730,754.37 N
		DATE STARTED	25/05/2021
		DATE COMPLETED	25/05/2021
CLIENT	Ramboll	GROUND LEVEL (m)	72.87
ENGINEER		EXCAVATION METHOD	8T Tracked

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
TOPSOIL: Soft brown sandy silt with rootlets.					AA158652	D	0.10		
		0.30	72.57						
Firm yellow brown sandy slightly gravelly SILT with low cobble content. Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded, limestone.		0.50	72.37		AA148083	B	0.40		
Stiff to very stiff grey slightly sandy gravelly CLAY/SILT with low cobble content. Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded, limestone.					AA148084 AA148085	B B	1.00-1.50 1.00-1.50		
Medium strong grey shaley LIMESTONE. Recovered as angular cobbles with occasional tabular cobbles and boulders (<0.3m) in a matrix of silty gravel.		1.50	71.37	1 (Seepage)	AA148086 AA148087	B B	1.50-2.00 1.50-2.00		
End of Trial Pit at 2.10m		2.10	70.77						

Groundwater Conditions
Seepage at 1.5m

Stability
Good

General Remarks
Stopped on probable bedrock.

IGSL TP LOG 23300A.GPJ IGSL.GDT 8/7/21

TRIAL PIT RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle	**TRIAL PIT NO.**	**TP12**
		SHEET	Sheet 1 of 1
LOGGED BY	AG	**CO-ORDINATES**	703,610.05 E 730,682.31 N
		DATE STARTED	25/05/2021
		DATE COMPLETED	25/05/2021
CLIENT	Ramboll	**GROUND LEVEL (m)**	73.78
ENGINEER		**EXCAVATION METHOD**	8T Tracked

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0 TOPSOIL: Soft brown sandy silt with rootlets.					AA158663	D	0.10		
Stiff to very stiff light grey mottled orange brown slightly sandy slightly gravelly SILT with low cobble content. Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded, limestone.		0.30	73.48		AA148088 AA148089	B B	0.50-1.00 0.50-1.00		
1.0									
Medium strong grey shaley LIMESTONE. Recovered as angular cobbles with occasional tabular cobbles and boulders (<0.3m) in a matrix of silty gravel.		1.60	72.18	1 (Slow)	AA148090	B	1.60-1.90		
End of Trial Pit at 1.90m		1.90	71.88						
2.0									
3.0									
4.0									

Groundwater Conditions
Seepage at 1.8m

Stability
Good

General Remarks
Stopped on probable bedrock.

IGSL TP LOG 23300A.GPJ IGSL.GDT 8/7/21

TRIAL PIT RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo. Grangecastle	TRIAL PIT NO.	TP13
		SHEET	Sheet 1 of 1
LOGGED BY	AG	CO-ORDINATES	703,770.82 E 730,707.07 N
		DATE STARTED	25/05/2021
		DATE COMPLETED	25/05/2021
CLIENT	Ramboll	GROUND LEVEL (m)	72.98
ENGINEER		EXCAVATION METHOD	8T Tracked

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0 TOPSOIL: Soft brown sandy silt with rootlets.					AA158651	D	0.10		
		0.30	72.68						
Firm to stiff orange brown slightly sandy slightly gravelly SILT. Gravel is subangular to subrounded fine to coarse, limestone.					AA148091	B	0.50		
		0.60	72.38		AA148092	B	0.50		
Very stiff grey slightly sandy gravelly CLAY/SILT with low cobble content. Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded, limestone.									
1.0					AA148093	B	1.00-1.40		
					AA148094	B	1.00-1.40		
		1.40	71.58	1					
Medium strong grey shaley LIMESTONE. Recovered as angular cobbles with occasional tabular cobbles and boulders (<0.3m) in a matrix of silty gravel.		1.60	71.38	(Seepage)	AA148095	B	1.50		
End of Trial Pit at 1.60m									
2.0									
3.0									
4.0									

Groundwater Conditions
Seepage at 1.5m

Stability
Good

General Remarks
Stopped on probable bedrock.

TRIAL PIT RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle	**TRIAL PIT NO.**	**TP2**
		SHEET	Sheet 1 of 1
LOGGED BY	AG	**CO-ORDINATES**	703,579.78 E 730,875.16 N
		DATE STARTED	24/05/2021
		DATE COMPLETED	24/05/2021
CLIENT	Ramboll	**GROUND LEVEL (m)**	71.83
ENGINEER		**EXCAVATION METHOD**	8T Tracked

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
TOPSOIL: Soft brown sandy silt with rootlets.					AA158657	D	0.10		
Firm grey sandy slightly gravelly SILT with low cobble content. Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded, limestone.		0.30	71.53		AA143089	B	0.50		
Very stiff grey mottled orange brown sandy gravelly CLAY with medium cobble content and occasional angular boulders of limestone (<0.4m diameter). Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded.		0.80	71.03		AA143090 AA143091	B B	1.00-1.50 1.00-1.50		
					AA143092 AA143093	B B	1.50-1.90 1.50-1.90		
End of Trial Pit at 1.90m		1.90	69.93	(Seepage)					

Groundwater Conditions
Seepage at 1.9m

Stability
Good

General Remarks
Stopped on probable bedrock.

TRIAL PIT RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle	TRIAL PIT NO.	TP3
		SHEET	Sheet 1 of 1
LOGGED BY	AG	CO-ORDINATES	703,634.83 E 730,909.44 N
		DATE STARTED	24/05/2021
		DATE COMPLETED	24/05/2021
CLIENT	Ramboll	GROUND LEVEL (m)	72.92
ENGINEER		EXCAVATION METHOD	8T Tracked

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0 TOPSOIL: Soft brown sandy silt with rootlets.					AA158656	D	0.10		
Firm grey mottled orange brown sandy slightly gravelly SILT with low cobble content. Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded, limestone.		0.30	72.62		AA143094	B	0.50		
Very stiff grey sandy gravelly CLAY/SILT with medium cobble content and occasional angular boulders of limestone (<0.5m diameter). Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded,		0.80	72.12		AA143095 AA143096	B B	1.00-1.50 1.00-1.50		
1.0				1 (Seepage)					
2.0					AA143097 AA143098	B B	2.00-2.50 2.00-2.50		
				2 (Seepage)					
End of Trial Pit at 2.60m		2.60	70.32						
3.0									
4.0									

Groundwater Conditions
Seepage at 1.5 & 2.5m

Stability
Good

General Remarks
Stopped on probable bedrock.

IGSL TP LOG 23300A.GPJ IGSL.GDT 8/7/21

TRIAL PIT RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle	**TRIAL PIT NO.**	**TP4**
		SHEET	Sheet 1 of 1
LOGGED BY	AG	**CO-ORDINATES**	703,566.81 E 730,841.73 N
		DATE STARTED	24/05/2021
		DATE COMPLETED	24/05/2021
CLIENT	Ramboll	**GROUND LEVEL (m)**	71.86
ENGINEER		**EXCAVATION METHOD**	8T Tracked

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
TOPSOIL: Soft grey sandy gravelly silt with medium cobble content and rootlets.					AA158659	D	0.10		
		0.30	71.56						
Firm grey sandy slightly gravelly SILT with low cobble content. Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded, limestone.					AA143099	B	0.50		
		0.80	71.06						
Stiff grey sandy gravelly CLAY/SILT with medium cobble content and occasional angular boulders of limestone (<0.5m diameter). Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded,					AA143100 AA148059	B B	1.00-1.50 1.00-1.50		
		2.00	69.86	1 (Seepage)					
Weak to medium strong grey shaley LIMESTONE. Recovered as angular gravel with occasional tabular cobbles.		2.10	69.76						
End of Trial Pit at 2.10m									

Groundwater Conditions
Seepage at 1.8m

Stability
Moderate

General Remarks
Stopped on probable bedrock.

TRIAL PIT RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle	**TRIAL PIT NO.**	**TP5**
		SHEET	Sheet 1 of 1
LOGGED BY	AG	**CO-ORDINATES**	703,684.37 E 730,876.62 N
		DATE STARTED	24/05/2021
		DATE COMPLETED	24/05/2021
CLIENT	Ramboll	**GROUND LEVEL (m)**	72.26
ENGINEER		**EXCAVATION METHOD**	8T Tracked

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0 TOPSOIL: Soft brown sandy silt with rootlets.					AA158654	D	0.10		
Firm brown sandy slightly gravelly SILT. Gravel is subangular to subrounded, fine to coarse, limestone.		0.30	71.96						
Very stiff grey slightly sandy gravelly CLAY with low cobble content. Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded, limestone.		0.60	71.66		AA148060	B	0.50		
1.0					AA148061	B	1.00-1.50		
					AA148062	B	1.00-1.50		
Weak to medium strong grey shaley LIMESTONE. Recovered as angular gravel with occasional tabular cobbles and boulders (<0.4m).		1.80	70.46						
2.0				(Seepage)	AA148063	B	2.00		
End of Trial Pit at 2.10m		2.10	70.16		AA148064	B	2.00		
3.0									
4.0									

Groundwater Conditions
Seepage at 2.1m

Stability
Good

General Remarks
Stopped on probable bedrock.

TRIAL PIT RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle	TRIAL PIT NO.	TP6
		SHEET	Sheet 1 of 1
LOGGED BY	AG	CO-ORDINATES	703,731.59 E 730,881.26 N
		DATE STARTED	24/05/2021
		DATE COMPLETED	24/05/2021
CLIENT	Ramboll	GROUND LEVEL (m)	72.73
ENGINEER		EXCAVATION METHOD	8T Tracked

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
TOPSOIL: Soft brown sandy silt with rootlets.					AA158655	D	0.10		
		0.30	72.43						
Firm brown sandy slightly gravelly SILT with low cobble content. Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded, limestone.					AA148065	B	0.50		
		0.60	72.13		AA148066	B	0.60-1.00		
Stiff brown sandy gravelly CLAY with medium cobble content and occasional angular boulders of limestone (<0.5m diameter). Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded,					AA148067	B	0.60-1.00		
					AA148068	B	1.00-1.50		
					AA148069	B	1.00-1.50		
				1 (Seepage)					
End of Trial Pit at 1.70m		1.70	71.03						

0.0
1.0
2.0
3.0
4.0

Groundwater Conditions
Seepage at 1.9m

Stability
Moderate

General Remarks
Stopped on probable bedrock.

IGSL TP LOG 23300A.GPJ IGSL.GDT 8/7/21

TRIAL PIT RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle	**TRIAL PIT NO.**	**TP7**
		SHEET	Sheet 1 of 1
LOGGED BY	AG	**CO-ORDINATES**	703,587.57 E 730,825.11 N
		DATE STARTED	24/05/2021
		DATE COMPLETED	24/05/2021
CLIENT	Ramboll	**GROUND LEVEL (m)**	72.36
ENGINEER		**EXCAVATION METHOD**	8T Tracked

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
TOPSOIL: Soft brown sandy silt with rootlets.					AA158660	D	0.10		
		0.30	72.06						
Firm grey brown sandy gravelly SILT with low cobble content. Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded, limestone.		0.60	71.76		AA148070	B	0.50		
Stiff grey and brown sandy gravelly CLAY with medium cobble content and occasional angular boulders of limestone (<0.3m diameter). Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded,				1 (Seepage)	AA148071 AA148072	B B	1.00-1.50 1.00-1.50		
End of Trial Pit at 1.60m		1.80	70.56						

Groundwater Conditions
Seepage at 1.7m

Stability
Good

General Remarks
Stopped on probable bedrock.

IGSL TP LOG 23300A.GPJ IGSL.GDT 8/7/21

TRIAL PIT RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle	TRIAL PIT NO.	TP8
		SHEET	Sheet 1 of 1
LOGGED BY	AG	CO-ORDINATES	703,707.83 E 730,841.23 N
		DATE STARTED	24/05/2021
		DATE COMPLETED	24/05/2021
CLIENT	Ramboll	GROUND LEVEL (m)	72.63
ENGINEER		EXCAVATION METHOD	8T Tracked

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
TOPSOIL: Soft brown sandy silt with rootlets.					AA158653	D	0.10		
Very stiff grey sandy gravelly CLAY with high cobble content and occasional angular boulders of limestone (<0.5m diameter). Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded,		0.50	72.13		AA148073 AA148074	B B	0.50-1.00 0.50-1.00		
				1 (Seepage)					
End of Trial Pit at 1.80m		1.80	70.83		AA148075 AA148076	B B	1.80 1.80		

0.0
1.0
2.0
3.0
4.0

Groundwater Conditions
Seepage at 1.7m

Stability
Good

General Remarks
Stopped on probable bedrock.

IGSL TP LOG 23300A.GPJ IGSL.GDT 8/7/21

TRIAL PIT RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle	**TRIAL PIT NO.**	**TP9**
		SHEET	Sheet 1 of 1
LOGGED BY	AG	**CO-ORDINATES**	703,562.57 E 730,801.27 N
		DATE STARTED	24/05/2021
		DATE COMPLETED	24/05/2021
CLIENT	Ramboll	**GROUND LEVEL (m)**	72.48
ENGINEER		**EXCAVATION METHOD**	8T Tracked

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
TOPSOIL: Soft brown sandy silt with rootlets.					AA158661	D	0.10		
		0.30	72.18						
Firm grey brown sandy gravelly SILT with low cobble content. Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded, limestone.					AA148076	B	0.50		
		0.60	71.88		AA148077	B	0.60-1.00		
Stiff grey and brown sandy gravelly CLAY with medium cobble content and occasional angular boulders of limestone (<0.3m diameter). Gravel is subangular to subrounded fine to coarse, limestone. Cobbles are subangular to subrounded,					AA148078	B	0.60-1.00		
		1.10	71.38						
Medium strong grey shaley LIMESTONE. Recovered as angular cobbles and boulders (<0.3m) in a matrix of silty angular gravel.					AA148079	B	1.20-1.40		
		1.40	71.08	1 (Seepage)					
End of Trial Pit at 1.40m									

0.0
1.0
2.0
3.0
4.0

Groundwater Conditions
Seepage at 1.4m

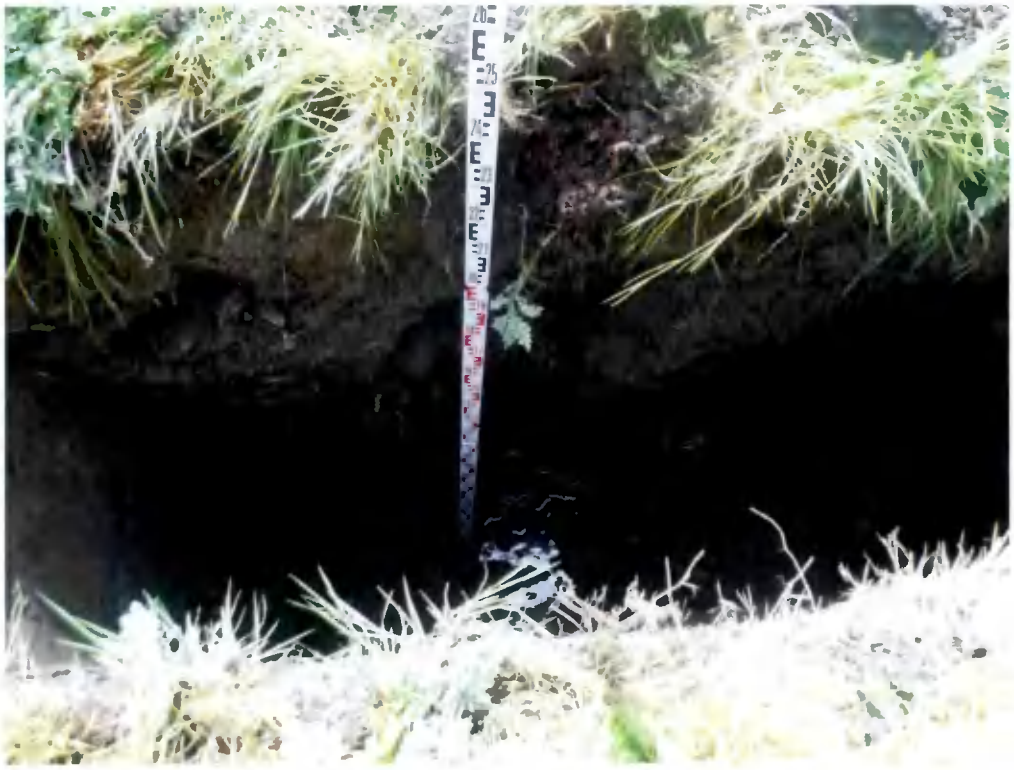
Stability
Good

General Remarks
Stopped on probable bedrock.

Trial Pit TP01

Trial Pit TP02

Trial Pit TP03



Trial Pit TP04

Trial Pit TP05

Trial Pit TP06

Trial Pit TP07

Trial Pit TP08

Trial Pit TP09

Trial Pit TP10

Trial Pit TP11

Trial Pit TP12

Trial Pit TP13

Appendix 2

Cable Percussive Borehole Records

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH01**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,648.29 E 730,881.51 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	72.04	**BOREHOLE DEPTH (m)**	2.30
		DATE COMMENCED	25/05/2021
		DATE COMPLETED	25/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		71.84	0.20						
	Firm dark brown sandy SILT/CLAY with occasional fine gravel				AA181001	B	1.00		N = 12 (2, 3, 3, 2, 3, 4)	
1			70.64	1.40						
	Very stiff black sandy SILT/CLAY with some angular gravel								N = 31 (5, 7, 8, 8, 7, 8)	
2			69.74	2.30						
	Obstruction End of Borehole at 2.30 m									
3										
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.20	2.30	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
1.80	1.80	No	1.50	20	Slow

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend
D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH02**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,592.89 E 730,852.38 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	71.91	**BOREHOLE DEPTH (m)**	2.40
		DATE COMMENCED	26/05/2021
		DATE COMPLETED	26/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		71.71	0.20						
	Firm brown sandy SILT/CLAY with occasional angular gravel		71.01	0.90						
1	Very stiff grey/brown sandy gravelly SILT/CLAY with some cobbles				AA181007	B	1.00		N = 34 (4, 6, 6, 8, 10, 10)	
2					AA181008	B	2.00		N = 40 (5, 9, 10, 11, 11, 8)	
			69.51	2.40						
	End of Borehole at 2.40 m									
3										
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.30	2.40	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH03**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,699.90 E 730,856.63 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	72.46	**BOREHOLE DEPTH (m)**	2.30
		DATE COMMENCED	24/05/2021
		DATE COMPLETED	24/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		72.31	0.15						
	Firm dark brown sandy SILT/CLAY with occasional gravel		71.66	0.80						
1	Very stiff dark brown sandy gravelly CLAY with occasional angular cobbles				AA181002	B	1.00		N = 17 (3, 3, 4, 4, 4, 5)	
2			70.16	2.30	AA181003	B	2.00		N = 50/75 mm (8, 10, 50)	
	Obstruction End of Borehole at 2.30 m									
3										
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.00	2.30	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH04**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,613.34 E 730,805.46 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	73.23	**BOREHOLE DEPTH (m)**	2.10
		DATE COMMENCED	28/05/2021
		DATE COMPLETED	28/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		73.03	0.20						
	Firm brown SILT/CLAY with occasional gravel		72.33	0.90						
1	Stiff to very stiff light brown sandy SILT/CLAY with occasional gravel and cobble				AA181015	B	1.00		N = 31 (4, 6, 7, 7, 8, 9)	
2			71.13	2.10					N = 50/75 mm (18, 21, 50)	
	Obstruction End of Borehole at 2.10 m									
3										
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
1.90	2.10	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH05**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,708.11 E 730,818.90 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	72.47	**BOREHOLE DEPTH (m)**	1.70
		DATE COMMENCED	26/05/2021
		DATE COMPLETED	26/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		72.32	0.15						
	Firm brown SILT/CLAY with occasional gravel		71.67	0.80						
1	Stiff to very stiff dark brown sandy gravelly CLAY with occasional angular cobbles		70.77	1.70	AA181005	B	1.00		N = 29 (4, 5, 5, 6, 8, 10)	
2	Obstruction End of Borehole at 1.70 m									
3										
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
1.50	1.70	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	BH06
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,585.72 E 730,778.72 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	72.89	**BOREHOLE DEPTH (m)**	2.60
		DATE COMMENCED	26/05/2021
		DATE COMPLETED	26/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		72.69	0.20						
	Firm dark brown sandy SILT/CLAY with occasional gravel		72.09	0.80						
1					AA181008	B	1.00		N = 16 (2, 3, 3, 4, 4, 5)	
			70.99	1.90						
2	Very stiff black sandy gravelly CLAY with some cobbles				AA181009	B	2.00		N = 51 (8, 10, 12, 14, 13, 12)	
			70.29	2.60						
	Obstruction End of Borehole at 2.60 m									
3										
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.40	2.60	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
2.40	2.40	No	1.90	20	Moderate

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH07**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,641.65 E 730,785.09 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	73.56	**BOREHOLE DEPTH (m)**	2.90
		DATE COMMENCED	27/05/2021
		DATE COMPLETED	28/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		73.41	0.15						
	Firm dark brown sandy SILT/CLAY with osome gravel and occasional cobbles									
1					AA181010	B	1.00		N = 17 (2, 3, 4, 4, 4, 5)	
2			71.36	2.20	AA181011	B	2.00		N = 27 (4, 3, 5, 8, 7, 7)	
	Stiff to very stiff black gravelly CLAY									
			70.66	2.90					N = 50/75 mm (18, 50)	
3	Obstruction End of Borehole at 2.90 m									
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.70	2.90	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
2.60	2.60	No	2.10	20	Moderate

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH08**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,696.13 E 730,791.36 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	72.71	**BOREHOLE DEPTH (m)**	2.30
		DATE COMMENCED	25/05/2021
		DATE COMPLETED	26/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		72.56	0.15						
	Light brown sandy SILT/CLAY with occasional gravel		72.31	0.40						
1	Firm dark brown sandy SILT/CLAY with some gravel and occasional cobbles				AA181005	B	1.00		N = 17 (3, 6, 6, 4, 4, 3)	
			71.11	1.60						
2	Very stiff dark brown sandy gravelly CLAY with some angular gravel and cobbles				AA181006	B	2.00		N = 50/225 mm (8, 13, 19, 24, 7)	
			70.41	2.30						
	Obstruction End of Borehole at 2.30 m									
3										
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.10	2.30	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
1.60	1.60	No	0.50	20	Slow

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH09**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,556.10 E 730,720.16 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	72.84	**BOREHOLE DEPTH (m)**	2.20
		DATE COMMENCED	28/05/2021
		DATE COMPLETED	31/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		72.64	0.20						
	Firm dark brown sandy SILT/CLAY with occasional gravel				AA181012	B	1.00		N = 14 (2, 3, 3, 4, 3, 4)	
1			71.44	1.40						
	Very stiff dark brown sandy SILT/CLAY with some angular gravel and cobbles									
2			70.64	2.20					N = 50/225 mm (12, 10, 15, 14, 21)	
	Obstruction End of Borehole at 2.20 m									
3										
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.00	2.20	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH10**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,699.56 E 730,742.00 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	72.88	**BOREHOLE DEPTH (m)**	2.60
		DATE COMMENCED	31/05/2021
		DATE COMPLETED	31/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		72.73	0.15						
	Firm dark brown sandy SILT/CLAY with occasional fine gravel				AA181025	B	1.00		N = 12 (2, 3, 3, 3, 2, 4)	
			71.08	1.80						
2	Very stiff black gravelly CLAY with some cobbles				AA181025	B	2.00		N = 32 (4, 5, 6, 6, 8, 12)	
			70.28	2.60						
	Obstruction End of Borehole at 2.60 m									

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.40	2.60	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
2.30	2.30	No	1.20	20	Moderate

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH11**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,627.92 E 730,695.59 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	73.73	**BOREHOLE DEPTH (m)**	2.20
		DATE COMMENCED	27/05/2021
		DATE COMPLETED	27/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		73.58	0.15						
	Firm dark brown sandy SILT/CLAY with occasional fine gravel				AA181013	B	1.00		N = 15 (3, 4, 4, 4, 3, 4)	
1			72.13	1.60						
	Very stiff dark brown sandy SILT/CLAY with some angular gravel				AA181014	B	2.00		N = 50/150 mm (17, 8, 44, 6)	
2			71.53	2.20						
	Obstruction End of Borehole at 2.20 m									
3										
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
1.90	2.20	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH12**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,696.66 E 730,698.62 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	73.63	**BOREHOLE DEPTH (m)**	2.20
		DATE COMMENCED	28/05/2021
		DATE COMPLETED	28/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		73.43	0.20						
	Firm dark brown sandy SILT/CLAY with occasional fine gravel									
1	Very stiff black sandy gravelly CLAY with some cobbles		72.53	1.10	AA181016	B	1.00		N = 49 (8, 10, 10, 12, 13, 14)	
2					AA181017	B	2.00		N = 40 (6, 6, 8, 9, 10, 13)	
			70.93	2.70						
3	Obstruction End of Borehole at 2.20 m									
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.40	2.70	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
2.40	2.40	No	No	20	Seepage

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH13**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,563.79 E 730,657.33 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	73.62	**BOREHOLE DEPTH (m)**	1.90
		DATE COMMENCED	31/05/2021
		DATE COMPLETED	31/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		73.42	0.20						
	Firm brown SILT/CLAY with occasional fine gravel		72.82	0.80						
1	Stiff dark brown sandy SILT/CLAY with occasional gravel				AA181020	B	1.00		N = 36 (6, 6, 6, 8, 8, 14)	
			71.72	1.90					N = 50/75 mm (21, 25, 50)	
2	Obstruction End of Borehole at 1.90 m									
3										
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
1.70	1.90	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH14**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,610.80 E 730,650.91 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	73.85	**BOREHOLE DEPTH (m)**	2.30
		DATE COMMENCED	26/05/2021
		DATE COMPLETED	26/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		73.65	0.20						
	Dark brown sandy SILT/CLAY with occasional fine gravel		72.95	0.90						
1	Firm light and dark brown sandy SILT/CLAY with some angular gravel		72.45	1.40	AA181004	B	1.00		N = 18 (3, 4, 4, 4, 5, 5)	
	Very stiff dark grey/black sandy SILT/CLAY with angular gravel and cobbles		71.55	2.30	AA181005	B	2.00		N = 50/225 mm (10, 14, 16, 27, 7)	
2	Obstruction End of Borehole at 2.30 m									
3										
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.00	2.30	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH15**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,650.51 E 730,617.77 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	73.91	**BOREHOLE DEPTH (m)**	2.30
		DATE COMMENCED	31/05/2021
		DATE COMPLETED	31/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		73.76	0.15						
	Dark brown sandy SILT/CLAY with occasional fine gravel		73.31	0.60						
1	Stiff mottled brown sandy SILT/CLAY with some angular gravel		72.71	1.20	AA181021	B	1.00		N = 21 (3, 4, 6, 4, 5, 6)	
2	Stiff to very stiff dark brown sandy SILT/CLAY with some angular gravel and cobbles		71.61	2.30					N = 53 (5, 7, 11, 14, 15, 13)	
	Obstruction End of Borehole at 2.30 m									
3										
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
1.70	1.90	0.5	
2.20	2.30	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH16**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,712.57 E 730,662.15 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	73.77	**BOREHOLE DEPTH (m)**	2.30
		DATE COMMENCED	31/05/2021
		DATE COMPLETED	31/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		73.67	0.10						
	Light brown sandy SILT/CLAY with occasional fine gravel		73.27	0.50						
1	Firm dark brown sandy SILT/CLAY with some angular gravel				AA181023	B	1.00		N = 15 (3, 4, 3, 3, 4, 5)	
			72.37	1.40						
2	Very stiff dark grey /blue gravelly CLAY with some cobbles				AA181024	B	2.00		N = 50/225 mm (10, 12, 17, 19, 14)	
			71.47	2.30						
	Obstruction End of Borehole at 2.30 m									
3										
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.00	2.30	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL BORING RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo, Grangecastle, Co.Dublin	**BOREHOLE NO.**	**BH17**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,723.19 E 730,662.02 N	**RIG TYPE**	DANDO 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (mOD)	73.62	**BOREHOLE DEPTH (m)**	2.40
		DATE COMMENCED	28/05/2021
		DATE COMPLETED	28/05/2021
CLIENT		**SPT HAMMER REF. NO.**	
ENGINEER	Ramboll	**ENERGY RATIO (%)**	
		BORED BY	W.CAHILL
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		73.42	0.20						
1	Very stiff dark brown sandy SILT/CLAY with some gravel and cobbles		72.52	1.10	AA181018	B	1.00		N = 26 (4, 4, 6, 6, 7, 7)	
2	Firm dark brown sandy SILT/CLAY with occasional gravel Very stiff dark brown sandy SILT/CLAY with some gravel and cobbles Firm dark brown sandy SILT/CLAY with occasional gravel		71.22	2.40	AA181019	B	2.00		N = 56 (5, 9, 9, 11, 24, 12)	
3	Obstruction End of Borehole at 2.40 m									
4										
5										
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.30	2.40	1.5	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
2.20	2.20	No	1.80	20	Slow

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type

REMARKS 1hr Erecting Covid 19 Safe working Area . CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 23300A.GPJ IGSL.GDT 8/7/21

Appendix 3

Rotary Core Records

GEOTECHNICAL CORE LOG RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo	**DRILLHOLE NO**	**RC01**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,666.80 E 730,847.49 N	**DATE COMMENCED**	27/05/2021
GROUND LEVEL (mOD)	72.50	**DATE COMPLETED**	28/05/2021
CLIENT		**DRILLED BY**	IGSL
ENGINEER	Ramboll	**LOGGED BY**	D.O'Shea
RIG TYPE	BT-44		
FLUSH	Air/Mist		
INCLINATION (deg)	-90		
CORE DIAMETER (mm)	78		

Downhole Depth (m)	Core Run Depth (m)	T.C.R.%	S.C.R.%	R.Q.D.%	Description	Depth (m)	Elevation
0					SYMMETRIX DRILLING: No recovery, observed by driller as returns of gravelly CLAY	1.50	71.00
2					SYMMETRIX DRILLING: No recovery, observed by driller as returns of brown clayey GRAVEL	2.70	69.80
3	3.00				SYMMETRIX DRILLING: No recovery, observed by driller as returns of ROCK	3.00	69.50
	3.70	100	93	73	Strong to locally very strong, medium to thinly bedded, light to dark grey/black, fine-grained, LIMESTONE (predominately muddy with local subordinate sandy limestone layers, local stylolites, local pyrite crystallisation), fresh to very locally slightly weathered. Local shale laminations at 3.63-3.70m, 3.94-4.02m, 7.91-7.94m & 8.61-8.64m		
4		100	81	58			
5	5.20				Discontinuities are medium to closely spaced, smooth to locally rough, planar to locally undulose. Apertures are tight to locally moderately open, locally clay-smeared, locally calcite-veined (1-20mm thick), locally slightly iron-oxide stained. Dips are 20-40° & locally 70°		
6		100	84	66			
7	6.70						
		100	87	27			
8	8.20						
9		100	87	87			
	9.70						
10.00		100	97	97		10.00	62.50

Fracture Spacing Log (mm): 0 – 250 – 500

Non-intact Zone

Legend

Standpipe Details

SPT (N Value)

REMARKS

Hole cased 0.0-3.00m. Erect Covid-19 Safe Zone - 1hr.

End of Borehole at 10.00 m

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
2.60	2.60	N/S			Slow

GROUNDWATER DETAILS

Date	Hole Depth	Casing Depth	Depth to Water	Comments
28-05-21	10.00	3.00	1.70	Water level recorded 5 mins after end of drilling.

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type
28-05-21	10.00	3.00	10.00	50mm SP

IGSL RC FI 10M 23300B.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL CORE LOG RECORD

REPORT NUMBER 23300

CONTRACT Project Apollo

DRILLHOLE NO RC02
SHEET Sheet 1 of 1

CO-ORDINATES 703,662.62 E
730,744.94 N
GROUND LEVEL (mOD) 73.25

RIG TYPE BT-44
FLUSH Air/Mist
INCLINATION (deg) -90
CORE DIAMETER (mm) 78

DATE COMMENCED 28/05/2021
DATE COMPLETED 31/05/2021

CLIENT
ENGINEER Ramboll

DRILLED BY IGSL
LOGGED BY D.O'Shea

Downhole Depth (m)	Core Run Depth (m)	T.C.R.%	S.C.R.%	R.Q.D.%	Fracture Spacing Log (mm) 0 250 500	Non-intact Zone	Legend	Description	Depth (m)	Elevation	Standpipe Details	SPT (N Value)
0								SYMMETRIX DRILLING: No recovery, observed by driller as returns of CLAY	1.50	71.75		
1								SYMMETRIX DRILLING: No recovery, observed by driller as returns of brown clayey GRAVEL	2.60	70.65		
2								SYMMETRIX DRILLING: No recovery, observed by driller as returns of ROCK	3.00	70.25		
3	3.00	100	66	55				Strong to locally very strong, medium to thinly bedded, light to dark grey/black, fine-grained, LIMESTONE (predominately muddy with local subordinate sandy limestone layers, local stylolites, local pyrite crystallisation), fresh to very locally slightly weathered. Local shale laminations at 6.97-7.03m Discontinuities are medium to closely spaced, smooth to locally rough, planar to locally undulose. Apertures are tight to locally moderately open, locally clay-smeared, locally calcite-veined (1-5mm thick), locally slightly iron-oxide stained. Dips are 20-40° & locally 70°				
4	4.30	100	75	48								
5	5.80	100	56	37								
6	7.30	100	76	53								
7	8.70	100	80	58								
8	10.00								10.00	63.25		
9												

REMARKS

Hole cased 0.0-3.00m. Erect Covid-19 Safe Zone - 1hr.

End of Borehole at 10.00 m

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
2.60	2.60	N/S			Slow

GROUNDWATER DETAILS

Date	Hole Depth	Casing Depth	Depth to Water	Comments
31-05-21	10.00	3.00	1.70	Water level recorded 5 mins after end of drilling.

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type
31-05-21	10.00	2.50	10.00	50mm SP

IGSL RC FI 10M 23300B.GPJ IGSL.GDT 8/7/21

GEOTECHNICAL CORE LOG RECORD

REPORT NUMBER 23300

CONTRACT	Project Apollo	**DRILLHOLE NO**	**RC03**
		SHEET	Sheet 1 of 1
CO-ORDINATES	703,678.44 E 730,669.16 N	**DATE COMMENCED**	31/05/2021
GROUND LEVEL (mOD)	73.51	**DATE COMPLETED**	01/06/2021
CLIENT		**DRILLED BY**	IGSL
ENGINEER	Ramboll	**LOGGED BY**	D.O'Shea
RIG TYPE	BT-44		
FLUSH	Air/Mist		
INCLINATION (deg)	-90		
CORE DIAMETER (mm)	78		

Downhole Depth (m)	Core Run Depth (m)	T.C.R.%	S.C.R.%	R.Q.D.%	Description	Depth (m)	Elevation
0					SYMMETRIX DRILLING: No recovery, observed by driller as returns of CLAY		
1						1.50	72.01
2					SYMMETRIX DRILLING: No recovery, observed by driller as returns of brown clayey GRAVEL		
	3.00					3.00	70.51
3		100	45	10	Strong to locally very strong, medium to thinly bedded, light to dark grey/black, fine-grained, LIMESTONE (predominately muddy with local subordinate sandy limestone layers, local stylolites, local pyrite crystallisation), fresh to very locally slightly weathered. Local shale laminations at 3.18-3.23m & 3.74-3.77m Discontinuities are medium to closely spaced, smooth to locally rough, planar to locally undulose. Apertures are tight to locally moderately open, locally clay-smeared, locally calcite-veined (1-15mm thick), locally slightly iron-oxide stained. Dips are 20-40° & locally 70°		
4	4.00	100	59	13			
5	5.50						
6		100	59	38			
7	7.00	100	60	42			
	7.60						
8		100	51	24			
9	9.00						
		100	73	35			
	10.00				End of Borehole at 10.00 m	10.00	63.51

Fracture Spacing Log (mm): 0 – 250 – 500

Non-intact Zone

Legend

Standpipe Details

SPT (N Value)

REMARKS

Hole cased 0.0-3.00m. Erect Covid-19 Safe Zone - 1hr.

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
3.00	3.00	N/S			Slow

GROUNDWATER DETAILS

Date	Hole Depth	Casing Depth	Depth to Water	Comments
01-06-21	10.00	3.00	2.10	Water level recorded 5 mins after end of drilling.

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type
01-06-21	10.00	3.00	10.00	50mm SP

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RC01 Box 1 of 3 – 3.00-6.00m

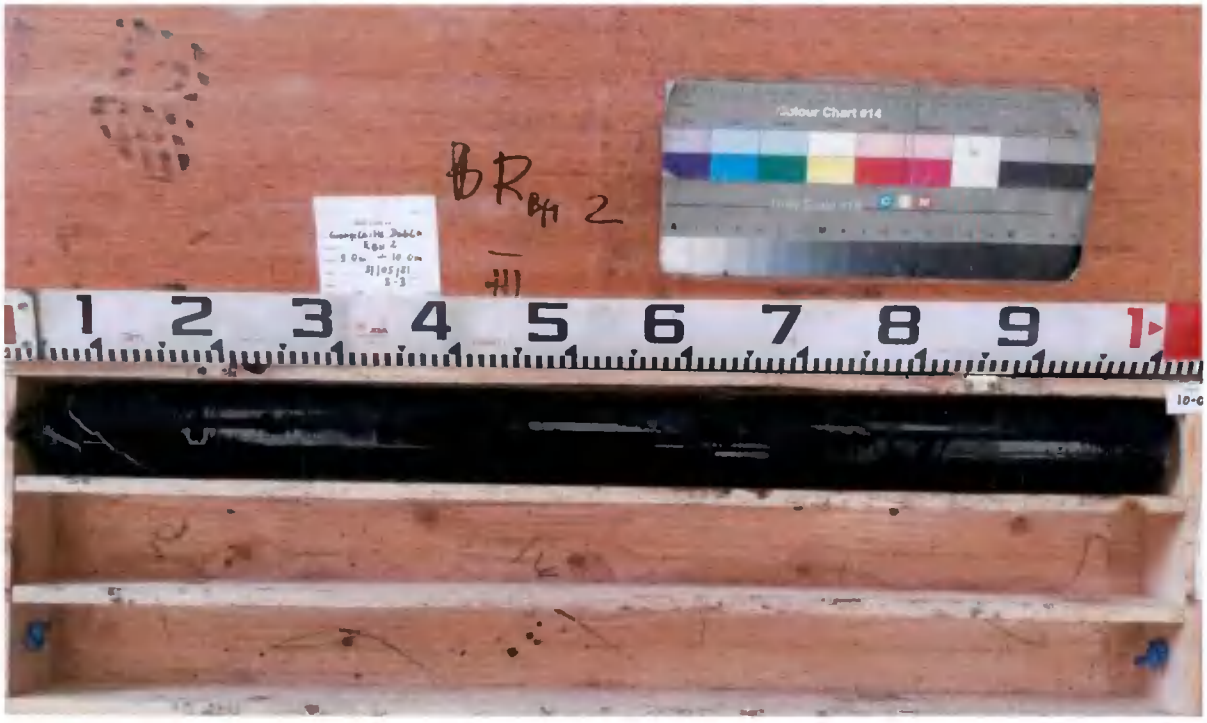
RC01 Box 2 of 3 – 6.00-9.00m

RC01 Box 3 of 3 – 9.00-10.00m

RC02 Box 1 of 3 – 3.00-6.00m

RC02 Box 2 of 3 – 6.00-9.00m

RC02 Box 3 of 3 – 9.00-10.00m



RC03 Box 1 of 3 – 3.00-6.00m

RC03 Box 2 of 3 – 6.00-9.00m

RC03 Box 3 of 3 – 9.00-10.00m

Appendix 4

Plate Load Test Records

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

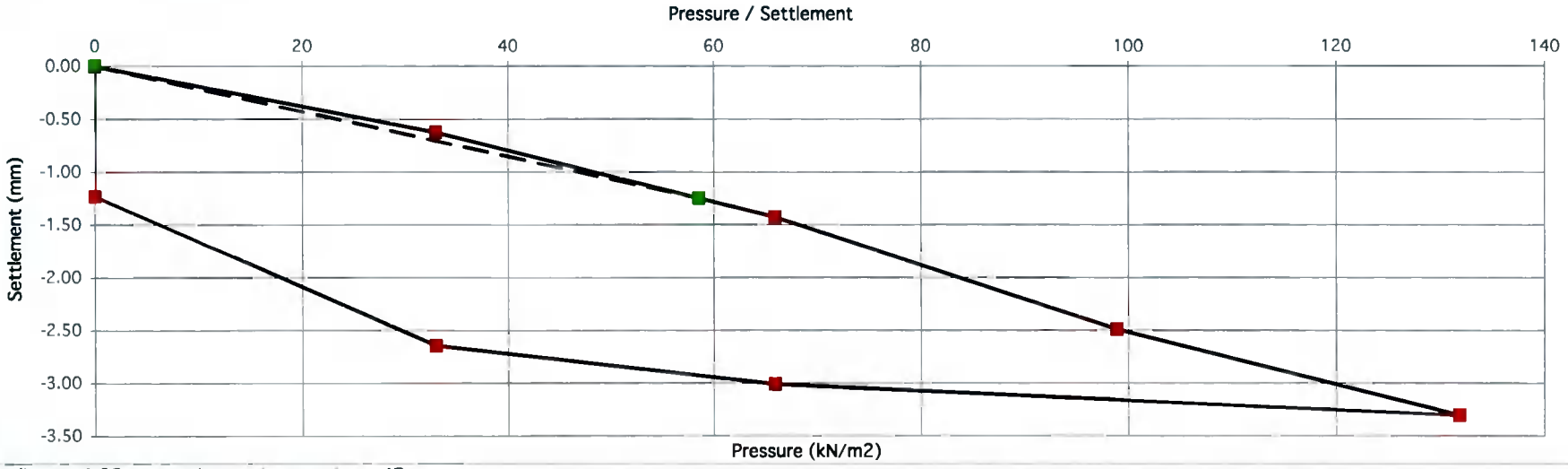
Reference No.	R122166
Contract	Project Appollo, Grangecastle
Test No.	PBT1 (LOAD)
Location	TP1
Depth	0.5m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	24/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 47

Modulus of subgrade reaction = 30 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 3.5 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

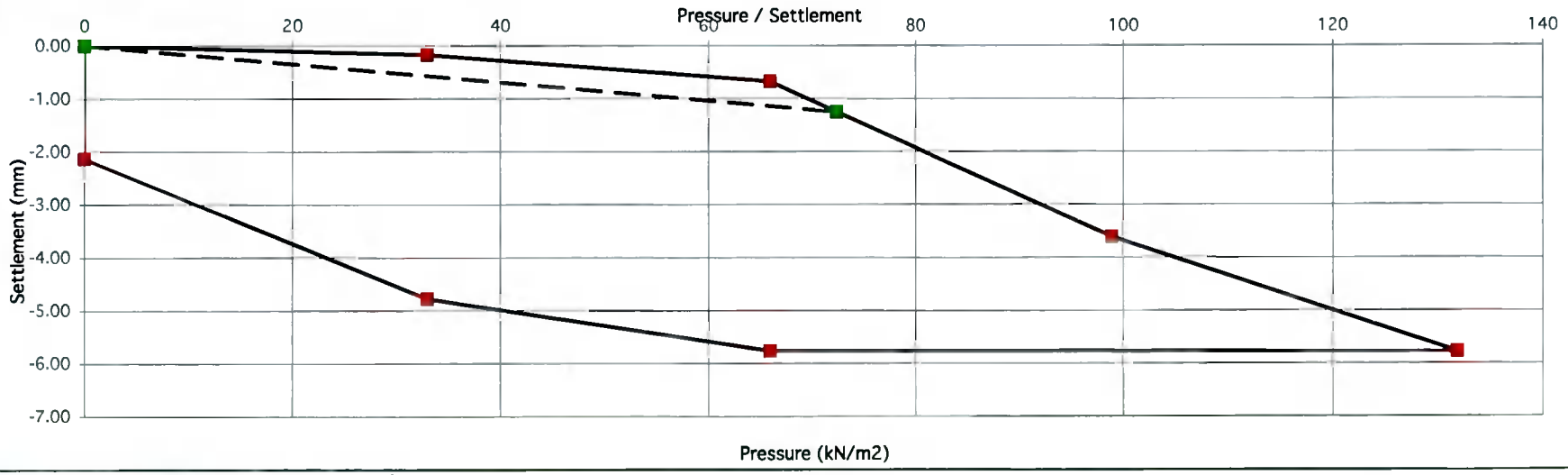
Reference No.	R122166
Contract	Project Appollo, Grangecastle
Test No.	PBT1 (RELOAD)
Location	TP1
Depth	0.5m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	24/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 58

Modulus of subgrade reaction = 37 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 5.1 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

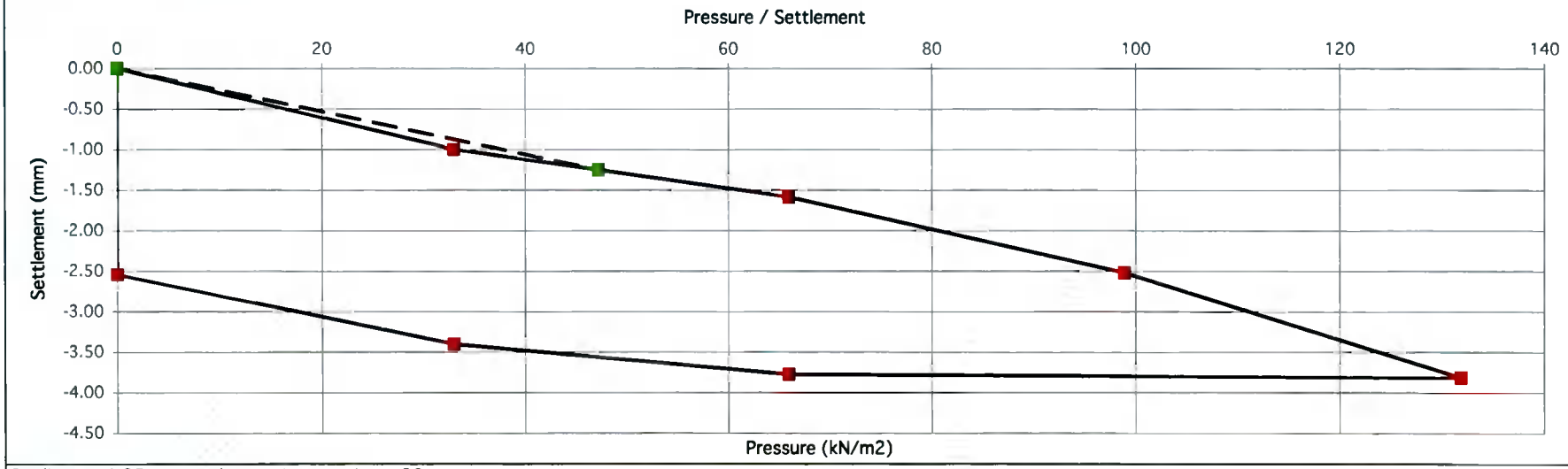
Reference No.	R122167
Contract	Project Appollo, Grangecastle
Test No.	PBT2 (LOAD)
Location	TP2
Depth	0.5m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	24/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 38

Modulus of subgrade reaction = 24 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 2.4 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

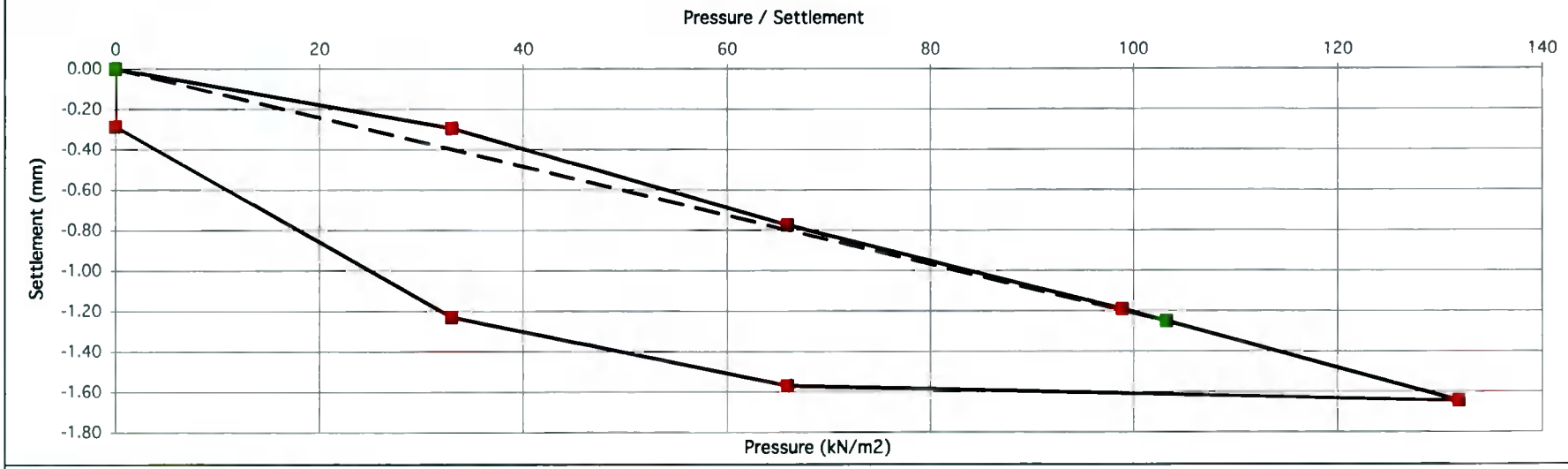
Reference No.	R122167
Contract	Project Appollo, Grangecastle
Test No.	PBT2 (LOAD)
Location	TP2
Depth	0.5m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	24/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 83

Modulus of subgrade reaction = 53 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 9.4 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

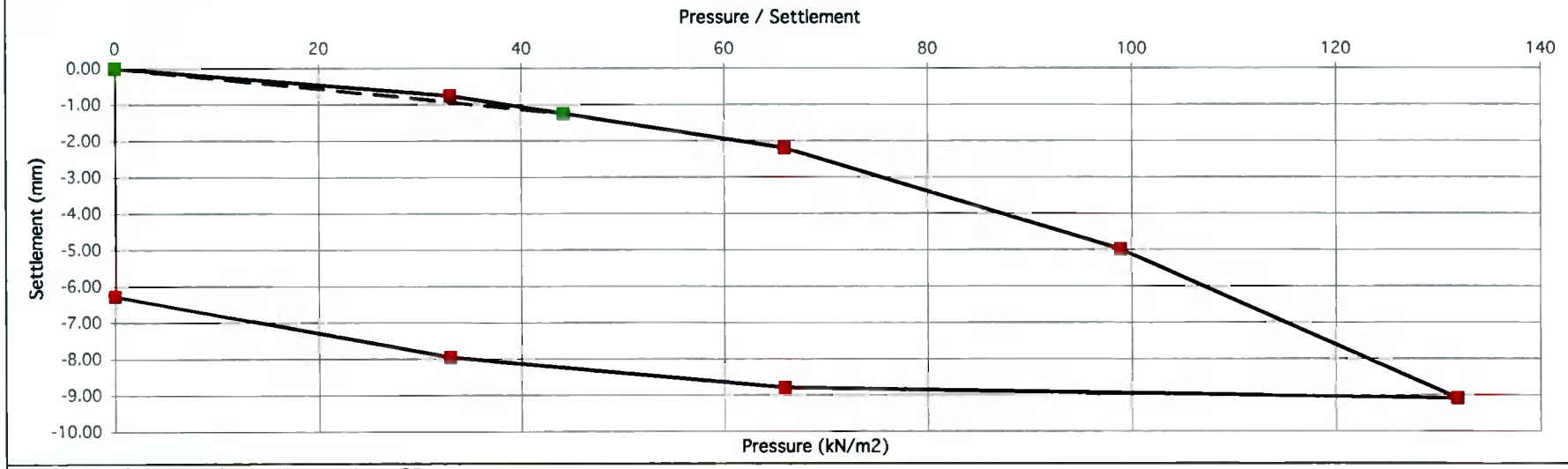
Reference No.	R122168
Contract	Project Appollo, Grangecastle
Test No.	PBT3 (LOAD)
Location	TP3
Depth	0.6m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	25/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 35

Modulus of subgrade reaction = 23 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 2.2 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

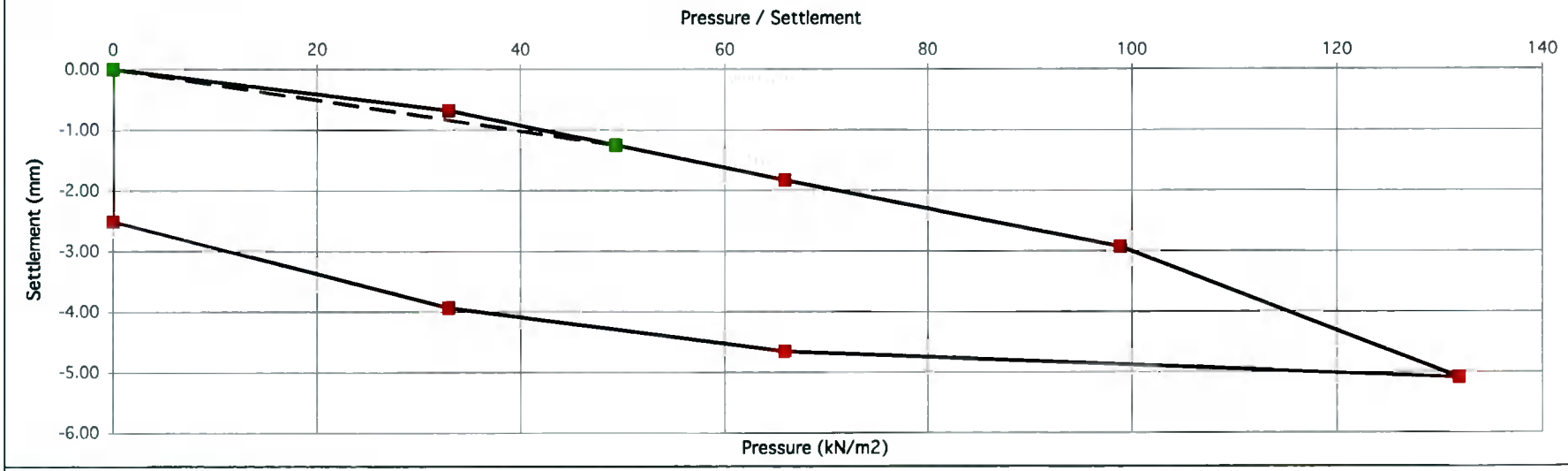
Reference No.	R122168
Contract	Project Appollo, Grangecastle
Test No.	PBT3 (RELOAD)
Location	TP3
Depth	0.6m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	25/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 39

Modulus of subgrade reaction = 25 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 2.6 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

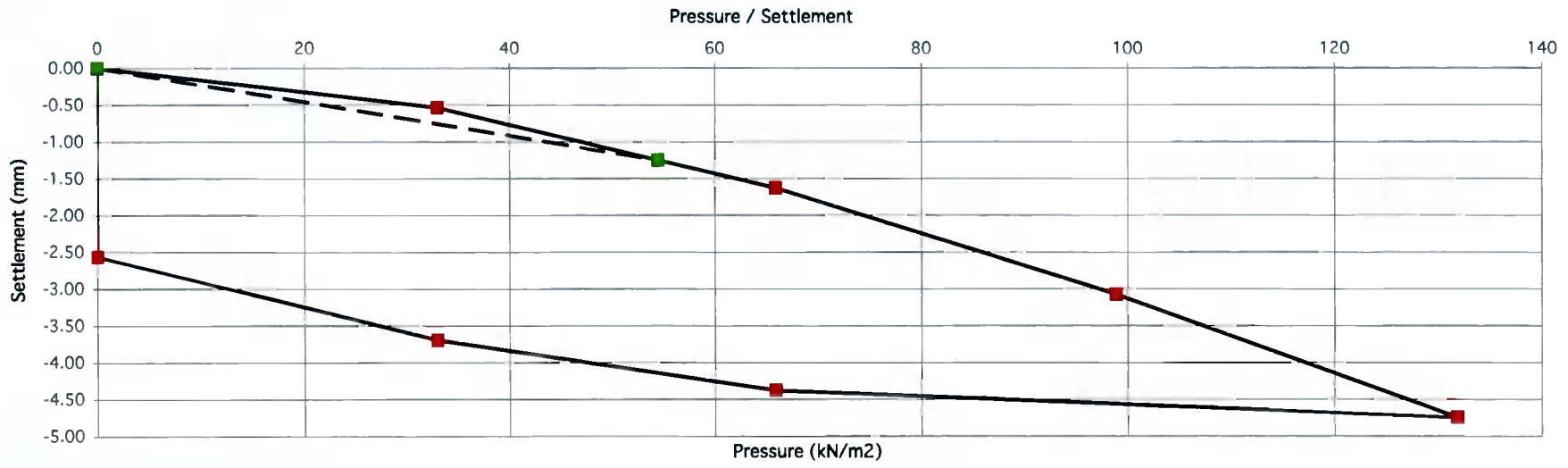
Reference No.	R122169
Contract	Project Appollo, Grangecastle
Test No.	PBT4 (LOAD)
Location	TP4
Depth	0.5m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	25/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 44

Modulus of subgrade reaction = 28 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 3.1 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

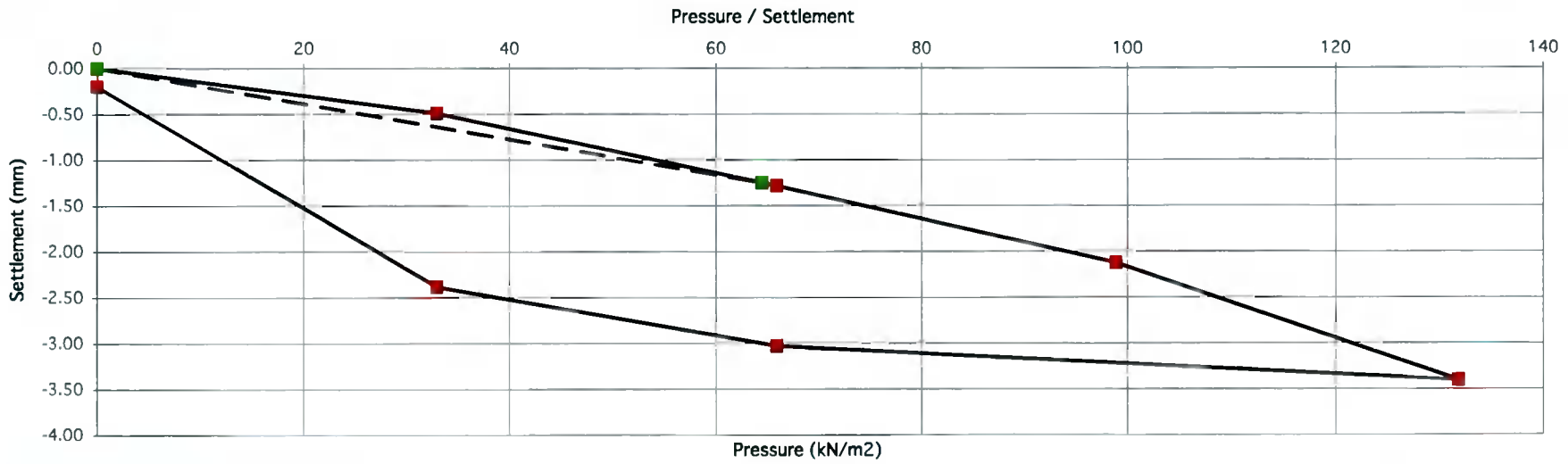
Reference No.	R122169
Contract	Project Appollo, Grangecastle
Test No.	PBT4 (RELOAD)
Location	TP4
Depth	0.5m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	25/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 52

Modulus of subgrade reaction = 33 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 4.2 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

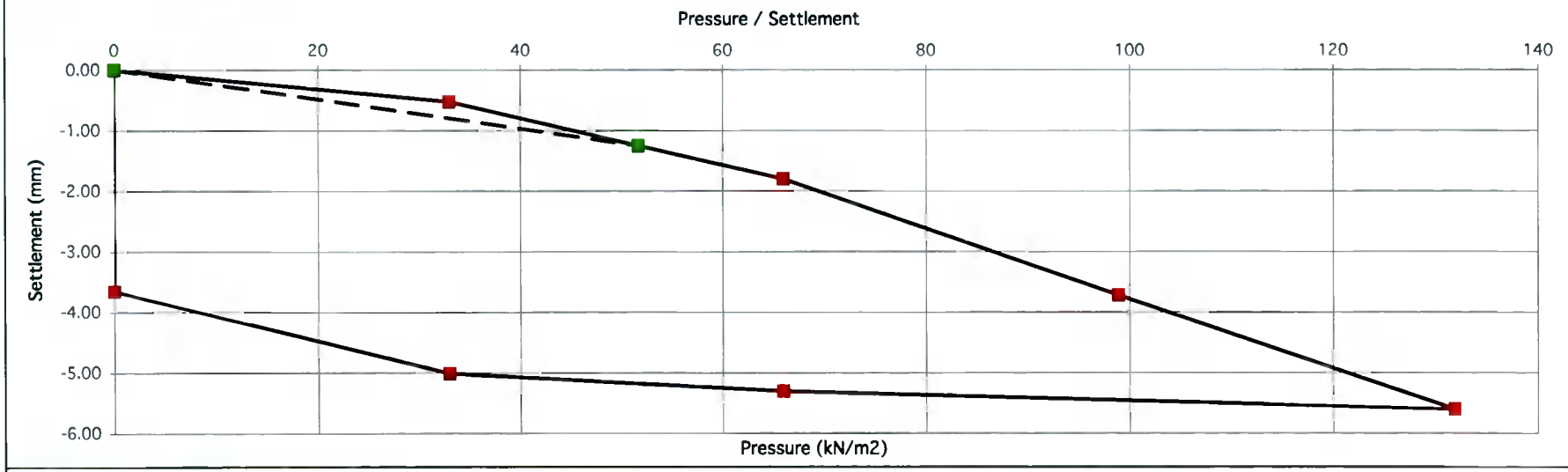
Reference No.	R122170
Contract	Project Appollo, Grangecastle
Test No.	PBT5 (LOAD)
Location	TP5
Depth	0.5m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	26/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Grey mottled sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 41

Modulus of subgrade reaction = 27 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 2.8 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

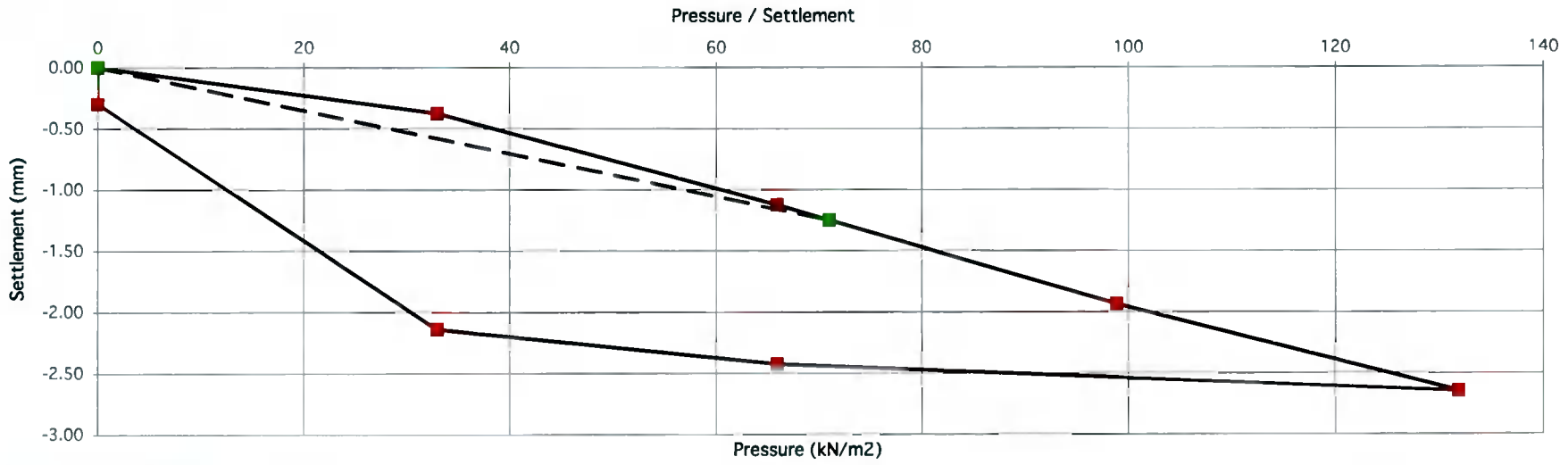
Reference No.	R122170
Contract	Project Appollo, Grangecastle
Test No.	PBT5 (RELOAD)
Location	TP5
Depth	0.5m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	26/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Grey mottled sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 57

Modulus of subgrade reaction = 37 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 4.9 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

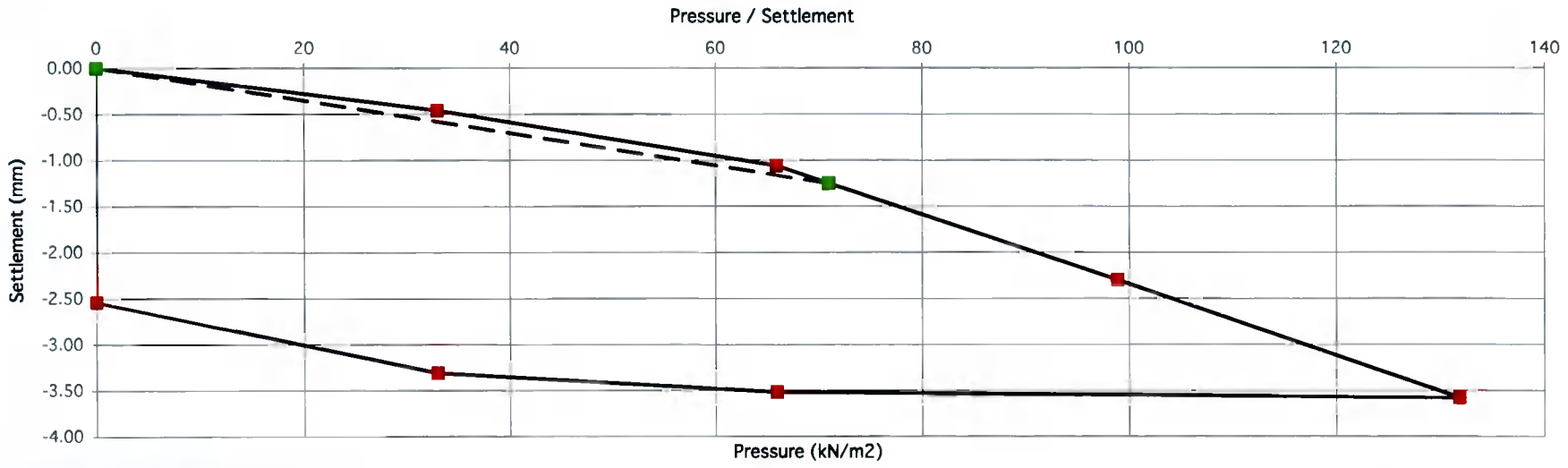
Reference No.	R122171
Contract	Project Appollo, Grangecastle
Test No.	PBT6 (LOAD)
Location	TP6
Depth	0.6m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	25/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Grey brown sandy gravelly CLAY

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 57

Modulus of subgrade reaction = 36 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 4.9 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

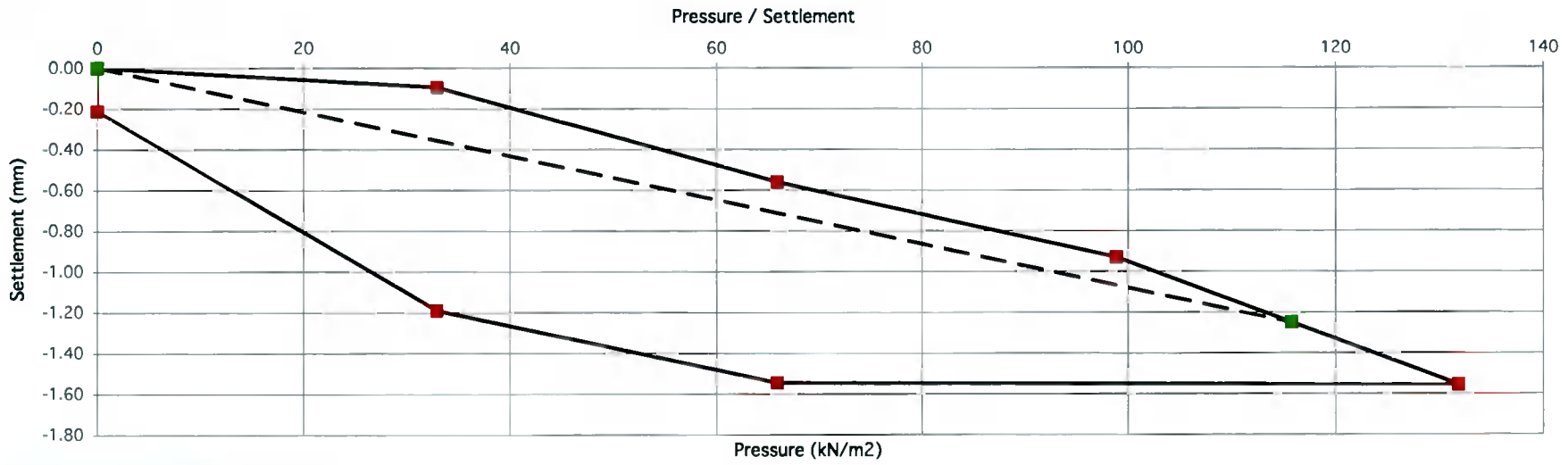
Reference No.	R122171
Contract	Project Appollo, Grangecastle
Test No.	PBT6 (RELOAD)
Location	TP6
Depth	0.6m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	25/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Grey brown sandy gravelly CLAY

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 93

Modulus of subgrade reaction = 60 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 11.5 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

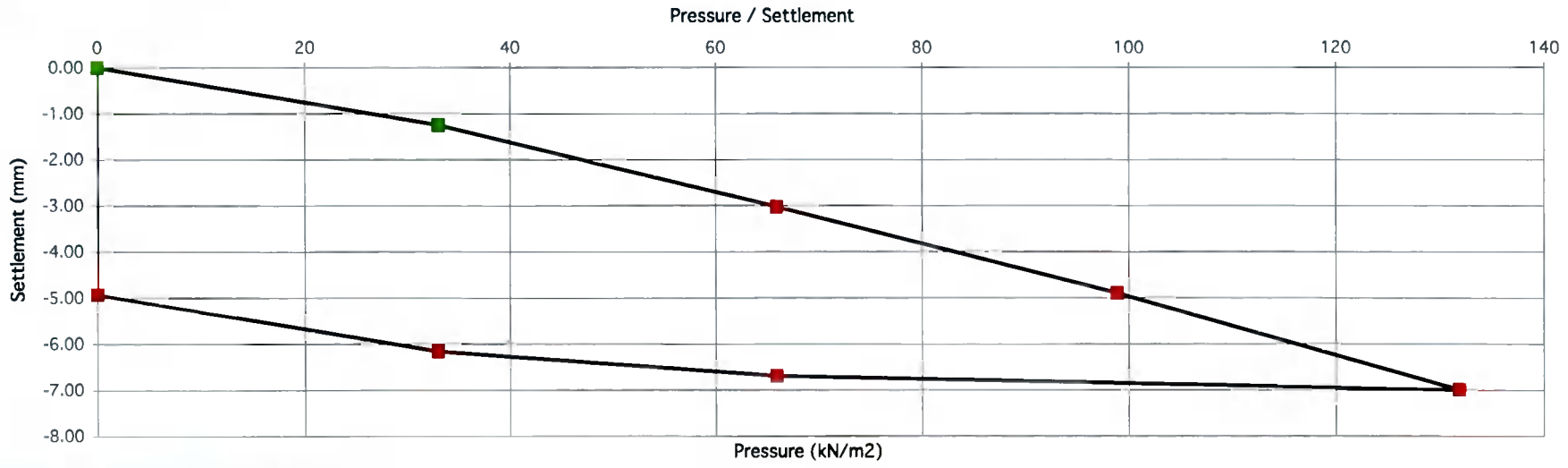
Reference No.	R122172
Contract	Project Appollo, Grangecastle
Test No.	PBT7 (LOAD)
Location	TP7
Depth	0.5m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	25/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 26

Modulus of subgrade reaction = 17 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 1.3 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

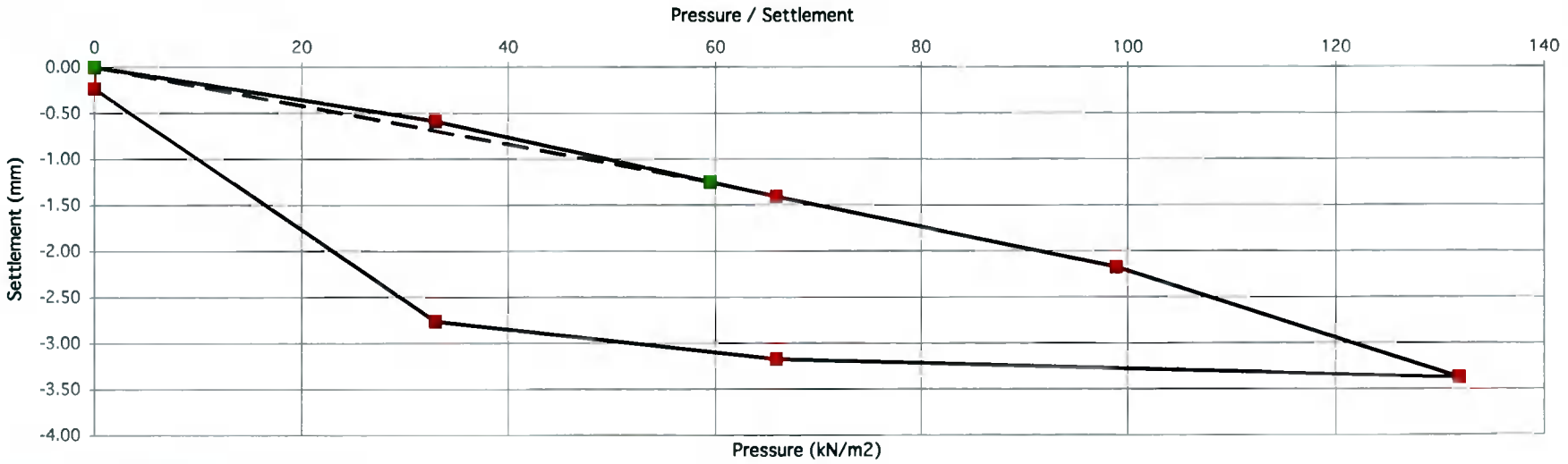
Reference No.	R122172
Contract	Project Appollo, Grangecastle
Test No.	PBT7 (RELOAD)
Location	TP7
Depth	0.5m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	25/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 48

Modulus of subgrade reaction = 31 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 3.6 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

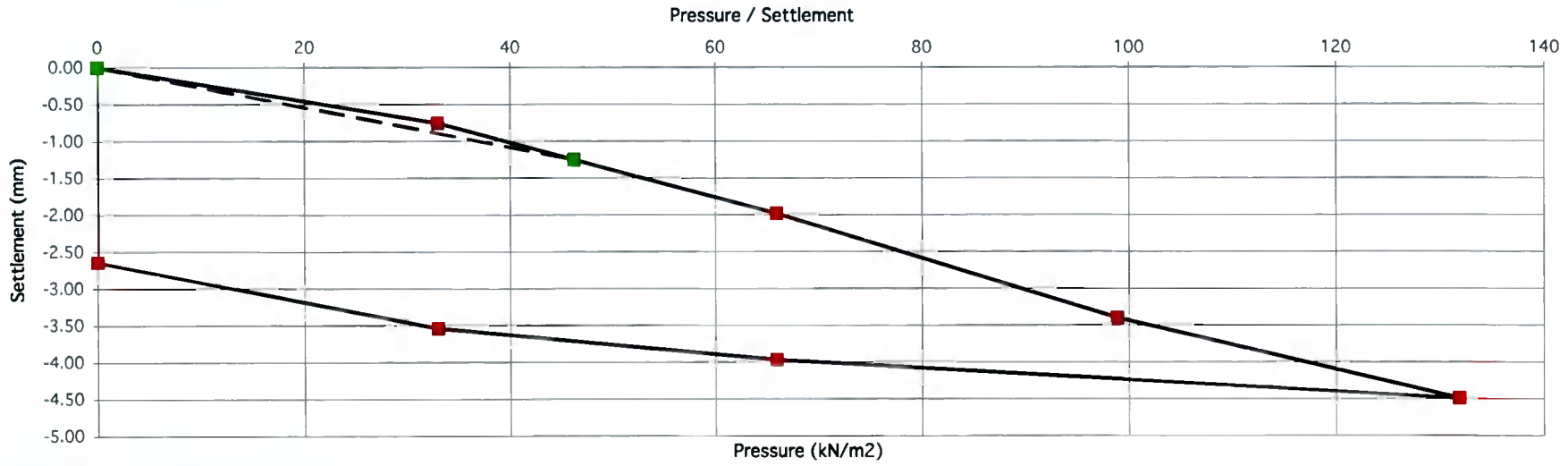
Reference No.	R122173
Contract	Project Appollo, Grangecastle
Test No.	PBT8 (LOAD)
Location	TP8
Depth	0.5m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	26/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Grey sandy gravelly CLAY

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 37

Modulus of subgrade reaction = 24 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 2.3 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

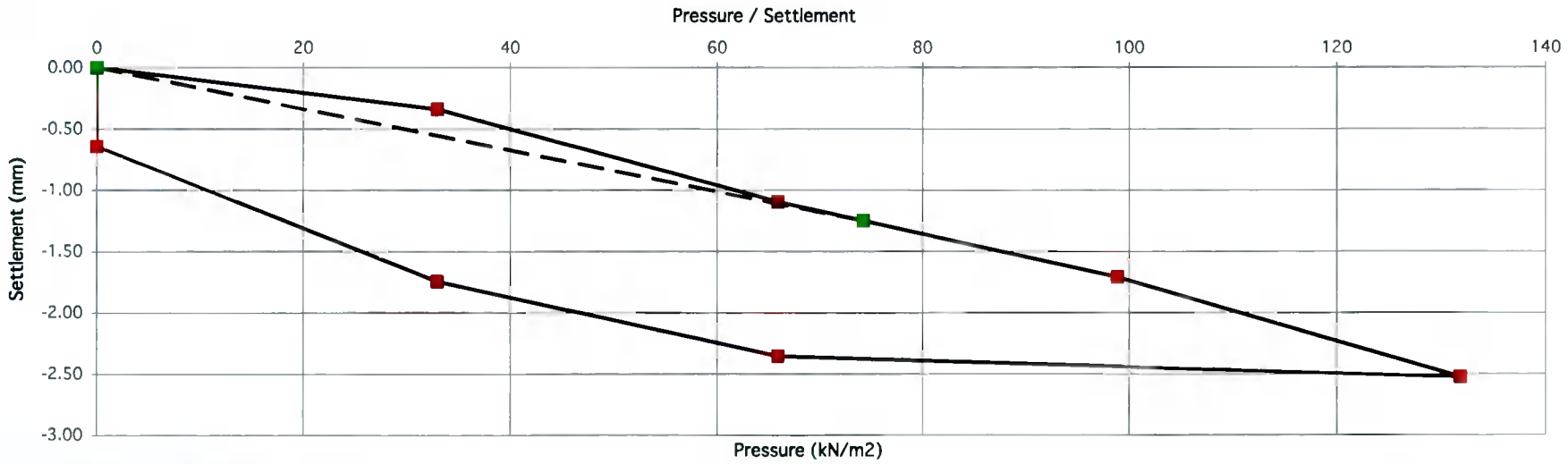
Reference No.	R122173
Contract	Project Appollo, Grangecastle
Test No.	PBT8 (RELOAD)
Location	TP8
Depth	0.5m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	26/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Grey sandy gravelly CLAY

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 59

Modulus of subgrade reaction = 38 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 5.3 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

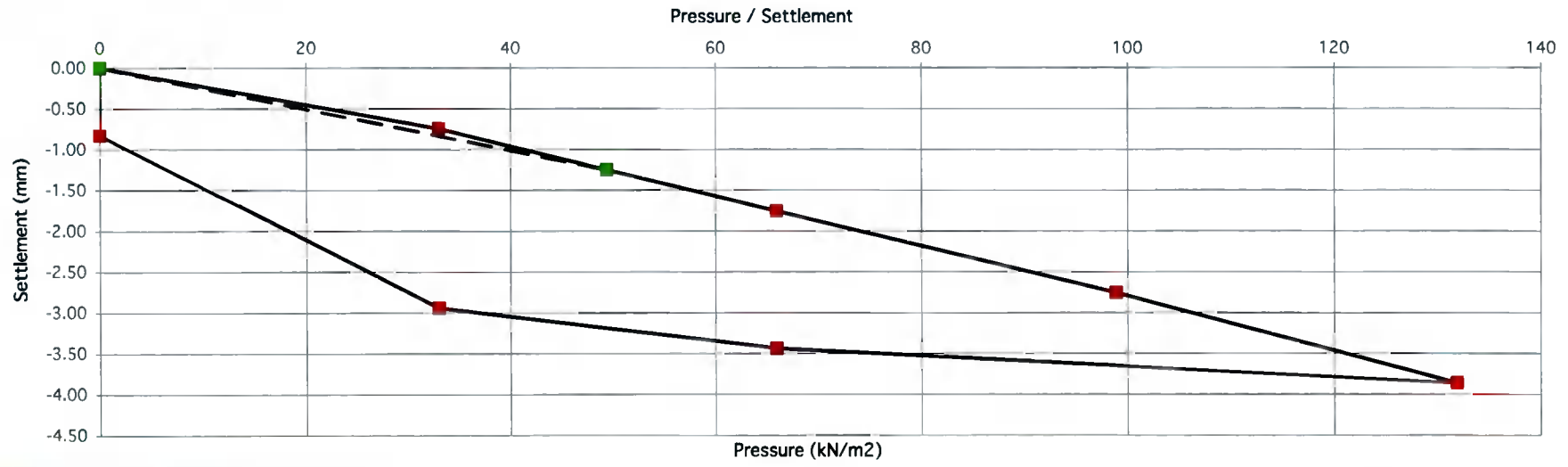
Reference No.	R122174
Contract	Project Appollo, Grangecastle
Test No.	PBT9 (LOAD)
Location	TP9
Depth	0.4m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	25/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 40

Modulus of subgrade reaction = 25 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 2.6 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

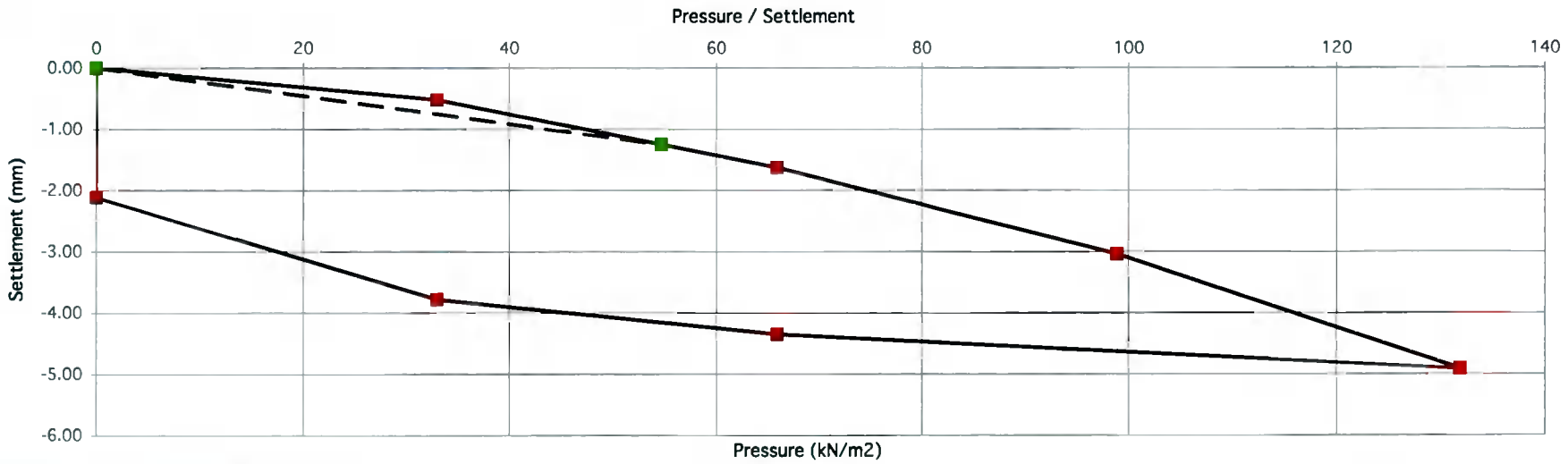
Reference No.	R122174
Contract	Project Appollo, Grangecastle
Test No.	PBT9 (RELOAD)
Location	TP9
Depth	0.4m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	25/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 44

Modulus of subgrade reaction = 28 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 3.1 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

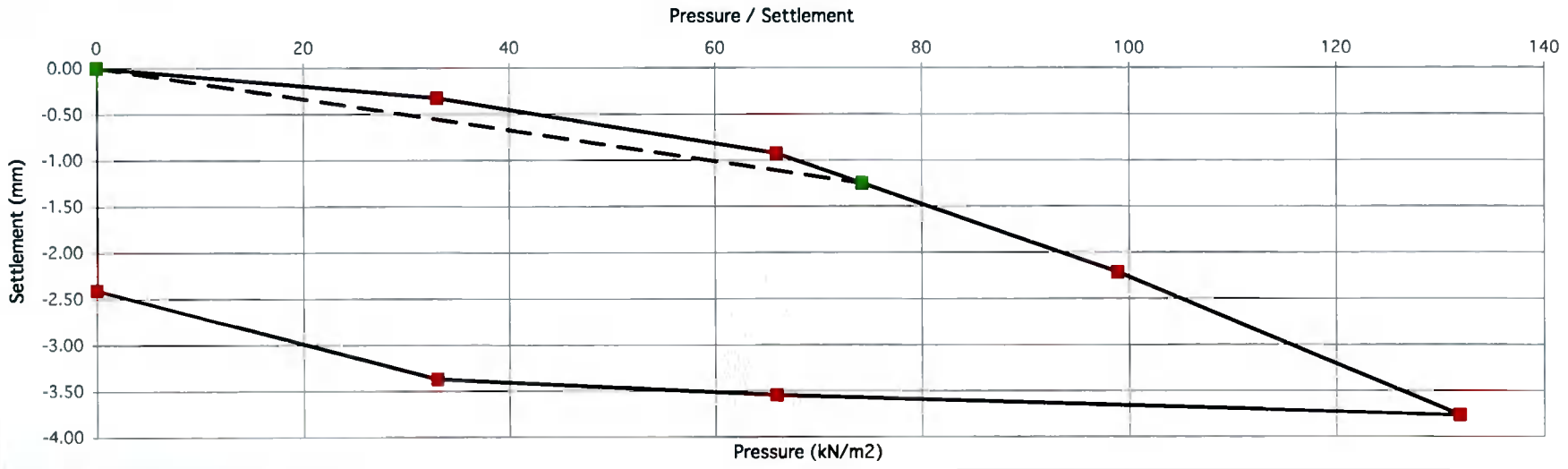
Reference No.	R122175
Contract	Project Appollo, Grangecastle
Test No.	PBT10 (LOAD)
Location	TP10
Depth	0.4m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	25/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Grey sandy gravelly CLAY

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 59

Modulus of subgrade reaction = 38 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 5.3 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

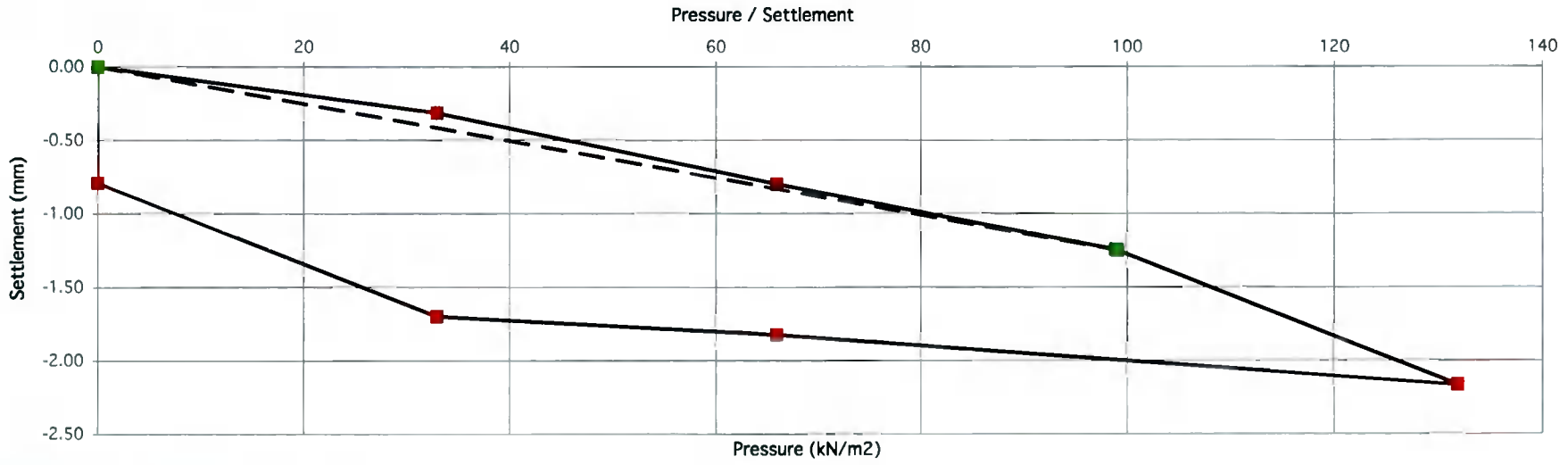
Reference No.	R122175
Contract	Project Appollo, Grangecastle
Test No.	PBT10 (RELOAD)
Location	TP10
Depth	0.4m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	25/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Grey sandy gravelly CLAY

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 79

Modulus of subgrade reaction = 51 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 8.8 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

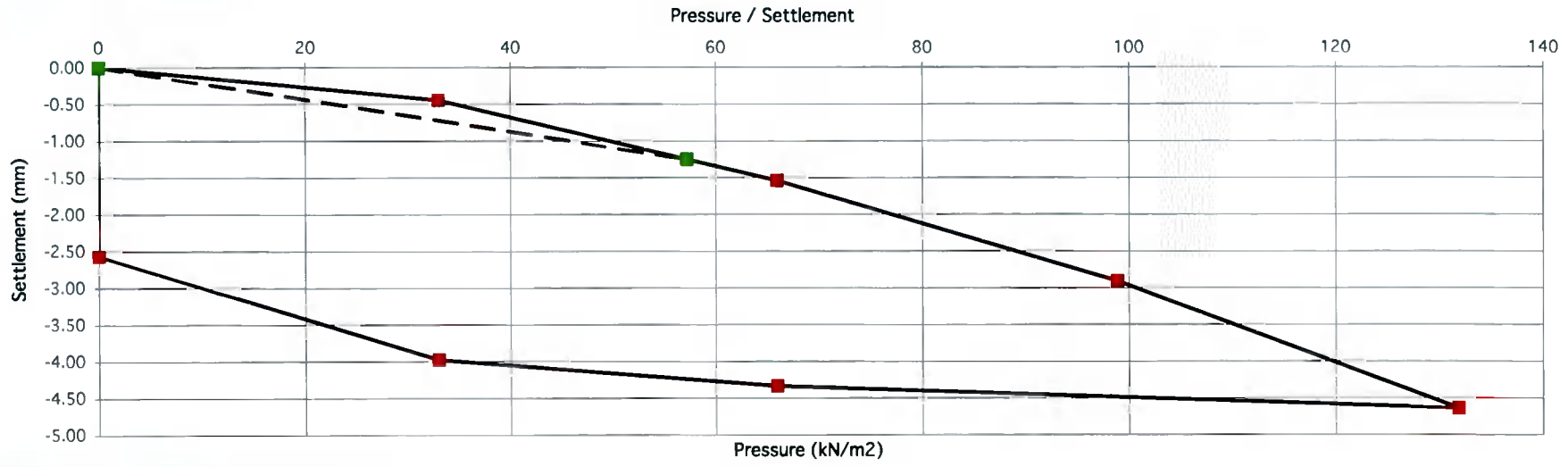
Reference No.	R122176
Contract	Project Appollo, Grangecastle
Test No.	PBT11 (LOAD)
Location	TP11
Depth	0.4m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	26/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 46

Modulus of subgrade reaction = 29 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 3.4 %

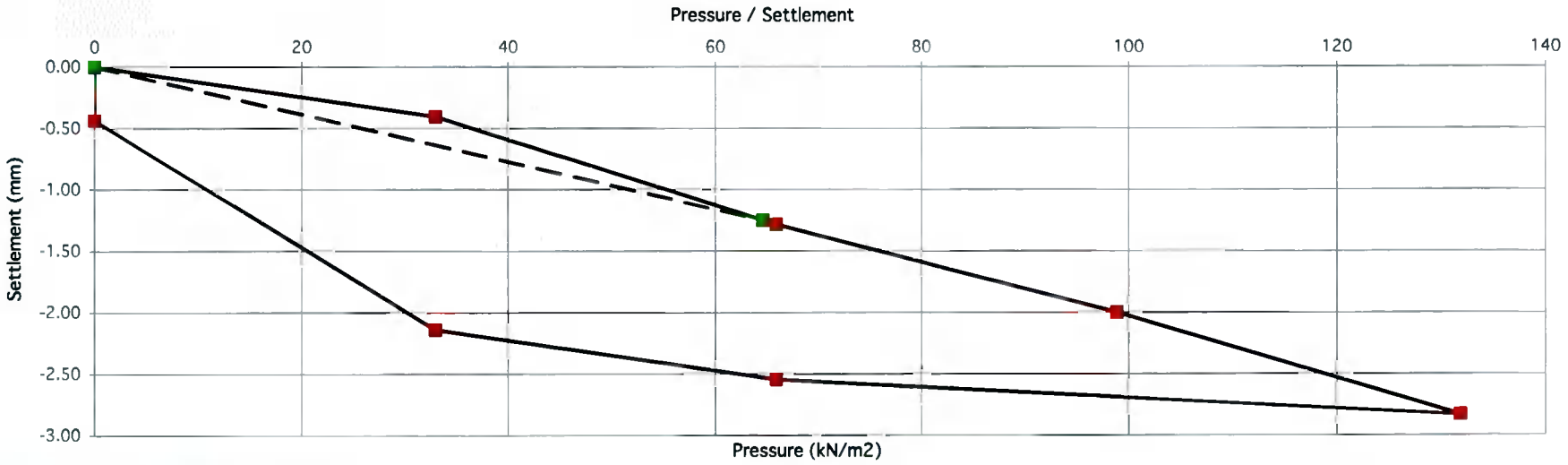
PLATE TEST REPORT SHEET (F3.1)		Applied Pressure/Settlement Curve
Reference No.	R122176	
Contract	Project Appollo, Grangecastle	
Test No.	PBT11 (RELOAD)	
Location	TP11	
Depth	0.4m	
Client	Ramboll	
Plate Diameter:	450 mm	
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test	
Technician	A. Garne	
Authorised by		
Date	26/05/2021	

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 52

Modulus of subgrade reaction = 33 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 4.2 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

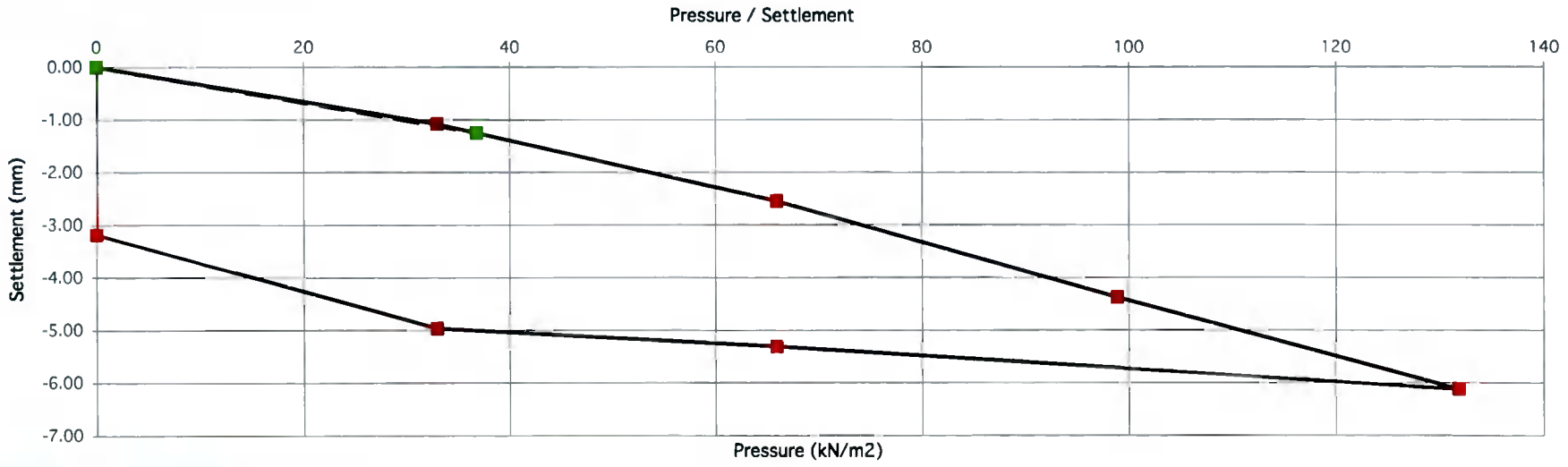
Reference No.	R122177
Contract	Project Appollo, Grangecastle
Test No.	PBT12 (LOAD)
Location	TP12
Depth	0.4m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	25/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Grey sandy gravelly CLAY

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 29

Modulus of subgrade reaction = 19 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 1.6 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

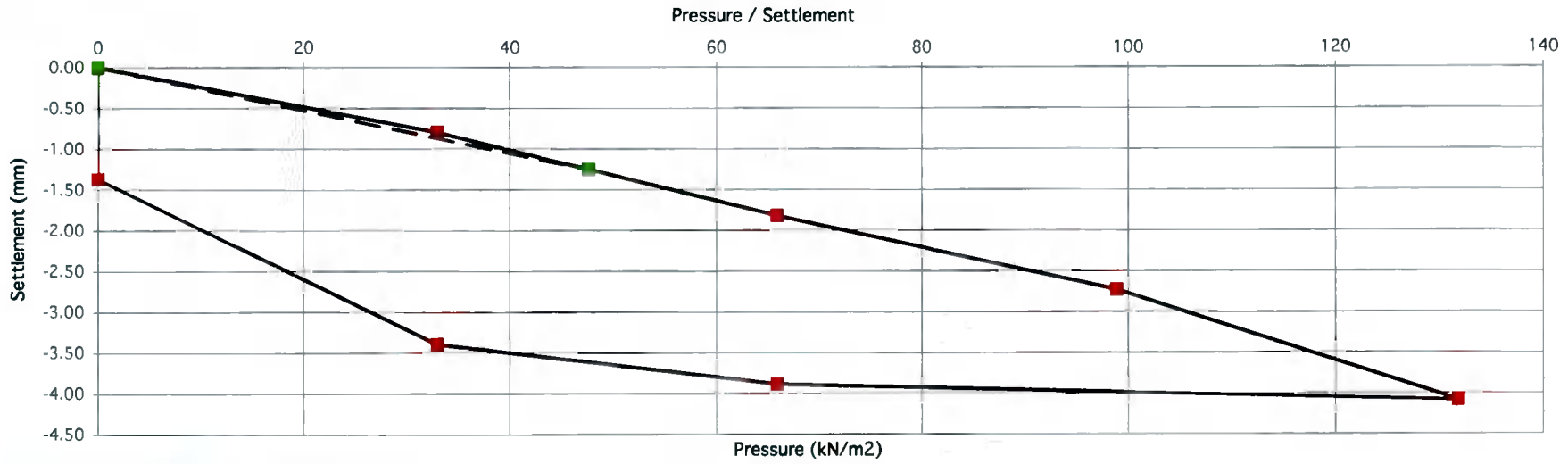
Reference No.	R122177
Contract	Project Appollo, Grangecastle
Test No.	PBT12 (RELOAD)
Location	TP12
Depth	0.4m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	25/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Grey sandy gravelly CLAY

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 38

Modulus of subgrade reaction = 24 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 2.5 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

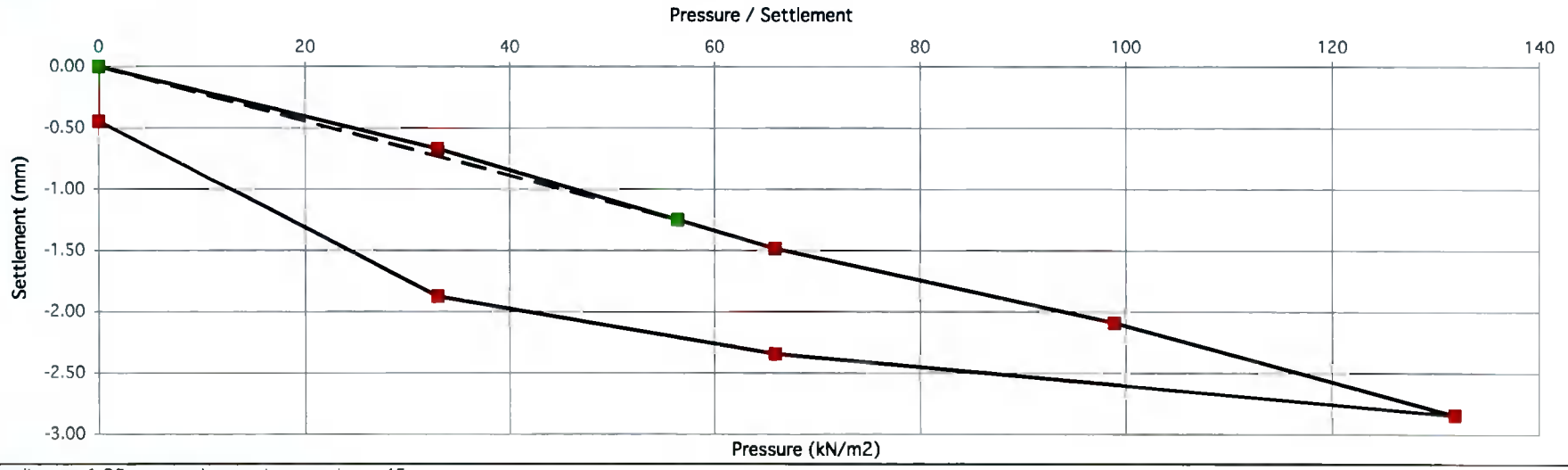
Reference No.	R122178
Contract	Project Appollo, Grangecastle
Test No.	PBT13 (LOAD)
Location	TP13
Depth	0.4m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	26/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 45

Modulus of subgrade reaction = 29 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 3.3 %

PLATE TEST REPORT SHEET (F3.1)

Applied Pressure/Settlement Curve

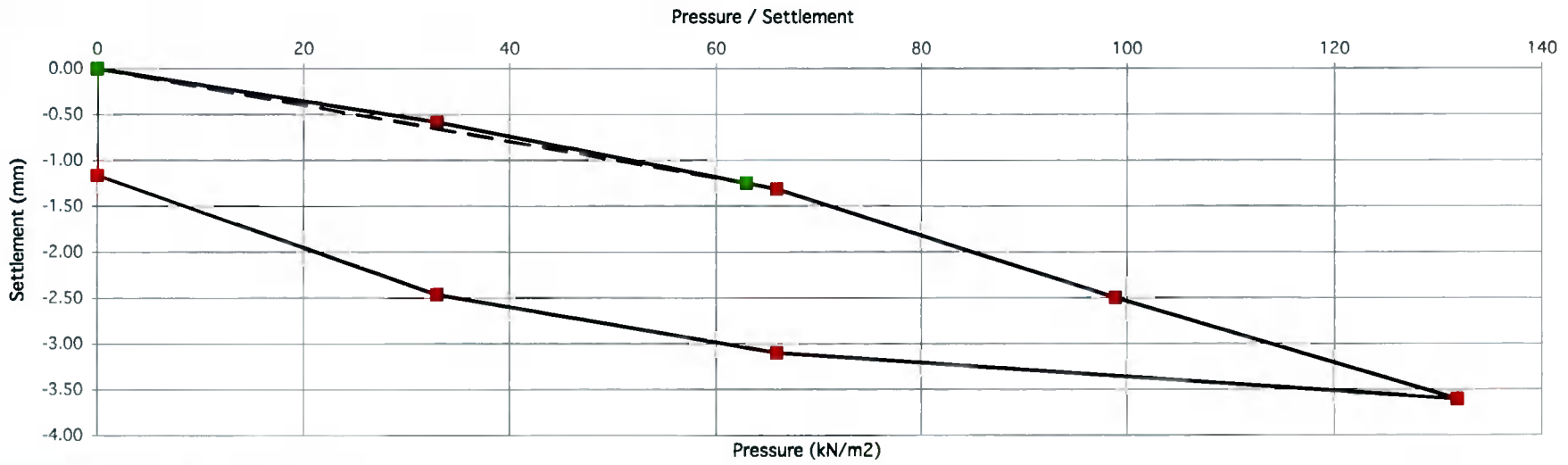
Reference No.	R122178
Contract	Project Appollo, Grangecastle
Test No.	PBT13 (RELOAD)
Location	TP13
Depth	0.4m
Client	Ramboll
Plate Diameter:	450 mm
Test Method	BS 1377: Part 9: 1990 Test4 - Incremental Loading Test
Technician	A. Garne
Authorised by	
Date	26/05/2021

Description of soil under test (natural soil, placed fill, sub-base)

Orange brown sandy SILT

Sample Ref No. N/A

Depth _____ m bgl



Gradient at 1.25 mm settlement intersection = 50

Modulus of subgrade reaction = 32 MPa/m

Correction factor applied = 0.64 as per HD 25-26/10

Equivalent CBR value in accordance with NRA HD25-26/10 4.0 %

Appendix 5

Soakaway Test Records

Soakaway Design f -value from field tests (F2C) IGSL

Contract: Project Appollo
Contract No. 23300
Test No. SA1 (cycle 1)
Client Ramboll
Date: 22/06/2021

Summary of ground conditions

from	to	Description	Ground water
0.00	0.40	TOPSOIL	Seepage from 1.9m
0.40	1.20	Firm grey / brown silty sandy gravelly CLAY with medium cobble content.	
1.20	2.00	Firm black very sandy gravelly CLAY with medium to high cobble content.	

Notes: Water was allowed to rise naturally

Field Data

Depth to Water (m)	Elapsed Time (min)
1.98	0.00
1.98	1.00
1.98	2.00
1.97	3.00
1.97	4.00
1.96	5.00
1.96	6.00
1.95	7.00
1.95	8.00
1.94	9.00
1.94	10.00
1.93	12.00
1.92	14.00
1.91	16.00
1.90	18.00
1.90	20.00
1.88	25.00
1.87	30.00
1.87	35.00
1.86	40.00
1.84	50.00
1.83	60.00
1.81	90.00
1.79	120.00

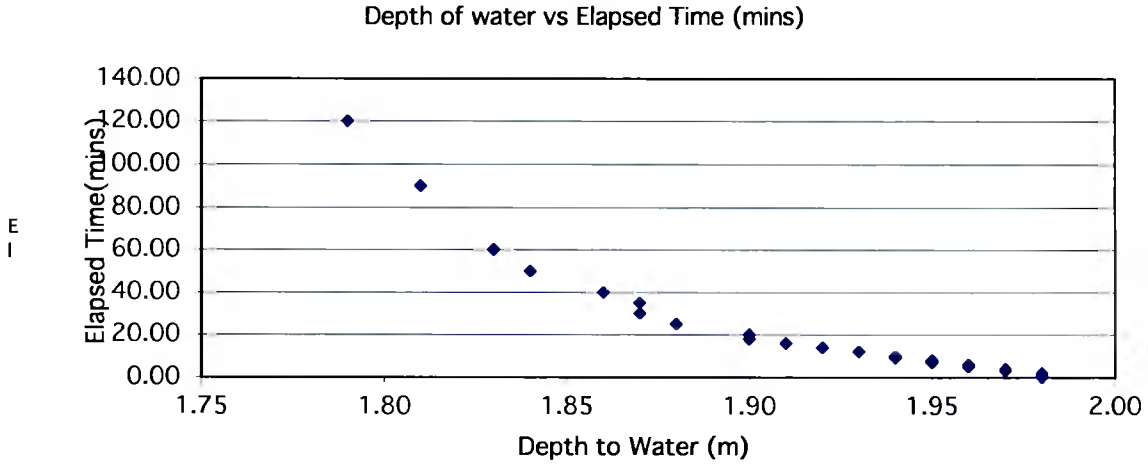
Field Test

Depth of Pit (D)	2.00	m
Width of Pit (B)	0.60	
Length of Pit (L)	2.50	m
Initial depth to Water =	1.98	m
Final depth to water =	1.79	m
Elapsed time (mins)=	120.00	
Top of permeable soil		m
Base of permeable soil		m
Base area=	1.5	m2
*Av. side area of permeable stratum over test perio	0.713	m2
Total Exposed area =	2.213	m2

Infiltration rate (f) = Volume of water used/unit exposed area / unit time

f= 0 m/min or 0 m/sec

Water rose during test - test failed



Soakaway Design f -value from field tests (F2C) IGSL

Contract: Project Appollo Contract No. 23300
Test No. SA1 (cycle 2)
Client Ramboll
Date: 22/06/2021

Summary of ground conditions

from	to	Description	Ground water
0.00	0.40	TOPSOIL	Seepage from 1.9m
0.40	1.20	Firm grey / brown silty sandy gravelly CLAY with medium cobble content.	
1.20	2.00	Firm black very sandy gravelly CLAY with medium to high cobble content.	

Field Data

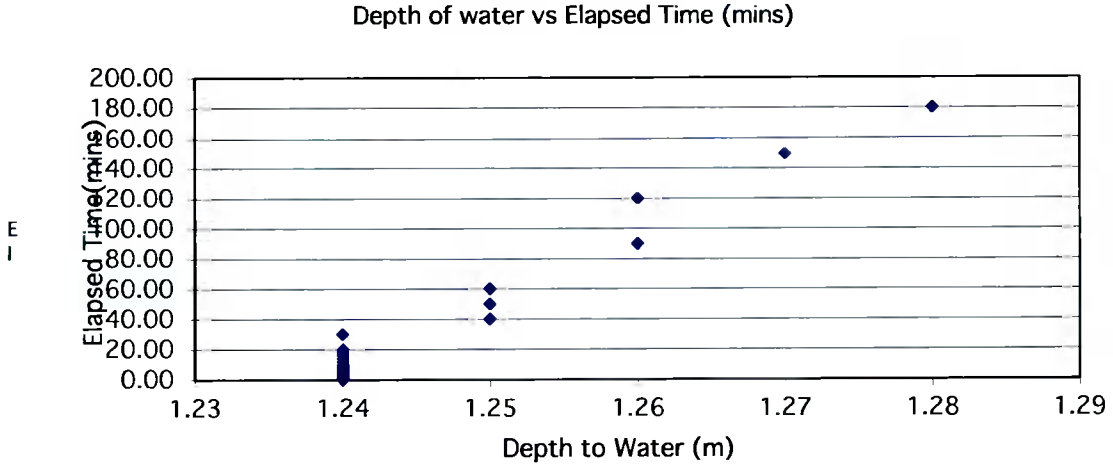
Depth to Water (m)	Elapsed Time (min)
1.24	0.00
1.24	1.00
1.24	2.00
1.24	3.00
1.24	4.00
1.24	5.00
1.24	6.00
1.24	7.00
1.24	8.00
1.24	9.00
1.24	10.00
1.24	12.00
1.24	14.00
1.24	16.00
1.24	18.00
1.24	20.00
1.24	30.00
1.25	40.00
1.25	50.00
1.25	60.00
1.26	90.00
1.26	120.00
1.27	150.00
1.28	180.00

Field Test

Depth of Pit (D)	2.00	m
Width of Pit (B)	0.60	
Length of Pit (L)	2.50	m
Initial depth to Water =	1.24	m
Final depth to water =	1.28	m
Elapsed time (mins)=	180.00	
Top of permeable soil		m
Base of permeable soil		m
Base area=	1.5	m2
*Av. side area of permeable stratum over test perio	4.588	m2
Total Exposed area =	6.088	m2

Infiltration rate (f) = Volume of water used/unit exposed area / unit time

f= 5.5E-05 m/min or 9.12542E-07 m/sec



Soakaway Design f -value from field tests (F2C) IGSL

Contract: Project Appollo
Test No. SA2 (cycle 1)
Client Ramboll
Date: 22/06/2021

Contract No. 23300

Summary of ground conditions

from	to	Description	Ground water
0.00	0.40	TOPSOIL	Seepage from 1.7m
0.40	1.60	Firm grey / brown silty sandy gravelly CLAY with medium cobble content.	
1.60	2.00	Firm black very sandy gravelly CLAY with medium to high cobble content.	

Notes: Water was allowed to rise naturally

Field Data

Depth to Water (m)	Elapsed Time (min)
1.93	0.00
1.93	1.00
1.92	2.00
1.92	3.00
1.91	4.00
1.91	5.00
1.90	6.00
1.90	7.00
1.89	8.00
1.89	9.00
1.88	10.00
1.87	12.00
1.86	14.00
1.85	16.00
1.84	18.00
1.84	20.00
1.81	30.00
1.78	40.00
1.76	50.00
1.74	60.00
1.72	90.00
1.70	120.00

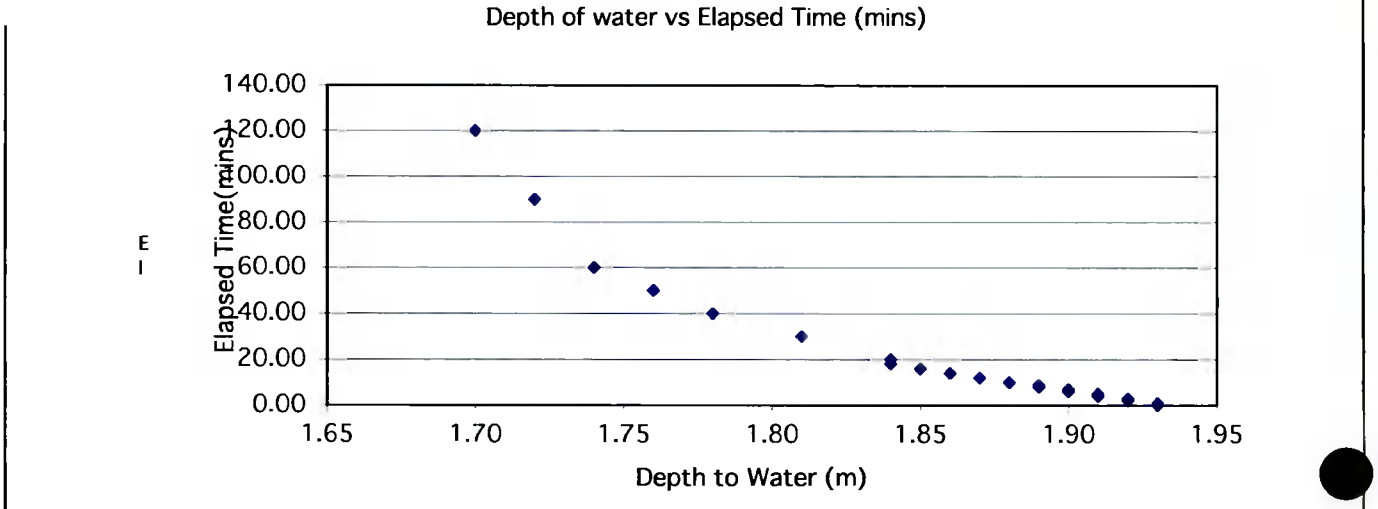
Field Test

Depth of Pit (D)	2.00	m
Width of Pit (B)	0.60	
Length of Pit (L)	2.30	m
Initial depth to Water =	1.93	m
Final depth to water =	1.70	m
Elapsed time (mins)=	120.00	
Top of permeable soil		m
Base of permeable soil		m
Base area=	1.38	m2
*Av. side area of permeable stratum over test perio	1.073	m2
Total Exposed area =	2.453	m2

Infiltration rate (f) = Volume of water used/unit exposed area / unit time

f= 0 m/min or 0 m/sec

Water rose during test - test failed



Soakaway Design f -value from field tests (F2C) IGSL

Contract: Project Appollo Contract No. 23300
Test No. SA2 (cycle 2)
Client Ramboll
Date: 22/06/2021

Summary of ground conditions

from	to	Description	Ground water
0.00	0.40	TOPSOIL	Seepage from 1.7m
0.40	1.60	Firm grey / brown silty sandy gravelly CLAY with medium cobble content.	
1.60	2.00	Firm black very sandy gravelly CLAY with medium to high cobble content.	

Notes:

Field Data

Depth to Water (m)	Elapsed Time (min)
1.43	0.00
1.43	1.00
1.43	2.00
1.43	3.00
1.43	4.00
1.43	5.00
1.43	6.00
1.43	7.00
1.43	8.00
1.43	9.00
1.43	10.00
1.43	12.00
1.43	14.00
1.43	16.00
1.43	18.00
1.43	20.00
1.43	30.00
1.43	40.00
1.43	50.00
1.43	60.00
1.43	90.00
1.43	120.00
1.43	150.00
1.43	180.00

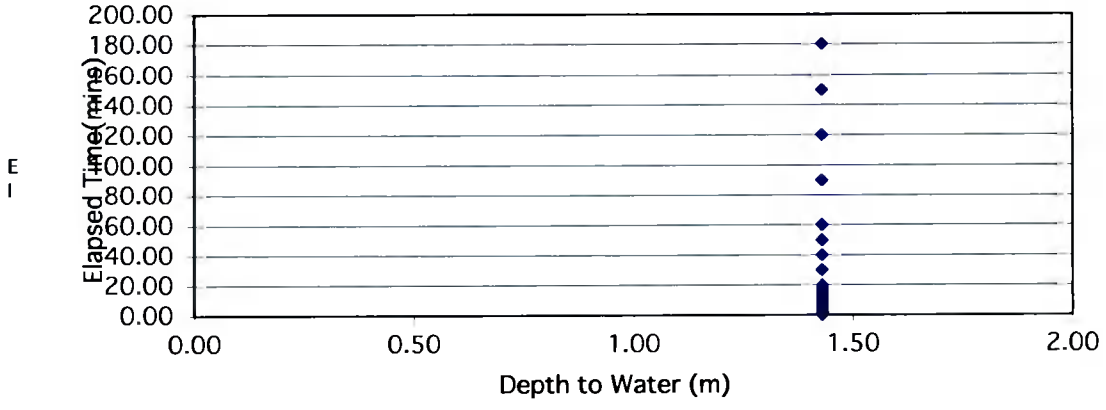
Field Test

Depth of Pit (D)	2.00	m
Width of Pit (B)	0.60	
Length of Pit (L)	2.30	m
Initial depth to Water =	1.43	m
Final depth to water =	1.43	m
Elapsed time (mins)=	180.00	
Top of permeable soil		m
Base of permeable soil		m
Base area=	1.38	m2
*Av. side area of permeable stratum over test perio	3.306	m2
Total Exposed area =	4.686	m2

Infiltration rate (f) = Volume of water used/unit exposed area / unit time

f= 0 m/min or 0 m/sec

Depth of water vs Elapsed Time (mins)



Soakaway Design f -value from field tests (F2C) IGSL

Contract: Project Appollo Contract No. 23300
Test No. SA3 (cycle 1)
Client Ramboll
Date: 22/06/2021

Summary of ground conditions

from	to	Description	Ground water
0.00	0.30	TOPSOIL	None observed
0.30	1.10	Soft brown sandy gravelly CLAY with low cobble content	
1.10	2.00	Firm grey mottled brown slightly silty sandy gravelly CLAY.	

Notes:

Field Data

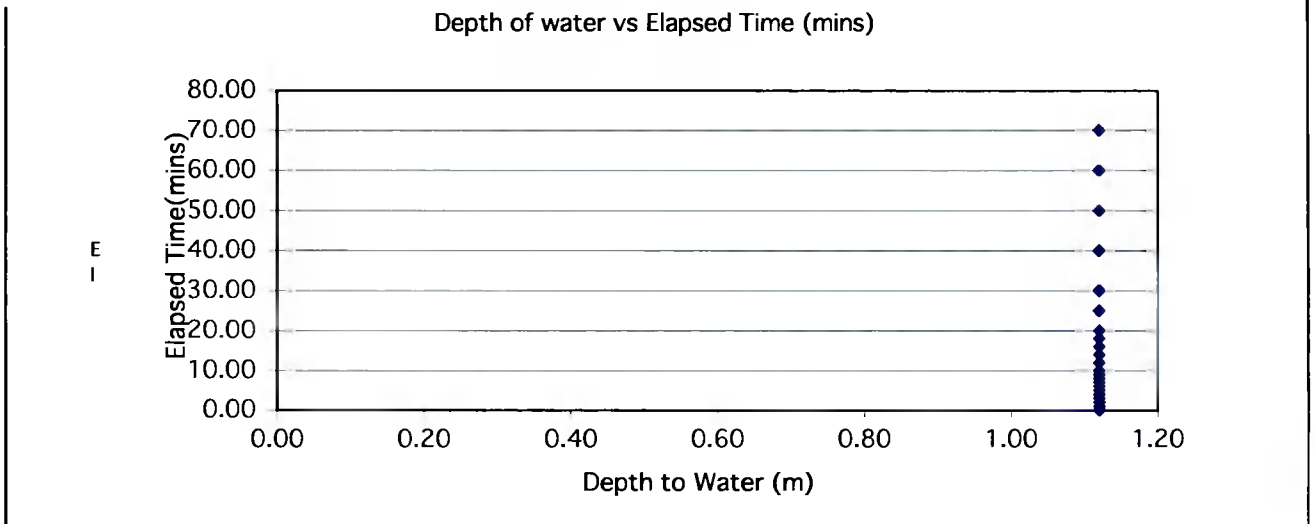
Depth to Water (m)	Elapsed Time (min)
1.12	0.00
1.12	1.00
1.12	2.00
1.12	3.00
1.12	4.00
1.12	5.00
1.12	6.00
1.12	7.00
1.12	8.00
1.12	9.00
1.12	10.00
1.12	12.00
1.12	14.00
1.12	16.00
1.12	18.00
1.12	20.00
1.12	25.00
1.12	30.00
1.12	40.00
1.12	50.00
1.12	60.00
1.12	70.00

Field Test

Depth of Pit (D)	2.00	m
Width of Pit (B)	0.60	
Length of Pit (L)	2.40	m
Initial depth to Water =	1.12	m
Final depth to water =	1.12	m
Elapsed time (mins)=	70.00	
Top of permeable soil		m
Base of permeable soil		m
Base area=	1.44	m2
*Av. side area of permeable stratum over test perio	5.28	m2
Total Exposed area =	6.72	m2

Infiltration rate (f) = Volume of water used/unit exposed area / unit time

f= 0 m/min or 0 m/sec



Soakaway Design f -value from field tests (F2C) IGSL

Contract: Project Appollo Contract No. 23300
Test No. SA3 (cycle 2)
Client Ramboll
Date: 22/06/2021

Summary of ground conditions

from	to	Description	Ground water
0.00	0.30	TOPSOIL	None observed
0.30	1.10	Soft brown sandy gravelly CLAY with low cobble content	
1.10	2.00	Firm grey mottled brown slightly silty sandy gravelly CLAY.	

Notes:

Field Data

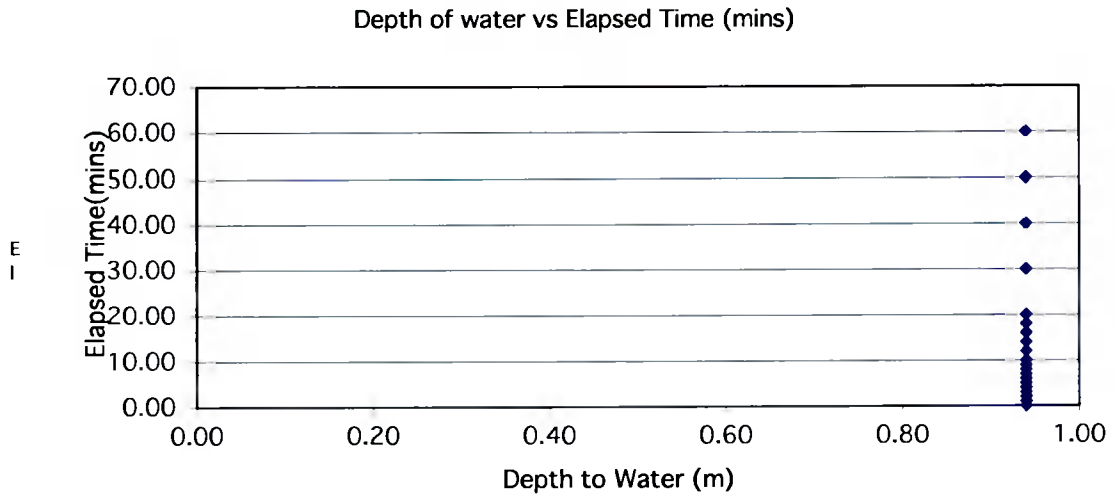
Depth to Water (m)	Elapsed Time (min)
0.94	0.00
0.94	1.00
0.94	2.00
0.94	3.00
0.94	4.00
0.94	5.00
0.94	6.00
0.94	7.00
0.94	8.00
0.94	9.00
0.94	10.00
0.94	12.00
0.94	14.00
0.94	16.00
0.94	18.00
0.94	20.00
0.94	30.00
0.94	40.00
0.94	50.00
0.94	60.00

Field Test

Depth of Pit (D)	2.00	m
Width of Pit (B)	0.60	
Length of Pit (L)	2.40	m
Initial depth to Water =	0.94	m
Final depth to water =	0.94	m
Elapsed time (mins)=	60.00	
Top of permeable soil		m
Base of permeable soil		m
Base area=	1.44	m2
*Av. side area of permeable stratum over test perio	6.36	m2
Total Exposed area =	7.8	m2

Infiltration rate (f) = Volume of water used/unit exposed area / unit time

f= 0 m/min or 0 m/sec



Appendix 6

Groundwater Monitoring Records

Groundwater Monitoring

Site Location	Project Apollo
Project No.	23300
Engineer	Ramboll

Hole No.	Elevation (m OD)	Date of Reading					
		21/06/2021					
		m bgl	m OD	m bgl	m OD	m bgl	m OD
RC01	72.50	0.97	71.530				
RC02	73.25	1.54	71.710				
RC03	73.51	1.89	71.620				

NOTES

Appendix 7

Geophysical Survey Report