

GEOTECHNICAL REVIEW

3rd June 2025

Project Name:	Dove Valley Park
Project No:	255659
Revision:	P01
Reference:	255659-BWB-ZZ-XX-TDN-GE-4001-S1-P01.1
Author:	Ian Gardner
Reviewer	
Approver:	

1. INTRODUCTION

BWB Consulting Ltd (BWB) had been appointed by Benniman Construction Group Ltd (BCG) to assist them in providing geotechnical advice with respect to the proposed development identified as Dove Valley Park. The specific development areas is also known as Miry Lane, Dove Valley Park, Foston.

The ultimate Client for the development is Clowes Developments UK Ltd (Clowes). Clowes had appointed Jackson Purdue Lever (JPL) as the Civil Engineer for the scheme, with an understanding that JPL would also be acting as the Structural Engineer.

A number of documents have been provided to BWB for review, including the following sources of information.

- Site Investigation Report, Dove Valley, Foston. Reported prepared by Lucion Ground Engineering Ltd, on behalf of Clowes Developments UK Ltd, document reference 118613-Rev0 (Draft) dated April 2025.
- Base Build Specification, Unit 11C, Dove Valley Park, 450,000 sq ft. Document prepared by Clowes Developments UK Ltd, Revision 1, dated 17th April 2024.
- AutoCAD Topographical Survey. Document reference 43317A_T_REV3 3D. Document provided by electronic link from Jackson Purdue Lever.
- AutoCAD model of proposed earthworks, including earthwork isopach indicating proposed cut to fill requirements. Document reference 002949-JPL-ZZ-ZZ-D-C-1101-S2-P03 Earthworks Assessment. Document provided by electronic link from Jackson Purdue Lever.

The content of this Technical Design Note (TDN) has been prepared on behalf of BCG, to assist them in understanding the likely geotechnical solution required for the development. It is noted that within the Site Investigation report (GIR, document reference 118613-Rev0), that the authors of the report had identified specific geological sequences present on site, that they considered unsuitable for a founding stratum. In addition to the suitability or otherwise of specific strata to support new structures, consideration has to be given to the implications of the required earthworks cut to fill, and the potential for excessive settlement to occur where new fill is placed over potentially compressible deposits.

This TDN includes a resume of the review of the currently available geotechnical information, identifies a potential ground improvement strategy, and presents a scope of recommended supplementary design investigation intended to remove as far as possible, any uncertainties in the optimum solution for the site.

As required by the Base Build Specification, all geotechnical designs have to be completed in accordance with all current codes of practice and British Standards. For the purpose of this review, the following standards represent the current UK code for geotechnical design have been adopted:

- BS EN 1997-1:2004+A1:2013: Geotechnical Design, general rules.
 - Reference has also been made to the second generation of BS EN 1997-1: 2024, BS EN 1997-2:2024 & BS EN 1997-3:2025, which whilst not formerly adopted until March 2028, do provide an enhancement of the geotechnical design process and the required content for a Geotechnical Design Report.
 - This standard requires each geostructural element to be given a Geotechnical Category (GC), with earthworks and embankments defined as GC 2.
 - This standard requires the preparation of a Geotechnical Design Report (GDR), where the qualitative and quantitative findings of the geotechnical design process are to be presented, along with the necessary drawings, specifications and schedule of monitoring and inspection.
 - The GDR is to be prepared once the appointment of the contractor is made and shall be specific to the geotechnical elements to be constructed, including earthworks, ground improvement and any associated retaining walls.
 - The content of the GDR is now defined in BS EN 1997-3:2025, which whilst not to be formerly adopted until March 2028, is considered to be relevant where no other form of report structure has been given. The structure of the report should also be cognisant of the guidance provided in DMRB CD 622, as advised by BS 6031.
- BS EN 1997-2:2007: Geotechnical design, ground investigation and testing.
- BS 6031:2009: Code of practice for earthworks.
 - This standard is subservient to BS EN 1997
- BS EN 16907:1 2018 to BS EN 16907-5:2018, Earthworks
 - This series of standards covers the preparation of the earthwork specification, following the requirements of BS EN 1997 and BS 6031.
 - As defined by BS 6031 & BS EN 16907, the basis for the earthwork specification would be the Manual of Contract Documents for Highway Works, Volume 1, Specification for Highway Works (SHW), modified as required by the geotechnical design process.

In preparing this TDN, reference has been made to the above standards. It should be recognised that this TDN does not represent the geotechnical design solution, and as a requirement of BS EN 1997, a GDR will need to be prepared.

2. GEOLOGICAL GROUND MODEL

From a review of the available data presented in the GIR, a geological ground model has been developed. The following figures present key aspects of the geological model and have been used in the development of the preliminary geotechnical recommendations.

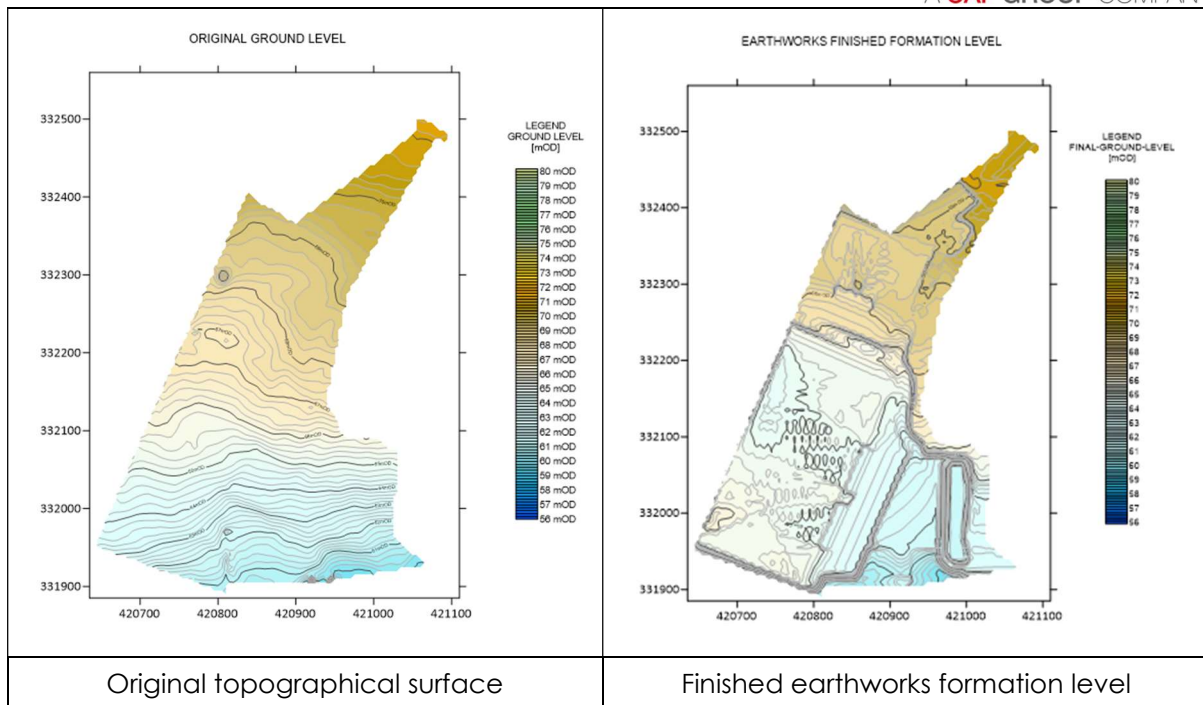


Figure 2-1: Original (left) and final ground level (right)

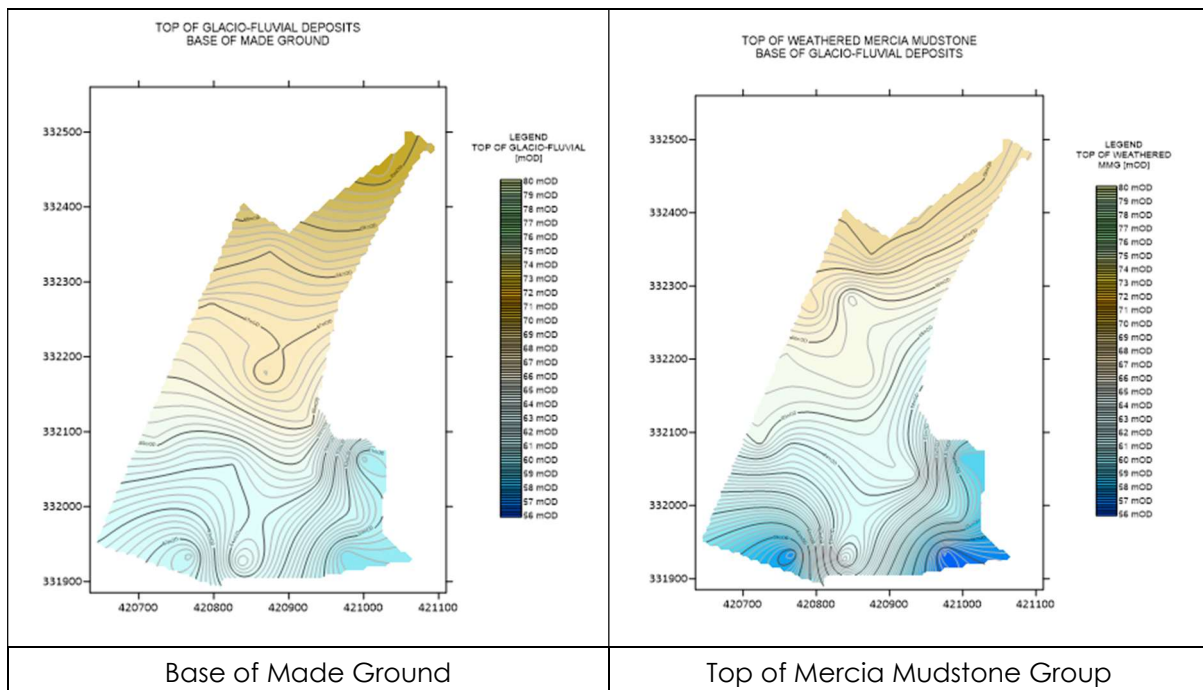


Figure 2-2: Key geological surfaces, base of Made Ground and Top of Mercia Mudstone

Figure 2-1 and Figure 2-2 present several of the geological surfaces that had been prepared based on the available geotechnical information. From a review of the GIR, an additional surface was developed, based on the inferred depth to a suitable founding strata. It is of note that the extent and complexity of the available GIR is limited, and that a quantum of interpretation has had to be made, to infer the competency of material between investigation locations, as well as the strength of stiffness of each deposit.

Based on the review of the likely depth to suitable founding stratum, a surface was prepared identifying the corresponding reduced level to this layer, as well as a model of the predicted

residual thickness of 'poor' ground remaining, following the proposed cut to fill. These figures are presented as Figure 2-3

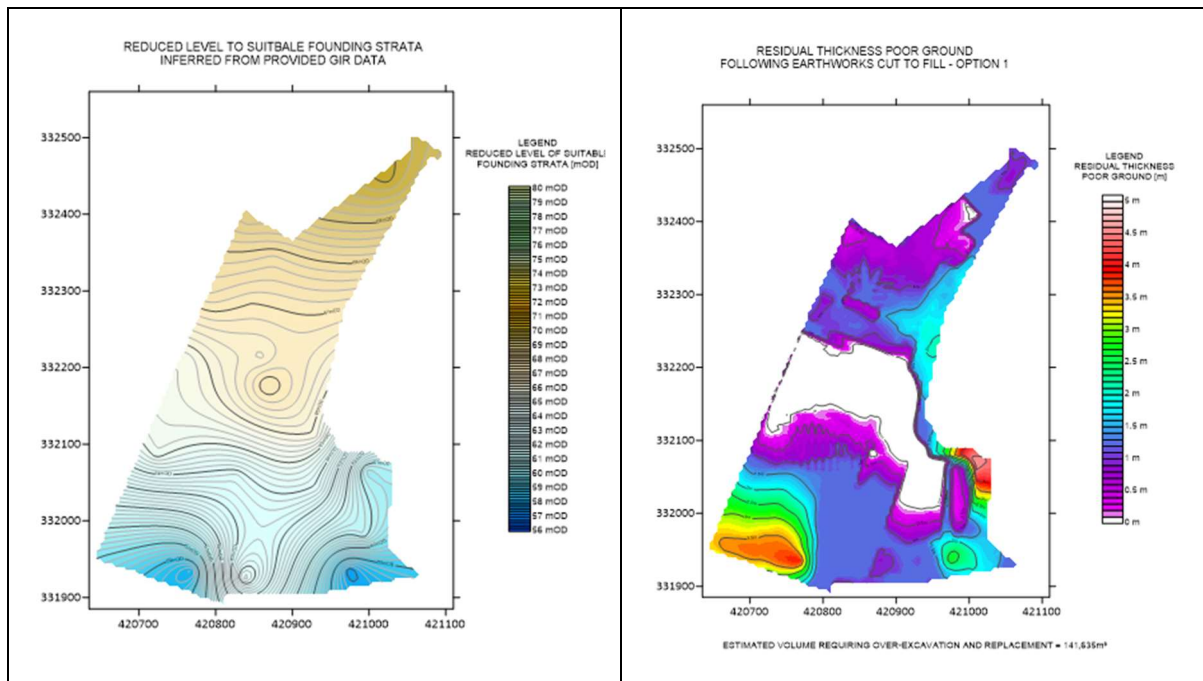


Figure 2-3: Reduced level to suitable founding stratum and residual thickness of poor ground following cut to fill.

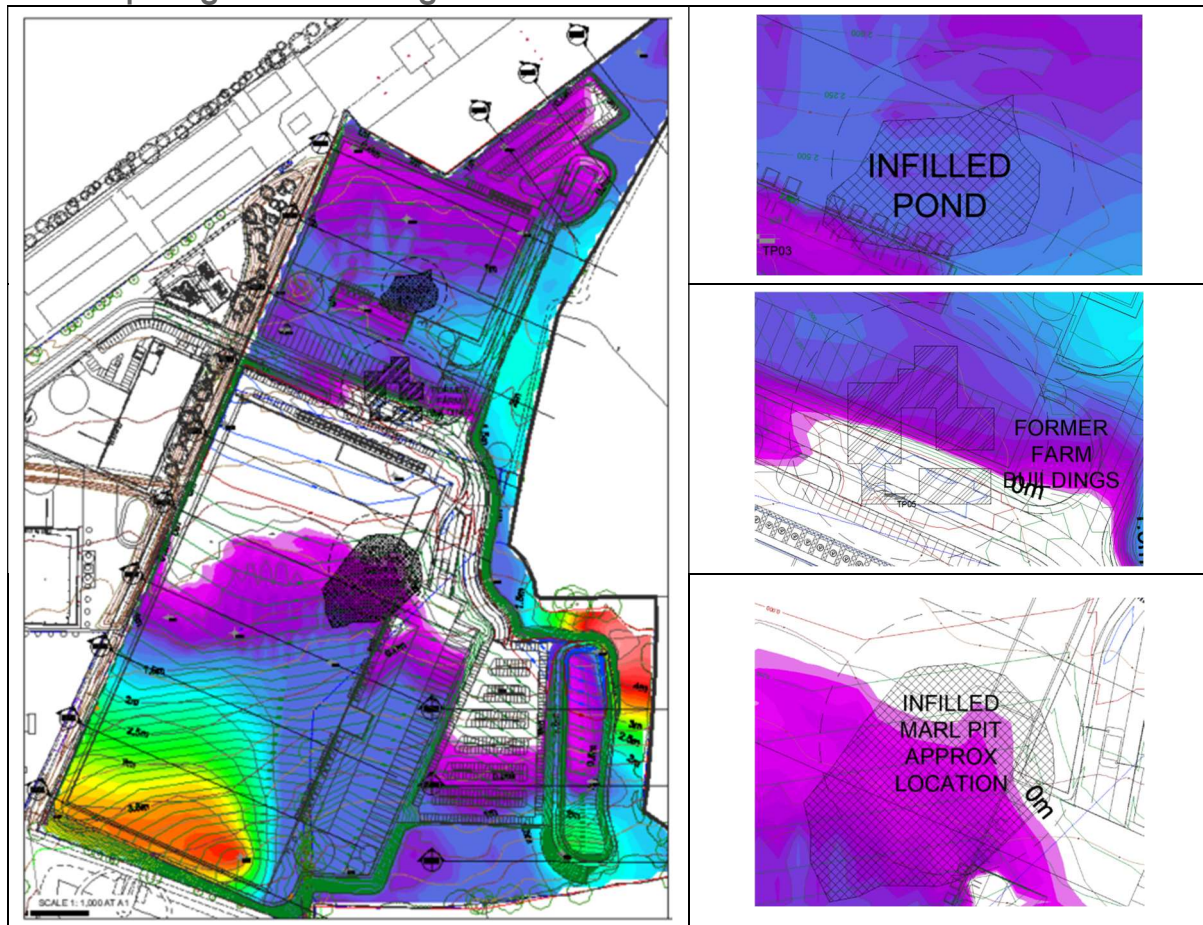


Figure 2-4: Residual thickness of poor ground following earthworks cut to fill

The model surface presented in Figure 2-3 has been overlaid with the proposed development plan, as shown on BWB drawing 255659-BWB-ZZ-XX-DR-GE-4001-Sheet1, a copy of which is presented at Appendix A, and an extract provided as Figure 2-4.

Figure 2-4 and Drawing 255659-BWB-ZZ-XX-DR-GE-4001 also present the approximate location of three historical features, that can impact the geotechnical solution and had not been investigated during the previous phase of works. Although they were noted to be present. The three features are:

- An infilled former pond in the northern sector of the site.
- The location of the former farm, and associated buildings, to the immediate South of the infilled pond.
- An infilled former Marl Pit, within the central section of the site, located below Unit 11C.

The geological model has then been developed into a geotechnical model, in order to inform the proposed ground solution and enabling works strategy.

3. GEOTECHNICAL GROUND MODEL

The findings from the GIR was that the superficial glacio-fluvial and alluvial deposits would be unsuitable for the support of foundations, as well as ground bearing floor slabs. The modelling of the deposition of this material indicated that the greatest thickness of this material would be in the South of the wider site area. This is also the region where the greatest depth of fill is required. The combination of both of these aspects would mean that in the South of the site, the combined thickness of poor bearing strata, and engineered fill, could exceed 8m.

In the centre of the site, following the cut to fill operation, all superficial soils would be removed and there is a section to the North of Unit 11C where the intact Mercia Mudstone could be exposed.

In the North of the site, the residual thickness of the poorer bearing strata is expected to be less than 1.5m. This would mean that foundations could be extended to bear into the competent Mercia Mudstone, with little impact on engineering requirements. However, for the floor slab, should the residual weaker soils be left *in situ*, this could impact the performance of the slab, should a ground bearing solution be adopted.

Further to the above consideration relevant to the building structures, along the Southwestern and Southern boundary of the site, as well as the placement of engineered fill and slopes to be formed, two retaining walls are also required. Given the reported competency of the of the subgrade, it is considered that some form of ground improvement would be required, before any engineered fill could be placed, where slopes and retaining walls are required. The same situation has been identified in the East of the site, where the proposed landscape bund is underlain by a notable thickness of potentially compressible material, that could lead to slope instability both during construction as well as in the long-term condition.

In consideration of the above points and geotechnical risks, the outline proposal would be to undertake ground improvement in the form of Vibro-replacement Stone Columns (VSC). Areas of the site would require their installation prior to the placement of engineered fill, whilst in the majority of instances, there are engineering and commercial advantages to this being undertaken post earthworks filling. This approach would then be coupled with targeted over-excavation and replacement of material, in order to optimise the geotechnical solution for the support of the new buildings and infrastructure.

The following points summarise the proposed treatment across the site.

- Zone A: VSC treatment prior to earthworks, along the Southwestern and Southern extent of the proposed embankment.
 - This would then be followed by the placement of the engineered fill, and the installation of the two retaining walls, identified as Retaining Wall B (Southwest embankment) and Retaining Wall A (Southern embankment).
- Zone B: Post earthworks VSC treatment to support the ground bearing floor slab and the foundations, across the Southern portion of Unit 11C.
 - This treatment is also proposed to be undertaken within the area of the infilled Marl Pit, located within Unit 11C.
- Zone C: Post earthworks VSC treatment to support the ground bearing floor slab, with pad foundations extended to competent strata, where the depth of the residual poor soils is less than 1.5m from base of slab.
- Zone D: Post earthworks VSC treatment to support the slab, as a transitional zone, where the residual thickness of poor ground is reduced or removed through the earthworks exercise
 - This transitional zone is likely to comprise VSC installed on a wider grid

The above zones of treatment, based on the current understanding of the geological ground model, is presented on BWB Drawing 255659-BWB-ZZ-XX-DR-GE-4002, a copy of which is presented at Appendix A, and an extract provided as Figure 3-1.

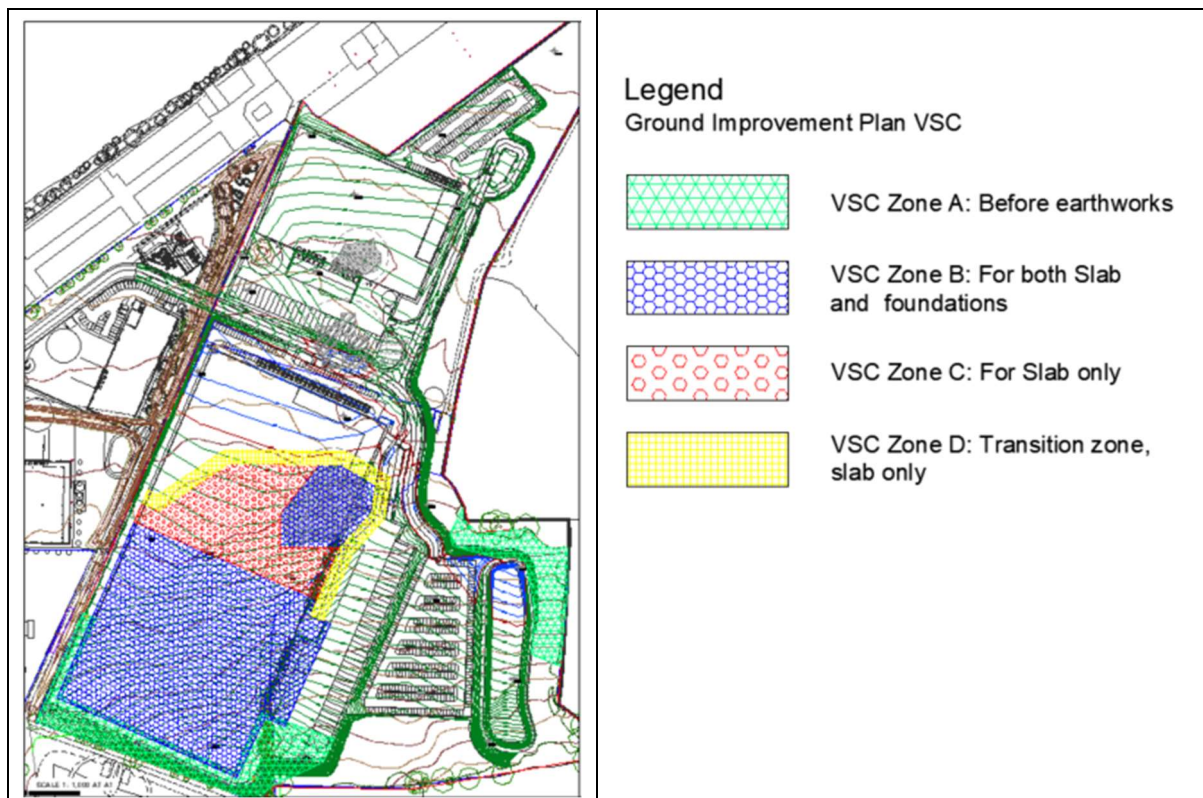


Figure 3-1: Proposed VSC treatment zones

For the North of the site, the current geological model has indicated that the residual thickness of 'poor' ground is likely to be less than 1m below the proposed structures. Given the limited thickness of this material, there are two potential strategies that have been considered, as summarised below:

- Option 1: Over-excavation of poor soils and their replacement with acceptable fill, meeting the requirements of the GDR and its Earthwork Specification.
- Option 2: In situ ground treatment, such as High Energy Impact Compaction (HEIC), using a BOMAG BW 226 (or similar).
 - This option has been considered, as the GIR has indicated that the soils which requirement improvement in this area are likely to be predominantly granular in nature, and that their thickness is unlikely to exceed 2m.

In support of the development of the proposed ground treatment, a series of cross-sections have been developed and are presented on drawings 255659-BWB-ZZ-XX-DR-GE-4001-SHEET 2 to SHEET 4 inclusive. Copies of these drawings are provided at Appendix A.

As noted previously, the current scope of investigation has identified problematic materials across the site for which mitigation will be required. However. The extent of the information upon which this has been based is limited, with gaps in the data set, including the three features that were identified but not investigated. In consideration of this, a scope of supplementary investigation has been proposed, and is described in more detail in Section 4.

4. DESIGN INVESTIGATION

A supplementary investigation is proposed to be undertaken in order to inform the geotechnical design and subsequent development of the GDR.

The proposed form of investigation is to utilise Static Cone Penetrometer (CPT) equipment, fitted with a piezocone, so that measurements of in situ pore pressure can be made, in order to assist with the interpretation of the data.

The location and spacing of the CPT positions has been based on the indicative site zonation for treatment, as described in Section 3 and as presented on BWB Drawing 255659-BWB-ZZ-XX-DR-GE-4002. In general, a spacing of 50m centre to centre has been adopted for Zones A, B, C and D, with a tightening up of the grid related to the infilled Marl Pit and Pond.

A total of 59 CPT's are proposed. A priority list has been considered, so that should some locations not be able to be completed within the given timescale for this investigation, the implications of missing data should not adversely impact the finalised geotechnical design. Of the 59 locations, 48 are considered to be priority 1, as these will be used to delineate the extent of treatment, including the infilled Marl Pit and Pond. The remaining 11 are intended to provide a greater level of detail related to composition and competency of the infilled material within both the Marl Pit and Pond.

The locations for the proposed CPTs are shown on BWB Drawing 22569-BWB-ZZ-XX-DR-GE-4002, and have been extracted and tabulated, as presented as Table 4-1.

Table 4-1: Scope of Design Investigation using CPT equipment.

Ref	Easting	Northing	Depth	Priority	Reason
CPT001	420651.645	331964.951	10.00 m	1	Correlation to BH 04, design of pre-earthworks VSC
CPT002	420694.946	331939.951	10.00 m	1	Design of pre-earthworks VSC
CPT003	420694.946	331989.951	10.00 m	1	Below building VSC
CPT004	420694.946	332039.951	10.00 m	1	Design of pre-earthworks VSC, and below building

Ref	Easting	Northing	Depth	Priority	Reason
CPT005	420738.248	331964.951	10.00 m	1	Below building VSC
CPT006	420738.248	332014.951	10.00 m	1	Below building VSC
CPT007	420738.248	332064.951	10.00 m	1	Below building VSC
CPT008	420738.248	332114.951	6.00 m	1	Transition zone for VSC
CPT009	420748.538	331918.786	10.00 m	1	Design or pre-earthworks VSC
CPT010	420781.549	331939.951	10.00 m	1	Below building VSC
CPT011	420781.549	331989.951	10.00 m	1	Below building VSC
CPT012	420781.549	332039.951	10.00 m	1	Below building VSC
CPT013	420781.549	332089.951	8.00 m	1	Slab VSC
CPT014	420781.549	332139.951	8.00 m	1	Slab VSC
CPT015	420792.502	331902.826	10.00 m	1	Design of pre-earthworks VSC
CPT016	420824.850	331914.951	10.00 m	1	Design of pre-earthworks VSC
CPT017	420824.850	331964.951	10.00 m	1	Below building VSC
CPT018	420824.850	332014.951	10.00 m	1	Below building VSC
CPT019	420824.850	332064.951	8.00 m	1	Slab VSC
CPT020	420824.850	332089.951	15.00 m	1	Infilled Marl Pit
CPT021	420824.850	332114.951	10.00 m	1	Highwall of infilled pit / Slab VSC
CPT022	420839.096	332114.793	15.00 m	2	Infilled Marl Pit
CPT023	420839.284	332089.951	15.00 m	2	Infilled Marl Pit
CPT024	420839.284	332139.951	8.00 m	1	Slab VSC
CPT025	420846.501	332077.451	10.00 m	1	Highwall of infilled pit / Slab VSC
CPT026	420846.501	332102.451	15.00 m	1	Infilled Marl Pit
CPT027	420846.501	332127.451	15.00 m	1	Infilled Marl Pit
CPT028	420853.718	332114.951	15.00 m	1	Infilled Marl Pit
CPT029	420857.212	332281.489	10.00 m	1	Pond delineation
CPT030	420857.212	332306.489	10.00 m	1	Pond delineation
CPT031	420860.934	332102.451	15.00 m	1	Infilled Marl Pit
CPT032	420864.902	332293.989	10.00 m	1	Pond delineation
CPT033	420868.151	332089.951	15.00 m	1	Infilled Marl Pit
CPT034	420868.151	332114.951	15.00 m	2	Infilled Marl Pit
CPT035	420868.151	332127.451	15.00 m	2	Infilled Marl Pit
CPT036	420868.151	332139.951	15.00 m	1	Infilled Marl Pit
CPT037	420871.646	332281.489	10.00 m	1	Pond delineation
CPT038	420871.646	332293.989	10.00 m	1	Pond delineation
CPT039	420871.646	332306.489	10.00 m	1	Pond delineation
CPT040	420875.254	332287.739	10.00 m	2	Pond delineation
CPT041	420875.254	332300.239	10.00 m	2	Pond delineation
CPT042	420878.863	332268.988	10.00 m	1	Pond delineation

Ref	Easting	Northing	Depth	Priority	Reason
CPT043	420878.863	332293.989	10.00 m	1	Pond delineation
CPT044	420878.863	332318.989	10.00 m	2	Pond delineation
CPT045	420882.471	332287.739	10.00 m	2	Pond delineation
CPT046	420882.471	332300.239	10.00 m	2	Pond delineation
CPT047	420882.585	332114.951	15.00 m	1	Infilled Marl Pit
CPT048	420885.706	332306.532	10.00 m	1	Pond delineation
CPT049	420886.080	332281.489	10.00 m	1	Pond delineation
CPT050	420886.080	332293.989	10.00 m	2	Pond delineation
CPT051	420889.802	332102.451	10.00 m	1	Highwall of infilled pit / Slab VSC
CPT052	420889.802	332127.451	10.00 m	1	Highwall of infilled pit / Slab VSC
CPT053	420893.296	332293.989	10.00 m	1	Pond delineation
CPT054	420900.513	332281.489	10.00 m	2	Pond delineation
CPT055	420900.513	332306.489	10.00 m	1	Pond delineation
CPT056	420956.921	332088.417	10.00 m	1	Design of pre-earthworks VSC
CPT057	421009.182	332076.516	10.00 m	1	Design of pre-earthworks VSC
CPT058	421015.278	332014.455	10.00 m	1	Design of pre-earthworks VSC
CPT059	421022.084	332049.227	10.00 m	1	Design of pre-earthworks VSC

Subject to the supplementary, design investigation being undertaken, the recommendations for ground treatment will be reviewed and revised accordingly.

The duration for the proposed design investigation using the CPT equipment is likely to take between four and five days on site, with the provision of data, in AGS 4.0 format, expected within one working week of the completion of the site works. Experience has shown that the data may be available for review with several days of site works being completed, but this would need prior agreement with the Specialist Contractor.

Upon receipt of the AGS data, the records would undergo a separate interpretation by BWB, before being used to develop an updated geotechnical ground model. Typically, this would comprise the derivation of the stiffness and settlement characteristics of the ground, supported by a series of plots of subgrade stiffness. At the completion of this exercise, a revised ground strategy would be provided. At present, it is expected that this could be provided within one top two weeks from receipt of the CPT records, as it is expected that during this two week analysis period, discussions would be held with Specialist Contractors regarding the scope of ground treatment, including the use of VSC as well as HEIC.

APPENDIX A: DRAWINGS