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Area 2, Docksway Disposal Site Newport

**Construction Quality Assurance Plan & Performance Specification for
Cell 4a Basal Clay Lining**

On behalf of **Newport City Council**



Project Ref: 14739/3544 | Rev: CQA_4_rev01 | Date: May 2019

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For and on behalf of Peter Brett Associates LLP				

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This report has been prepared by Peter Brett Associates LLP ('PBA') on behalf of its client to whom this report is addressed ('Client') in connection with the project described in this report and takes into account the Client's particular instructions and requirements. This report was prepared in accordance with the professional services appointment under which PBA was appointed by its Client. This report is not intended for and should not be relied on by any third party (i.e. parties other than the Client). PBA accepts no duty or responsibility (including in negligence) to any party other than the Client and disclaims all liability of any nature whatsoever to any such party in respect of this report.

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1 General

1.1 Introduction

- 1.1.1 This Construction Quality Assurance (CQA) Plan and Performance Specification has been prepared by Peter Brett Associates LLP (PBA). It applies to the basal clay lining works that are required as part of the construction of the next engineered waste containment cell (Cell 4a) in Area 2 of Docksway Disposal Site, Newport.
- 1.1.2 Cell 4 has been split into two halves, with the basal clay lining works for the first half (4b) having previously been completed during summer 2018. This document refers to the proposed basal clay lining works for Cell 4a but includes review of and reference to clay source testing carried out in both 2017 and 2018 on material from the same source (see Section 2.2)
- 1.1.3 The general principles of the basal clay lining works have previously been provided as part of the revision to the Environmental Permit (EPR/DP3733BK) for the site in 2015. This describes that the Engineered Barrier System (EBS) incorporates a minimum 1.2m thick engineered clay liner constructed over the natural geological barrier that exists at the site. This CQA plan describes the processes, methods, tests and controls that will be applied to the importation and construction of the engineered clay liner. The general principles of the basal clay lining works have previously been applied to Cells 1, 2, 3 and 4b at the site.
- 1.1.4 The objectives of this CQA Plan are to define the roles and responsibilities of the various parties involved in the contract for the basal clay lining works. It also sets out the quality procedures to be adopted during the construction works in order to promote effective management of the contract and provide verification that the construction works have been undertaken to meet the requirements of the design.
- 1.1.5 The objectives of the Performance Specification are to define the compliance criteria that are required to be achieved by the completed liner, and the acceptability limits and testing frequency required during the construction of the liner to meet the requirements of the guidance provided in Environment Agency (EA) document LFE 4 – Earthworks in landfill engineering.

1.2 Definitions and Duties

Definitions

- 1.2.1 In the context of this document, the following definitions shall apply:
- 1.2.2 **Construction Quality Assurance (CQA):** A systematic, planned and recorded series of actions designed to provide confidence that items, services or activities meet contractual or regulatory design and specification requirements and will perform satisfactorily in service. The CQA for the basal clay lining works will be recorded by an independent CQA Inspector and certified by a CQA Engineer based on test and results provided by the Contractor and records and reports provided by the CQA Inspector.

Parties (Definitions)

- 1.2.3 The following parties shall be defined as follows, with associated duties:
- 1.2.4 **Employer** means the person or persons, firm, company, or other body who own and have responsibility for the facility. The Employer has entered in to a contract with the Contractor for the execution of the Works specified in the Contract Documents provided by the Employer.

- 1.2.5 **Contractor** means the person or persons, firm, company or other body to whom the Contract has been awarded by the Employer, and includes the Contractor's personal representatives or other parties, for example, Sub-Contractors. The Contractor is the party responsible for the preparation and construction of the works as described within the Contract documents, and for ensuring that the clay liner meets the minimum requirements of the Performance Specification.
- 1.2.6 **CQA Engineer** means the person appointed by the Employer to act as independent CQA Engineer for the purposes of the Contract to provide independent oversight, technical direction and verification that the works, as recorded by the CQA Inspector, are constructed and recorded in accordance with the CQA Plan and Performance Specification. The CQA Engineer shall be responsible for the preparation of the CQA Validation Report.
- 1.2.7 **CQA Inspector** shall be responsible for the day to day technical direction, oversight and recording of all of the works undertaken as part of the basal clay lining works contract.

Parties (Roles)

- 1.2.8 The **Employer** is Newport City Council, who shall:
- prepare the contract documents and drawings and appoint the Contractor, CQA Engineer and CQA Inspector;
 - review other site-specific documentation including proposed layouts and Contractor's qualifications;
 - review all changes to the design, drawings, and specifications;
 - oversee budgetary and contractual matters;
 - provide day to day management of the works and direction to the Contractor;
 - provide surveying services;
 - provide setting out in accordance with contract documents;
 - provide technical support where required;
 - attend pre-construction, progress, site and CQA-related meetings;
 - liaise with all parties.
- 1.2.9 The **Contractor** is Jim Davis Civil Engineering Ltd, and they are responsible for undertaking the whole of the works in accordance with the Contract, and for providing a level of site attendance as defined in the Contract. The Contractor is responsible for control of the works, and for ensuring the suitability and acceptability of the source clay, and for ensuring sampling, testing and compliance of the clay liner are in accordance with the CQA Plan and Performance Specification. The Contractor will also ensure that all daily records and testing reports/results are made available to the Employer's CQA Engineer and the CQA Inspector.
- 1.2.10 The **CQA Engineer** is Peter Brett Associates LLP (PBA). The CQA Engineer:
- reviews the source material, specifies and attends the compaction trial.
 - reviews the compaction trial results and prepares the CQA Plan and Performance Specification in general accordance with LFE-4;

- reviews information and reports provided by the CQA Inspector, attends site to monitor progress in accordance with the scope agreed with the Employer, attends progress meetings, and liaises with the CQA Inspector. Provides confirmation that the CQA Inspectors records indicate that the construction and performance of the clay liner is compliant with the CQA Plan and Performance Specification.
- prepares the final CQA Validation Report.

1.2.11 The **CQA Inspector** is Mr William Watt, and is located at the site for the duration of the CQA works and is directed and monitored by the Employer and CQA Engineer. The CQA Inspector:

- acts as the on-site representative of the Employer providing independent 3rd party monitoring of the works under the technical direction of the CQA Engineer;
- familiarises the Contractor with the CQA and Performance requirements for the project;
- manages the daily activities of the Contractor;
- attends all CQA-related meetings (for example, Pre-construction and Progress meetings);
- prepares the ongoing preparation of the Record Drawings;
- monitors and records on-site acceptability and compliance testing;
- assigns and records locations for testing and sampling;
- prepares daily reports and logs and a weekly written report for the CQA Engineer;
- reports to the CQA Engineer, and logs in their daily report any relevant observations;
- oversees the collection and shipping of all samples for laboratory testing;
- reviews results of laboratory testing and makes appropriate recommendations following discussion with the CQA Engineer;
- reports any unresolved deviations from this CQA Plan to the Employer and CQA Engineer;
- provides all logs and relevant data to the CQA Engineer for the preparation of the final report;
- reviews all Certifications and Documentation from the Contractor and makes appropriate recommendations.

1.2.12 The above list of the CQA Inspector's duties is not exhaustive and may include additional roles as required.

1.3 Relationship with Other Documents

1.3.1 In the event of ambiguity or conflict between this CQA Plan and Performance Specification and other Contract Documents, then in general the CQA Plan and Performance Specification shall take precedence, where the matter relates to acceptability and compliance of the clay liner. Should resolution on this basis not be possible, then the Employer, in consultation with the CQA Engineer, shall decide on which interpretation is applicable.

1.4 Key Personnel

- 1.4.1 The **Client / Employer** is: Newport City Council, Civic Centre, Newport, Monmouthshire, South Wales, NP20 4UR.
- 1.4.2 The **CQA Engineer** is: Peter Brett Associates LLP, Caversham Bridge House, Waterman Place, Reading, Berkshire, RG1 8DN.
- 1.4.3 The **CQA Inspector** is: Mr William Watt. CV presented in Appendix 1.
- 1.4.4 The **Contractor** is: Jim Davis Civil Engineering Ltd, Ty-Gwyn, Banalog Terrace, Hollybush, Blackwood, South Wales, NP12 0SG.

2 Design Philosophy

2.1 Area 2 General Design

- 2.1.1 Area 2 is designed on a full containment principle and includes a basal liner as part of an engineered barrier system designed to minimise risks to groundwater from potential leachate leakage. The design is in accordance with the 'Area 2 Engineering Design Philosophy' (PBA, 2004) and the 'Conceptual Model and Hydrogeological Risk Assessment for Area 2' (PBA, 2005).
- 2.1.2 The presence of a low permeability engineered clay barrier and the underlying natural geological barrier (the natural alluvial clays underlying the site) will act to minimise the leakage and transport of contaminants from the site.
- 2.1.3 The engineered barrier system (EBS) will comprise 1.2m of imported clay, which will be engineered to have a maximum permeability of 1×10^{-9} m/s. The underlying in-situ alluvial clays typically have a permeability of lower than 1×10^{-9} m/s.

2.2 Clay Liner Design – Clay Source Evaluation

- 2.2.1 The clay to be used for the basal lining works will be from the Lower Lias Clay Formation, imported from Wingmoor Farm located at Bishops Cleeve in Gloucestershire. This is the same source material that has been used previously for the basal clay lining in Cells 2, 3, and 4b, and its suitability has therefore previously been fully demonstrated and accepted by Natural Resources Wales (NRW).
- 2.2.2 Notwithstanding the previous suitability testing for Cells 2 and 3, additional material suitability testing has been undertaken on seventeen samples of the source clay for use in Cell 4 (twelve in 2018 for Cell 4b and five in 2019 for Cell 4a). The source testing identified that the average Optimum Moisture Content (OMC) of the source material was 20% with an average maximum dry density (MDD) of 1.65Mg/m^3 . The moisture content of the 'as received' material was in the range between 15% and 25%. The average plastic limit was 24% and the liquid limit of each of the samples was <90% in accordance with LFE 4.
- 2.2.3 The classification and compaction testing results from the source clay samples were used to specify the criteria for remoulded permeability testing carried out in a triaxial cell and the results of these tests indicated a maximum permeability in the samples tested of 6.3×10^{-10} m/s. The samples for the laboratory permeability testing were recompacted at values that covered a range of positions both inside and outside of the acceptance envelope, including up to 10% air voids. The results therefore indicate not only that the source clay is capable of achieving the permeability requirements of the engineered clay liner, but that this can be achieved for material with up to 10% air voids.
- 2.2.4 The source testing results were used to define the ranges of acceptable limits for the specification of the imported clay, to be used initially in the clay compaction trial (undertaken in 2018), and then, subject to the results of the clay compaction trial, in the main basal clay lining works. Therefore, the acceptability limits for the imported clay for Cell 4a have been set as follows;
- Moisture content range: 21% to 26%. Based on the maximum mc for the material to achieve a minimum undrained shear strength (for trafficability) of 50kPa. The minimum is based on the mean plastic limit minus 3%.
 - Plasticity Index: between 10% and 65% in accordance with LFE 4.
 - Liquid Limit: $\leq 90\%$ in accordance with LFE 4.

- Percentage fines <0.063mm: ≥20% but with a minimum clay content of 8% in accordance with LFE 4.

2.2.5 The compliance requirements for the constructed clay liner are provided in both LFE4 and set out in the Environmental Permit for the site. Therefore, the compliance limits for the clay liner are as follows;

- In situ density tests must demonstrate that material selection and compaction achieve an air voids content of not more than 5% with a dry density of 1.56 Mg/m³ or above (95% of average Maximum Dry Density).
- Permeability: ≤1 x 10⁻⁹ m/sec.

2.3 Methodology and Plant

2.3.1 The moisture content range of the 'as received' material from the source has been identified during the source evaluation as sometimes being outside of the acceptable moisture content range due to it being too dry. This has similarly been the case during previous cell development. Therefore, the proposed methodology includes for 'conditioning' the material both prior to it leaving the source site and on the receiving site through the addition of water and mixing prior to laying the material within the cell. This process also helps to break down any clods of the material present. Once the material is conditioned, it will be transported to the working area and laid in layers of specified thickness (determined following a previous field trial, see Appendix 1 and Section 2.4 below). Samples of the material will then be taken for acceptability testing and then the layer will be compacted using a CAT CS-573D vibrating roller with padfoot shell kit attached (vibratory tamping roller). Each layer will be subject to a minimum number of passes of the roller (12 passes on a 300mm layer) determined following a previous field trial, (see Appendix 1 and Section 2.4 below), and then samples of the compacted material will be obtained using the core cutter method for laboratory permeability and in-situ density testing. The samples will be transported to a UKAS accredited laboratory appointed for the laboratory compliance testing.

2.4 Field Compaction Trial

2.4.1 A field compaction trial was undertaken at the site on the 15th May 2018 and this is described in Appendix 2. The laboratory results and destructive testing of the trial pad indicate that both methods of compaction could achieve the minimum compliance requirements for the clay liner.

3 Performance Specification

3.1.1 Based on the guidance provided in LFE4, the results of the clay source assessment and the field compaction trial, the following tables contain the specification for material acceptability and compliance for Cell 4a. An acceptance envelope is provided as Figure 1.

Table 3.1 – Specification - Acceptability

Property	Value	Test Method
Water Content	21% - 26%	In accordance with BS EN ISO 17892-1: 2014. Bulk sample
Atterberg Limits	PL ≤90% PI 10-65%	In accordance with BS1377-2: 1990. Bulk sample
Particle Size Distribution	Percentage fines <0.063mm: ≥20% but with a minimum clay content of 8%	In accordance with BS EN ISO 17892-4: 2016. Bulk sample
Determination of undrained shear strength using Hand shear vane	>50 kPa	In accordance with BS1377-9: 1990.
Maximum clod size	No greater than 2/3 rd compacted layer thickness	Visual observation and direct measurement.

Table 3.2 – Specification - Compliance

Property	Value	Test Method
Dry density/moisture content relationship (in situ density)	≤ 5% air voids ≥ 95% MDD (1.56 Mg/m ³)	In accordance with BS 1377-9: 1990. Sampled by core cutter method. Results to be within acceptance envelope shown in Figure 1.
Determination of permeability in a triaxial cell	Maximum 1 x 10 ⁻⁹ m/s	In accordance with BS 1377-6: 1990. Sampled by core cutter method
Clay Liner Thickness	Minimum 1.2m	Topographic Survey

4 Quality Procedures and Testing Requirements

4.1 Setting Out / Survey

4.1.1 The Employer shall provide the Contractor with a topographical survey of the site and shall agree with the Contractor the precise extents of the basal clay lining. The basal clay lining shall key in to the existing clay lining beneath the adjacent Cell 4b. The Contractor shall apply a grid to the survey drawing, indicating the maximum extent of the proposed areas for clay lining. The grid shall comprise 25m by 25m cells and each grid cell shall be assigned a unique ID and shall have a unique set of co-ordinates to allow identification for sampling purposes. The Contractor shall undertake pre commencement and post completion topographical surveys to demonstrate the minimum 1.2m liner thickness has been achieved. The Contractor shall provide to the CQA Engineer the as built drawings and cross sections to demonstrate this.

4.2 Sampling and Testing Requirements

4.2.1 Sampling and testing of imported materials both pre- and post-compaction shall be undertaken in accordance with the Specification, reproduced in Tables 4.1 and 4.2 below. The testing laboratory must be UKAS accredited for the tests being undertaken.

4.2.2 The CQA Inspector will determine the locations for the proposed sampling, based on the frequency of testing specified and their site observations, and shall inform the Contractor accordingly. The Contractor shall arrange for these samples to be undertaken in the presence of the CQA Inspector or a representative from the CQA Engineer. Copies of all test data shall be provided by the Contractor to the CQA Engineer and the CQA Inspector. The CQA Inspector will keep a daily record of all the work carried out, samples taken and results received, and shall provide weekly summary reports of the work, detailing progress, problems, testing and the proposed work programme. These summaries will be included in the CQA Validation Report.

Table 4.1 Testing Schedule - Acceptability

Test/Requirement	Frequency	Comments
Lift Thickness	per cell/layer (uncompacted thickness)	Direct observation/measurement
Topographic survey	Prior to commencement (commencing surface) and on completion of the basal clay lining	-
Water Content	Minimum 1 per 250m ³	-
Atterberg Limits	Minimum 1 per 250m ³	-

Test/Requirement	Frequency	Comments
Particle Density	1 per 500m ³	-
Particle size distribution	1 per 500m ³	-
Hand shear vane	3 per layer per 25m by 25m cell	To be included in CQA Engineers reports
Maximum clod size	Noted for each layer per 25m by 25m cell	To be included in CQA Engineers reports
Photographs	Daily	Must be labelled and referenced

Table 4.2 Testing Schedule - Compliance

Test	Frequency	Comments
Dry density/moisture content relationship (in situ density)	1 per layer, per 25m x 25m cell	Unique ID and labelling
Determination of permeability in a triaxial cell	1 per 2000m ³	Unique ID and labelling

4.3 Reinstatement of Sample Locations

4.3.1 Sample locations will be reinstated by replacement with conditioned material and hand tamped into place.

4.4 Clay Liner Acceptance

4.4.1 The clay liner shall be considered acceptable in respect of the Landfill Directive and Environmental Permit when:

- it has been verified that the Contractor's setting out, construction thickness and slope gradients conform with the Contract drawings and documents;
- placement has been undertaken correctly to achieve < 5% air voids;
- all permeability tests record a coefficient of permeability (k) of not greater than 1×10^{-9} m/s;
- all acceptability and compliance tests show conformance to the Performance Specification.

4.4.2 In addition, in order to form a suitable working platform for landfill construction, the clay liner shall have an undrained shear strength of not less than 50 kPa.

4.5 Contractor's Records

4.5.1 The Contractor shall record the following information and provide the information to the CQA Engineer and CQA Inspector in weekly progress reports:

- Number of layers/grid squares completed (that week and cumulative);
- Site photographs;
- Total volume of material placed that week;
- Acceptability and compliance test results for that week, including laboratory certificates;
- Description of any failures of acceptability or compliance tests and proposed remedial actions; and
- Minutes of site/progress meetings.

5 Documentation

5.1 Document Collation

- 5.1.1 The CQA Inspector will document that the Specification has been satisfied during construction. The CQA Inspector will maintain a site file of plans and specifications, checklists, test results, daily records, record drawings, photographs, and other pertinent documents. The Contractor shall provide the following documents to the CQA Engineer and CQA Inspector
- Laboratory details and accreditation certificates
 - Test results
 - Weekly reports
 - Construction drawings
- 5.1.2 The CQA Inspector shall promptly acknowledge receipt, review documentation, and either acknowledge that the information is satisfactory, or reject and provide reasons for doing so.
- 5.1.3 Should the CQA Inspector not receive this information, or if the information is unsatisfactory or not in compliance with the Specification, then the CQA Inspector shall reject the works related to the unsatisfactory/missing information, and the works shall not be allowed to proceed.

5.2 Daily Reports

- 5.2.1 The Contractor shall provide the CQA Inspector with daily reports which detail the following:
- the volume of material and number of layers placed, and their location with reference to the grid cell layout drawing;
 - the location and unique identification number (ID) of any samples obtained;
 - the results of any laboratory or in-situ testing, cross-referenced to the sample IDs;
 - location and volume of any materials removed as a result of failed testing.
- 5.2.2 In addition, the CQA Inspector shall maintain a Daily Diary, which will contain the following:
- Prevailing weather conditions
 - Contractor's plant and personnel
 - Work undertaken (cross-referenced to the grid layout plan) and results received and reviewed.
 - Construction problems and solutions
 - Record of site visitors
 - Photographs of work progress
- 5.2.3 Upon completion of the works, the CQA Inspector will prepare an 'as-built' layout plan of the works that will be referenced to the site records, together with results of all testing carried out.

- 5.2.4 The CQA Inspector will prepare and forward a weekly report to the CQA Engineer.
- 5.2.5 All of the above will be forwarded as one complete package by the CQA Inspector to the CQA Engineer on completion of the works, to be utilised for, and included within, the CQA Validation Report that will be prepared by the CQA Engineer.

5.3 CQA Validation Report

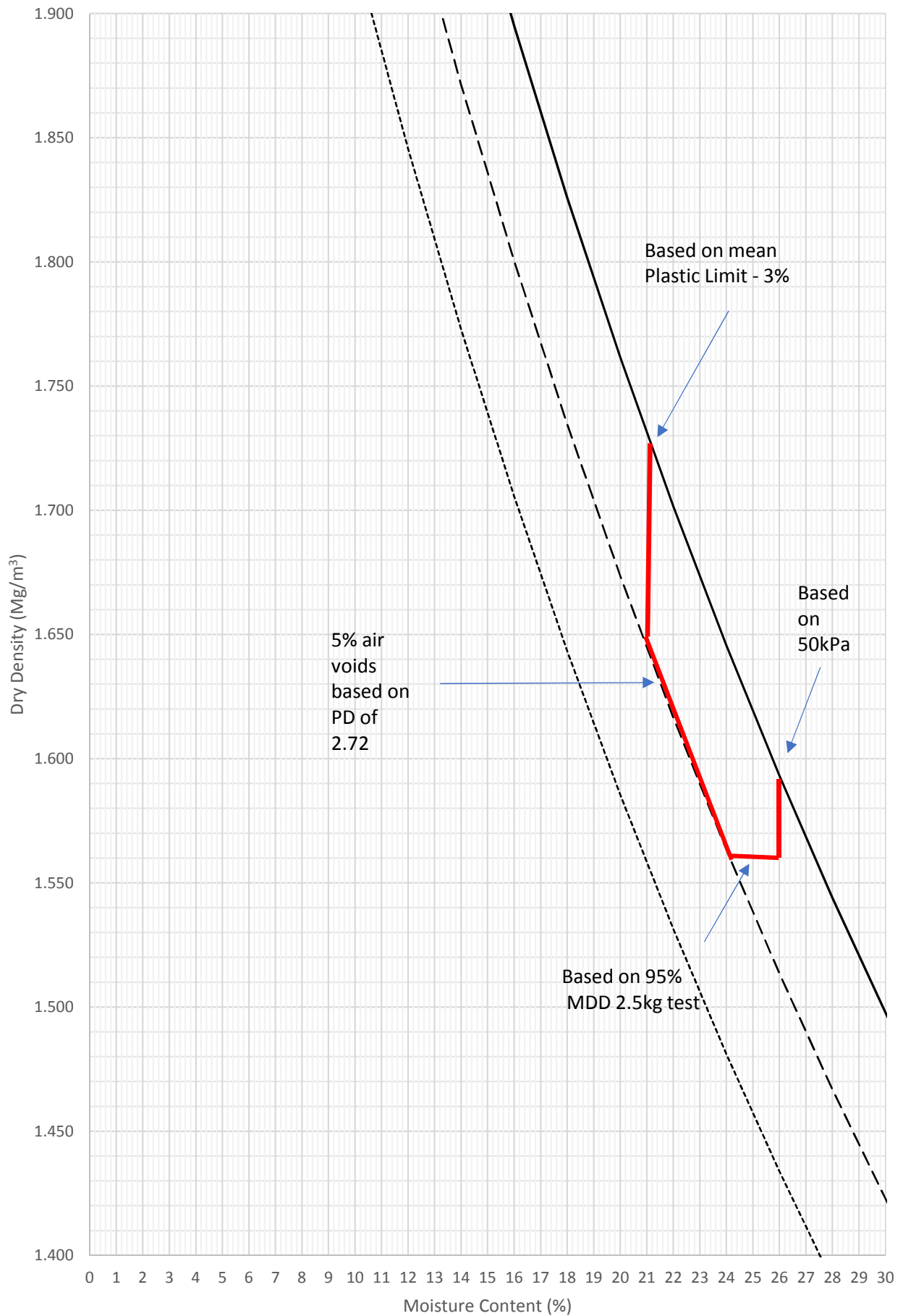
- 5.3.1 At the completion of the project, and once the CQA Engineer has received all the necessary and required data from the CQA Inspector, the CQA Engineer will provide to the Employer and to Natural Resources Wales (NRW), a signed Construction Quality Assurance Validation Report, which will outline the works undertaken and indicate whether compliance with the Specification and CQA Plan has been achieved. At a minimum, it will include:
- Project description.
 - Contractor's submissions.
 - Daily/weekly logs/records as received from the CQA Inspector.
 - As-constructed drawings received from the CQA Inspector/Employer.
 - Testing (laboratory) certificates.

References

- EA, 2014 Earthworks in landfill engineering: Design, construction and quality assurance of earthworks in landfill engineering. EA document reference LFE4, dated June 2014. Environment Agency.
- MCHW, 2016 Manual of Contract Documents for Highway Works. Volume 1, Specification for Highway Works. Series 600 – Earthworks. Department for Transport, 2016 amendment. Accessed via www.standardsforhighways.co.uk.

Figures

Figure 1 - Acceptance Envelope



Appendices



William Watt- Project Manager & construction Supervision

Chartered Professional Engineer
50554557
MB(App.Fin) Master of Business (Applied Finance), Queensland University of Technology, AUS 2008
B.Eng Civil (Hons) Bristol University UK 1996,

Profile

William has developed his engineering experience since 1996. He has managed and delivered infrastructure planning, design, supervision and verification projects.

William has experience in project management and supervision of civil design, analysing construction and delivering design policy, procedure and programs. He has undertaken due diligence, value engineering and variation assessments under various contract forms.

Key Experience

- contract administration and procurement for Infrastructure, property, highway and civil work, systems and procedures development including quality assurance, health and safety and Environment;
- Design and supervision of infrastructure: highways, drainage, hard standings, pavement, cycleway, traffic analysis implementation, signs and lines, public utilities plant, minor structures and civil works for ITS, lighting, mechanical and electrical

Project Experience

2016 Capita Infrastructure and Property Consulting Engineers

William is a Project Manager for the design and delivery of infrastructure projects.

2016-2018 Wales: Brynglas Tunnel Refurbishment, Newport

Civil Design Lead Client: Costain Group Plc

William was the civil design lead for the M4 Brynglas tunnels refurbishment. The tunnels were originally built in 1967 and are twin bore 360m long. My tasks included the development of the reference design and he managed the engineering discipline leads in hydraulics, geotechnics, environment, highways, pavement, structures and tunnel civil works.

Supervision, monitoring and design instructions for the onsite geotechnical testing for the pavement and geotechnical works

2011 Australia: Woogaroo Creek sewer TBM Shaft, Goodna,

Site supervision and design variations Client: WDS Construction

Construction certification for onsite testing and design variations for the sewerage thrust bore tunnel access shafts and temporary road diversion. The work comply with all safety requirements of the Principal Contract Theiss.

2008 Australia: Hale St Link (Go Between Bridge) Alliance, Brisbane

QA Manager identifying appropriate testing and QA

Client: Hale Street Alliance- Seymour Whyte, Macmahon, Bouygues Travaux Publics in an alliance, Hyder Consulting and Brisbane City Council

William was part of the team that produced the target cost estimate design for a AUD \$320 million Brisbane City Council Design & Build Alliance project. William worked with the construction team to develop the testing requirements for the design and construction. The design was for; a bridge across the Brisbane River, online

junction improvement and connecting infrastructure.

[2007 Australia: Grant and Station Road Junction Improvements, QLD](#)

Design Manager Client: Moreton Bay regional Council

A AUD 60,000 project for Caboolture Shire Council to design the upgraded and signalised two existing junctions. Supervising the onsite pavement foundation testing to confirm the

[2003 - 2006 DynCorp International, Sultanate of Oman](#)

William was head hunted to plan and deliver engineering services for the US Air Force War Reserve Material facilities repair and renewals program. With the Chief Engineer, William reported to DynCorp's Management team and US Air Force. William developed approved project scopes, a work program, external consultants' designs, contractors' award, site supervision and answered technical queries.

[2000 - 2003 WS Atkins, UK and Sultanate of Oman](#)

During his time at WS Atkins William developed from a highways design engineering role to design management and project management roles for the Highways Agency Area 2 program. William joined WS Atkins International team and was seconded to the Oman office to provide engineering design support for Civil Infrastructure projects.

[2002 Sultanate of Oman: Khasab Port Expansion—Khasab](#)

Resident Engineer Client: Ministry of Transport and Fisheries

An OMR 17 million project for the Ministry of Transportation Construction—supervised the construction of a 180 m quay wall, dredging, land reclamation, construction

of breakwaters and monitoring of quarrying operations.

[2002-2000 UK: M4 Motorway Junction 14 to 15 Earthworks stabilisation](#)

Project Manager Client: Highways Agency

A GBP 2 million framework contract for Highways Agency—managed the design and construction of 1 km of earthworks stabilisation; and responsible for the geotechnical design, drainage and specification.

[1997 - 2000 Parsons & Brinckerhoff, UK](#)

William developed his skills under supervision as a graduate highways engineer providing design and resident engineering services for the local and state networks within the southwest Wales region.

[1997-2000 UK: A40 Carmarthen Eastern Bypass, Wales](#)

Graduate Engineer & Supervision Client: National Assembly for Wales

A GBP 27 million construction project for National Assembly for Wales constructed in an environmentally sensitive area in West Wales, William supervised the construction of structures, earthworks and highways.

[1997-2000 UK: A485 On-Line Road Improvement, Wales](#)

Graduate Engineer Client: Carmarthen County Council

A GBP 7 million construction project for Carmarthen County Council, as part of a design team, William produced road alignment, pavement, drainage and structure designs for a project in the heart of rural Wales. William assisted within the public enquiry process developing documentation.

[1996 - 1997 UK: Powys Engineering Consultancy, Wales](#)

Having graduated from Bristol University William undertook freelance work as a minor works engineer for

Appendix 2: Field Trial Description

A field compaction trial was carried out on site on 15th May 2018, using stockpiles of imported clay from the source at Wingmoor Farm quarry, Bishops Cleeve. The material was conditioned on site. The conditioning was observed by the Contractor, the Employer and the CQA Inspector, and was controlled on site by the Contractor using MCV testing.

Following conditioning, an initial sacrificial basal layer was placed within the footprint of the proposed Cell 4, as marked out by the Contractor. The sacrificial base layer was not subject to any testing, in accordance with LFE4, but was compacted in two halves, in accordance with the proposed methodologies. The area marked out for the trial measured 14m wide, by 20m in length and additionally included ramps for acceleration and deceleration. The materials were brought from the stockpile to the trial area by a dumper and spread using a tracked dozer.

The trial pad was split into two halves with one half comprising un-compacted layers 300mm thick and subject to 12 passes of the roller, and the other half comprising un-compacted layers 250mm thick and subject to 6 passes of the roller. Each half of the trial pad received a total of 4 layers including the sacrificial base/first layer and therefore testing was undertaken on layers 2 through to 4 only.

Once the sacrificial base layer was completed, the second layer was placed with material from the conditioned stockpile. Disturbed sample for MCV testing and representative bulk samples were obtained from the placed material prior to spreading to the required thickness. A field MCV test was then carried out on the sample prior to the layer being compacted. The bulk samples were scheduled for moisture content, Atterberg limits, particle size distribution, particle density and compaction testing.

Following compaction of the second layer, four core samples were obtained by CJ Associates Site Testing Services from the completed layer. Laboratory permeability and density testing were scheduled on two of the cores, whilst the other two were taken as 'reserve' cores in case re-testing was required. Three hand shear vane (HSV) tests were carried out on the completed layer.

A further two layers were completed as described above until three layers had been placed, compacted, and sampled, in accordance with LFE 4, all on top of the sacrificial base layer

Once all four layers were completed, a trench was cut through both trial pad halves to allow visual observation of the effectiveness of the different compaction methods. The trench was inspected by the Employer, the Contractor, and the CQA Inspector to identify the presence of any oversize materials, clods, the achieved thickness and the nature of the inter-layer bonding. The conclusions are described in Section 2.4 of the main text of the CQA Plan and Performance Specification.

The results of the field and laboratory testing are summarised in Table A1 below.

Table A1 Summary of Compaction Trial Testing Results

	Trial Pad 1: 250mm – 6 passes			Trial Pad 2: 300mm – 12 passes		
	Layer 2	Layer 3	Layer 4	Layer 2	Layer 3	Layer 4
MC (%)	17-20	23-25	19-23	21-23	19-20	20-21
LL (%)	47-48	48	48	48-50	48	47-49
PI (%)	21-22	23-24	22	23-25	22	21-23
Percentage Fines <0.063mm	93-97	97	98	97-98	96-98	97-98
HSV (kPa)	120*	81*	100*	104*	79*	130*
% air voids	<5	<5	<5	<5	<5	<5
Permeability (m/s)	7.9×10^{-11}	4.3×10^{-11}	7.8×10^{-11}	4.4×10^{-11}	3.0×10^{-11}	1.2×10^{-10}

* denotes average value based on 3 readings