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BOW FARM ARTIFICIAL GEOLOGICAL BARRIER CONSTRUCTION QUALITY ASSURANCE PLAN TO SUPPORT A DEPOSIT OF WASTE FOR RECOVERY ENVIRONMENTAL PERMIT APPLICATION

For

MORETON C CULLIMORE (GRAVELS) LIMITED

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BOW FARM ARTIFICIAL GEOLOGICAL BARRIER CONSTRUCTION QUALITY ASSURANCE PLAN TO SUPPORT A DEPOSIT OF WASTE FOR RECOVERY ENVIRONMENTAL PERMIT APPLICATION

1. INTRODUCTION

1.1 Background

Moreton C Cullimore (Gravels) Limited (MCC) is applying for an Environmental Permit to operate a deposit for recovery activity at Bow Farm, Ripple, Worcestershire (the site).

GWP Consultants LLP (GWP) has been instructed by MCC to act as Construction Quality Assurance (CQA) Consultants responsible for generally overseeing the quality of the construction works of the side slopes artificial geological barrier (AGB) to be installed in excavation area Phases 1 to 9 of the deposit for recovery site development.

This CQA Plan has been prepared to support the Permit application and is submitted for Environment Agency (EA) approval.

The AGB will be constructed by MCC.

In order to provide protection to soil, groundwater and surface water the AGB will be constructed with a minimum thickness of 1.0m and a maximum permeability of 1×10^{-7} m/sec.

1.2 Scope of this Plan

The CQA Plan is principally concerned with providing documented procedures for ensuring that suitable materials are used in the construction of the AGB and that the quality of the work completed during the construction process can be properly verified and approved.

The CQA Plan identifies the principal parties involved and the levels of CQA supervision to be provided during the works. It defines the proposed monitoring and testing programmes to be implemented during the works, the analytical methods to be employed and the methods of recording and reporting the findings.

1.3 Principal Parties

The following organisations are the principal parties associated with the site, the AGB design and the construction works:

- Moreton C Cullimore (Gravels) Ltd — Client
- GWP Consultants LLP — Design and Construction Quality Assurance Consultants

1.4 Construction Quality Assurance Supervision

The CQA cover will be provided at several levels for the AGB construction:

- GWP will act as the *CQA Consultant* (CQAC) for the AGB construction works. The CQAC is the firm that observes and documents all aspects of the works (including standards of workmanship of the Client). The CQAC will report to the Client and to the EA.
- The *CQA Engineer* and *Monitor* (CQAE/M) will be the representative of the CQAC responsible for overall co-ordination of CQA activities and will be the main point of contact between the parties involved with CQA matters (MCC and the EA).

Specific responsibilities under this CQAP are discussed in the following sub-sections.

1.4.1 Construction Quality Assurance Engineer

The CQAE will be a Chartered Engineer with relevant experience of similar works on other sites. The principal functions and responsibilities of the CQAE are:

- Review site documentation.
- Familiarise themselves with the CQAP and any design changes and ensure these do not conflict with other CQA matters.

- Ensure all CQA personnel engaged on the site are familiar with the design requirements and the regime of CQA monitoring, inspections, testing and reporting as defined in this document.
- Develop site/circumstance specific addenda to the CQAP as circumstances on site dictate and update CQA personnel as appropriate.
- Review all field reports and draft CQA documentation.
- Provide a review of all CQA related engineering matters.
- Attend all quality assurance related meetings.
- Report any unapproved deviations from the CQAP to the Client and EA.
- Recommend approval of the AGB works to the Client and EA upon satisfactory completion.
- Co-ordinate the preparation of the final CQA Report.

Any differences in the interpretation of the specification by the CQAE and that of the Client will be properly and adequately addressed to ensure that there are no deficiencies in the standard of the AGB site works and conformance with the requirements of this CQAP.

1.4.2 Construction Quality Assurance Monitor

Where the CQAM is not the CQAE the person will be an appropriately qualified and experienced engineer working under the direction and supervision of the CQAE in performing their duties as required in the CQA Plan:

- Monitoring, logging, photographing and otherwise recording AGB operations when on site.
- Performing the stated in field testing or sampling as defined in the CQAP.
- Documenting and reporting to the CQAE any defects to the AGB works, including any damage post placement.
- Preparing summaries of activities completed.
- Maintaining all necessary files for recording and reporting the works.

The CQAM's role will be to perform surveillance and testing/sampling during construction sufficient to confirm that the Client has completed the works (or phases of the works) in accordance with the required specification and design requirements. In this regard, the CQAM's role will overlap with the Site Manager on site. No action taken by any of the CQA personnel will relieve the Client of his obligations in constructing the works in accordance with the specification and design.

2. SITE SETTING AND COMPONENTS OF ARTIFICIAL GEOLOGICAL BARRIER

2.1 General Site Setting

2.1.1 Physical Setting

The application site is located at Bow Farm, Ripple, Worcestershire (National Grid Reference SO 87565 36504).

Drawing No. BOWFEPR2511-1 shows the site location and Drawing No. BOWFEPR2511-2 shows the different areas of the site, including the excavation area Phases 1 to 9 where imported inert fill material will be placed under the EPR Permit. Drawing No. BOWFEPR2511-3 shows the Environmental Permit application area within the context of the site approved under the Planning Permissions.

The total site area covers *c.* 65ha, straddling the county boundary between Worcestershire and Gloucestershire. An area of *c.* 45ha of land has been approved for mineral extraction in the north and centre of the site (this is located entirely within Worcestershire). The approved mineral extraction areas are made up of excavation area Phases 1 to 9 (*c.* 30.9ha), Flexible Working Area A (*c.* 8.8ha) and Flexible Working Area B (*c.* 5.3ha). The processing plant and access route will be located in Gloucestershire (eastern part of the site).

A site plan is presented as Drawing No. BOWFEPR2511-4.

The Phases 1 to 9 excavation area in the north of the main part of the site is located *c.* 500m south of the village of Ripple. The processing plant area and main access road is located *c.* 300m south of

the village of Puckrup and *c.* 900m southwest of the village of Twyning. The town of Tewkesbury is located *c.* 2.5km to the south of the site.

From a geomorphological terrain perspective, the site can be split into three areas:

- a flat low lying (<10mAOD) area south of Ripple Quarry Lake;
- a raised north-west south-east trending 300m wide, 1000m long ridge rising to 14mAOD, separated from the Ripple Quarry area by the Napps Local Wildlife Site (LWS) wetland area (a former osier bed); and
- a hill side slope rising to >30mAOD, above the River Severn valley, separated from the southern end of the raised ridge and floodplain by a small stream named the Ripple Brook.

The Ripple Brook valley has an elevation of 9mAOD to 11mAOD adjacent to the site and divides the site in two.

2.1.2 Site Layout

The approved design and operation of the site reflects the three areas' different elevations and proximities to the River Severn (*c.* 25m to the west of the full site boundary and *c.* 400m west of the EPR Permit application area).

The north-south ridge in the centre of the site, approved under Planning Permissions 19/000048/CM (Worcestershire County Council) and 19/0081/TWMAJM (Gloucestershire County Council), is where excavation area Phases 1 to 9 are situated. Phases 1 to 9 is the location for year-round sand and gravel extraction and is the area of the site where the imported inert fill material will be placed with restoration back to pre-extraction ground levels. The Phases 1 to 9 area of the site is the focus of the deposit for recovery Environmental Permit being applied for, as this is the part of the site where the imported inert fill material will be used to restore the site.

The elevated hill slope area in the east of the site will be the location for the processing plant, main site office and weighbridge, silt settlement lagoons associated with the processing plant/mineral washing and the site access road from the A38.

The low-lying area of Flexible Working Areas A and B, *c.* 25m to the east of the River Severn at its closest approach, will only be excavated seasonally during non-high flow periods of the river. Restoration of Flexible Working Areas A and B will be to wetlands and water features using only site derived mineral waste (silts and clays) and will have a final landform below pre-extraction ground levels. No imported inert fill material will be placed in Flexible Working Areas A and B.

2.1.3 Geological Setting

The geological setting of the site has been determined based on a review of published information and historical and recent site investigation information.

Bedrock deposits

The solid geology underlying the site comprises the Triassic Branscombe Mudstone Formation of the Mercia Mudstone Group which consists of a sequence of red-brown mudstones and siltstones.

The Tewkesbury Fault crosses the site access road to the east of the processing plant area. The fault is therefore situated to the east of the Phases 1 to 9 excavation area of the EPR Permit application area. The Tewkesbury Fault has a north-south trend and juxtaposes limestone and shale of the younger Jurassic Rugby Limestone Member against the Branscombe Mudstone Formation.

Superficial deposits

The bedrock mudstone is overlain by a series of stepped river Terrace Deposits of sand and gravel formed during the Pleistocene by the early River Severn system. The Terrace Deposits are believed to have formed in a braided river environment in which lateral variation from clay or silty channel fill to gravel islands can be expected. Erosion of the bedrock clay may lead to thickening of Terrace Deposits.

The Terrace Deposits collectively belong to the Severn Valley Formation. The youngest Terrace Deposit at Ripple is concealed beneath alluvial sediment of the modern River Severn.

The four lowest (youngest) of the River Severn terrace sand and gravel deposits are present on the site:

Kidderminster Station Member (BGS 4th Terrace of the River Severn)

The Kidderminster Station Member is the oldest terrace deposit on site. The upper surface level is *c.* 32mAOD to 33mAOD and is found only at the eastern boundary of the full site area east of Ripple Brook where it caps the higher ground above the location of the processing plant. The British Geological Survey (BGS) memoir records that at Twyning, 4.1m of sandy gravel was proven in a borehole in which Bunter Sandstone gravel predominated.

Window Sampling of this terrace was carried out in 2018 and descriptions indicate that the terrace deposit comprises predominantly brown and red brown silty sand with pockets of fine and coarse gravel beneath a thin soil cover. The maximum thickness intersected was to the east of the processing plant area, where 4.7m of reddish-brown silty sand with rare gravel present.

Historic investigations showed that the base of the terrace gravel is at 26mAOD to 28mAOD leaving a step in the bedrock levels of approximately 10m to 11m, forming the hillside above the Holt Heath Member below.

Holt Heath Member (BGS 3rd Terrace or Main Terrace of the River Severn)

The Holt Heath Member underlies the level ground lying at *c.* 15mAOD to 17mAOD between the processing plant area and Puckrup Lane, to the east of the Phases 1 to 9 excavation area, which is largely occupied by the golf course at the Hilton Puckrup Hall Hotel and Golf Club. The extent continues into the site area to include the footprint of the processing plant area.

A wedge shaped remnant of this terrace also lies between the northern site boundary and Ripple Brook, extending north of the M50 as far as Ripple Village. It is evident that part of the terrace has been excavated in the past, possibly during construction of the M50 bridge in 1960.

The levels of the top of bedrock mudstone in exploratory boreholes, located outside of the northeastern part of excavation area Phases 1 to 9, reflect the step up in levels of bedrock (Mercia Mudstone) from the base of the Worcester Member along the site boundary in this area. There appears to be an overlap between the two terraces which may represent encroachment of material from the higher terrace over the slope.

Worcester Member (BGS 2nd Terrace of River Severn)

The Worcester Member is the main sand and gravel resource on the site within the Phases 1 to 9 excavation area and forms a prominent landform 3m to 4m above the flood plain. On the site, the front edge of the terrace forms a well-defined slope between the top of the terrace deposit at 12mAOD to 14mAOD and the flood plain at 9mAOD to 10mAOD.

South of Bow Farm the terrace was incised by the Ripple Brook which passes behind the back edge of and through the terrace. The area between the processing plant location and Ripple Brook is a remnant of this terrace.

The base of the terrace deposit is inferred to slope towards the river from *c.* 9.5mAOD at the eastern edge of the Phases 1 to 9 excavation area, to *c.* 6.5mAOD at the western edge of the same area, at a gradient of 1v in 90h to 1v in 120h. The underlying bedrock (mudstone) level rises at the back (east) of the terrace.

The Terrace Deposit appears to be continuous but thins to the edge of the site area against the rising bedrock mudstone adjacent to Bow Lane. A thickness of 5.5m of Terrace Deposit was intersected in the Trial Pits dug in 1987, however previous modelling indicates that the greatest thickness may exceed 6m close to the front edge (west) of the terrace.

The Member consists of medium dense, reddish-brown slightly clayey and occasionally pebbly fine to medium sand. The gravel and clay content varies between boreholes installed in the deposit, but the Terrace Deposit is always predominantly sand.

Overburden is between 0.4m and 0.8m thick across the terrace and comprises firm red-brown very sandy clay beneath thin sandy topsoil.

Power House Member (BGS 1st Terrace of River Severn)

The current channel and flood plain of the River Severn are cut into the Power House Member, the youngest of the Terrace Gravel Deposits of the Severn Valley Formation. The deposit is entirely obscured by silty clay alluvium and overbank sediments. The approved development allows for excavation of this terrace in Flexible Working Areas A and B only.

Historic trial pits excavated within Flexible Working Areas A and B in 1987 did not reach the base of the gravel. An estimate of the level of the base of the terrace has been made by extrapolating from the neighbouring Ripple Quarry site to the north of Flexible Working Areas A and B, where levels between 2.7mAOD and 4.8mAOD were recorded. It is likely that a thin horizon of gravel continues beneath the current river channel.

The maximum thickness of sand and gravel intersected on site through previous site investigations was 3.3m in the east of Working Area B. This is consistent with reported thickness from data from the adjacent Ripple Quarry site which reported an average thickness of 3.19m over the proposed extraction area with a maximum of 6.25m and minimum of 1.5m. Similar variation is expected at Bow Farm.

Investigations at the adjacent Ripple Quarry describes the material as *'brown medium to fine grained sandy gravel'*. The average composition was reported to be 41% gravel, 49% sand and 10% silt.

Overburden above the Power House Terrace comprises river alluvium and ranges in thickness from 2m to over 4.3m. Ground levels rise from *c.* 9.5mAOD to over 11mAOD towards the existing River Severn flood embankment to the west of Working Area A over a distance of 200m and the thickness of overburden is inferred to increase accordingly. There are no descriptions of alluvium from the site.

2.2 Components of the Artificial Geological Barrier

Details of the components of the AGB are illustrated on Drawing No. BOWFEPR2511-8.

2.2.1 Basal Sub-Grade Model

The basal sub-grade will comprise the *in situ* underlying Triassic Branscombe Mudstone Formation of the Mercia Mudstone Group.

2.2.2 Side Slopes Sub-Grade Model

The side slope sub-grade will comprise the perimeter slopes of the mineral excavation formed in the superficial Terrace Deposits of the River Severn.

2.2.3 Basal Artificial Geological Barrier Model

The Triassic Branscombe Mudstone Formation of the Mercia Mudstone Group underlying the site forms an adequate natural basal geological barrier. Accordingly, an engineered basal AGB is not required.

2.2.4 Side Slopes Artificial Geological Barrier Model

A side slopes AGB will be formed on a phased basis within excavation area Phases 1 to 9 using suitable indigenous clay material dug from the floor of the mineral excavation and/or site derived mineral waste (silts and clays).

The suitable material will be compacted in layers and brought up in lifts up to *c.* 7.5m high against the side slopes sub-grade formed in the superficial Terrace Deposits as the general placement of waste progresses.

Following the completion of each side slopes AGB lift, either imported inert waste material, or site derived mineral waste (silts and clays) will be graded against the compacted material in order to provide buttress support and to establish a stable platform for the placement and compaction of the next side slopes AGB lift. Excavated perimeter slopes in the superficial Terrace Deposits will have a maximum height of *c.* 7.5m and the maximum unsupported height of the side slopes AGB will be *c.* 3.75m. The side slopes AGB will have a minimum thickness of 1m and a permeability no greater than 1 x 10^{-7}m/s.

3. ARTIFICIAL GEOLOGICAL BARRIER WORKS

3.1 Environment Agency Advance Notification

At least one weeks' notice of the intention to commence work in each phase of AGB construction will be given to the EA Environment Officer having responsibility for the site.

3.2 Construction Methodology

The proposed AGB construction methodology is set out below:

- The extent of each phase of AGB construction will be planned on the basis of available site area and the amount of AGB construction material available.
- The side slopes are to be adequately stable. The *in situ* side slopes will be checked on a phased basis and regraded as necessary in advance of the construction of the side slopes AGB.
- All soft and/or compressible soils and unsuitable materials within the proposed AGB area are to be removed to provide a competent sub-grade for construction of the AGB.
- Ensure that the AGB construction area is dry and remains dry and that areas of ponded water do not accumulate.
- Cobbles, boulders, rock or waste fragments whose largest dimension is greater than 125mm shall not be incorporated into the AGB.
- Following preparation of the AGB area, AGB construction material will be hauled by articulated dump truck to the AGB construction area. A bulldozer will blade out the AGB construction material in layers having a loose layer thickness sufficient to give a compacted layer thickness of *c.* 1.0m. The bulldozer will also be used to break down any large clods by tracking over the material as it is placed. The minimum AGB thickness is to be 1.0m.

Each successive layer will be compacted using a sheep's foot roller (following the guidance set out in Specification for Highways Works (Series 600 – Earthworks). If an alternative method is proposed, an addendum to this CQA Plan with supporting evidence will be submitted for EA approval in advance of the commencement of AGB construction.

3.3 Source Materials

The AGB construction material will be indigenous clay material dug from the floor of the excavation and/or site derived mineral waste (silts and clays). Suitable construction material will be selected and subject to continual visual and tactile inspection by competent trained staff employed by MCC. The suitability of the material will be checked by the CQAE/M during routine inspections. Any material considered unsuitable for use in the AGB will be isolated and either removed from the site or if suitable stored pending disposal into the deposit for recovery development.

Should there be any significant variation in the material characteristics then the CQAE/M will verify that the material remains suitable or an alternative source will be used. Additional testing will be undertaken if required.

The CQAE/M will record any substantial variation in the material characteristics of the indigenous material and/or suitable selected imported inert waste as the site progresses and confirm the continued suitability for inclusion in the AGB.

The suitable materials will be selected on the basis of physical and chemical properties as set out below.

3.3.1 Physical Properties

Only cohesive materials that are capable of achieving the required permeability when placed in accordance with the CQA method specification will be used. The physical suitability of AGB construction material will be determined in accordance with the method set out in Appendix 1.

3.3.2 Chemical Properties

The indigenous clay AGB construction material will be deemed acceptable based on confirmation of its physically suitability. It will not be necessary to demonstrate by testing that the material is chemically suitable give its indigenous source.

3.4 Construction Supervision Protocols

Observation of the AGB construction will be undertaken and co-ordinated as part of the monitoring and testing CQA programme for the works. The CQAE/M will be present at the beginning of each phase of engineering construction works to instruct the Client on the engineering requirements. The Client may then proceed as instructed without the continual presence of the CQAE/M.

The CQAE/M will attend the site on a minimum basis of:

- 1 visit prior to the commencement of each phase of AGB construction;

- 1 visit per 10,000m^3 of AGB construction or 1 visit per fortnight of AGB construction works, whichever is the more frequent;
- 1 visit following the completion of each phase of AGB construction

in order to confirm the adequacy of the AGB construction work. The Site Manager will be responsible for overseeing the works whilst the CQAM/E is not present on site.

3.5 Acceptability Criteria and Specification

The completed AGB must achieve the following criteria:

- The suitable cohesive materials when compacted will have a maximum permeability of 1x10^{-7}m/s.
- The thickness of the AGB must exceed 1.0m measured perpendicular to the sub-grade.

3.6 Testing of Artificial Geological Barrier

3.6.1 Thickness

The thickness of the completed AGB will be determined either by isopachyte surveys or by trial pitting.

3.6.2 Permeability

In situ permeability tests will be completed at a frequency of 1 test per phase or 1 test per 2,500m^2 of AGB construction (whichever is greater).

The tests will be performed in accordance with the test method detailed in Appendix 2.

4. PROJECT DOCUMENTATION

The following section describes the documentation to be prepared as part of the AGB construction CQA validation process.

4.1 Daily Report

The Site Manager will complete a Daily Summary Report outlining all activities carried out that day and noting any variation and justification from agreed procedures. The Daily Summary Report will be prepared on a standard form (example included in Appendix 3) and will include field notes, construction observations, testing results and any other relevant information.

4.2 Weekly Progress Report

Should the engineering works extend beyond 1 week then a Weekly Progress Report will be prepared by the CQAE/M and Client on a standard form (example included in Appendix 3). This will include a review of progress to date, confirmation of suitability of materials used in construction, an outline of any deviations from the specification or design and descriptions of any discrepancies or non-conformities in the site works. Summary records of any additional testing and acceptance will also be included in the Weekly Progress Report.

4.3 Artificial Geological Barrier Acceptance Record

The CQAE/M will record the acceptance of each phase of the AGB on the Artificial Geological Barrier Acceptance Record (example included in Appendix 3). This will include details of the period over which the AGB was placed, the results of relevant testing, any non-conformities and the remedial measures taken.

5. THE CONSTRUCTION QUALITY ASSURANCE VALIDATION REPORT

The final CQA Validation Report will be prepared by the CQAC and approved by the CQAE for issue to the Client and the EA. This report will detail a record of the construction works completed, will verify conformance with the required specifications and will include complete details of the testing completed during the works. This report will represent the final as-built record of the construction works and will be compiled by reference to the CQAE/M's Daily and Weekly Records, all testing records, the design (as may be amended during the works) and the as-built records.

As the AGB is to be constructed on a phased basis, the CQA Validation Report will comprise an initial document recording procedures *etc.* detailed above and a base plan against which each subsequently

engineered phase of AGB may be cross referenced. Details of each subsequent phase of AGB construction works, results and approvals *etc.* will be submitted as separate reports.

The CQA Validation Report will contain the following:

- Details of the completed AGB construction works.
- Details of the AGB construction materials used.
- Details of the CQA procedures adopted.
- Results of testing undertaken.
- Plans indicating AGB extent, thickness and testing locations.
- A description of the construction works and comments on the results of the CQA work.
- Records of any non-conformance and or remedial works.
- Details of any modifications to the design or construction methods.
- Certification of the works.

The certification of the works will be a validation by the CQAE that the works were carried out in accordance with the specifications and design as detailed above and/or as agreed with the Environment Agency.

GWP CONSULTANTS
NOVEMBER 2025

APPENDIX 1

Flowchart for selection of suitable material for construction of a geological barrier

APPENDIX 2

In-situ permeability testing method

APPENDIX 3

Site proforma sheets