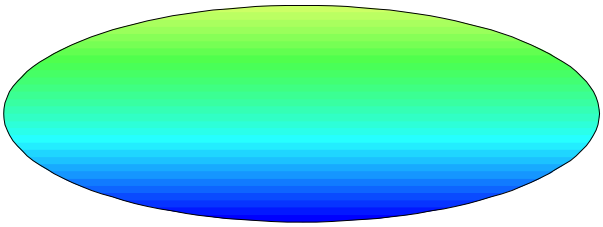

ENVIROARM LIMITED

CHADWICH LANE QUARRY LTD

CONSTRUCTION QUALITY ASSURANCE VALIDATION REPORT

EARTHWORKS CONSTRUCTION FOR BASAL GEOLOGCAL BARRIER PHASE 3
Sections 1 and 2

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CHADWICH LANE QUARRY LANDFILL SITE

EARTHWORKS CONSTRUCTION FOR BASAL GEOLOGICAL BARRIER PHASE 3 Sections 1 and 2

CONSTRUCTION QUALITY ASSURANCE VALIDATION REPORT

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1. INTRODUCTION

In June 2008, Enviroarm Limited were requested by Chadwich Lane Quarry Ltd to carry out supervision and quality control tests on earthworks construction of an engineered geological barrier on Phase 3 Section 1 and 2 at the Chadwich Lane Quarry landfill site.

Initial preparation works commenced during the later part of June and early July with final sand extraction in Phase 3.1 down to the 176m AOD.

Mineral liner works on Section 1 commenced on 30th June 2008 and were completed on 8th June 2007.

During the period and most of July the final sand was extracted from Section 2 down to a depth of 176m AOD.

Section 2 lining works and the initial side wall seal on the south and west wall were then all completed on the 29th July 2008.

The mineral liner works were carried out by Chadwich Lane Quarry Ltd.

During the works, Enviroarm Limited personnel were in attendance on site on a full time basis to assess and control the sub grade formation, mineral liner construction and to carry out asll testing.

The following Construction Quality Plans were used during the construction of the cell:

- Enviroarm Limited Chadwich Lane Quarry Construction Quality Assurance Plan
- Enviroarm Limited Source Evaluation of material for use in Geological Barrier at Chadwich Lane Quarry.

2. THE SITE

The Chadwich Lane Quarry landfill site is an operational landfill as defined under the Landfill Directive for the receipt of inert waste. Phase 9 Section 1 and 2 are the first sections of the landfill site that have required an artificial geological barrier to be engineered in accordance with requirements of the Permit TP3431SG. The former quarry off Chadwich Lane is situated on the south-western fringe of Birmingham at National Grid Reference SO 958 771. It is approximately 3km east of Rubery and 3km north of Catshill,

3. FORMATION

3.1 General

The excavation was in clean virgin Sherwood Sandstone. The side walls remained stable with no tension cracks visible and the base was excavated flat. The overall configuration was in accordance with the Slope Stability Risk Assessment for the site. The sand is well cemented and requires a minimum 30 tonnes excavator to break and remove the sand.

3.2 Formation Compaction

Following the excavation of sand from the each section each section the exposed lower sub grade was subject to 8 passes with the excavator tracks all over the surface prior to the placement of the geological barrier.

4. GEOLOGICAL BARRIER MINERAL LINER

4.1 General

The geological barrier mineral liner of Phase 3, Sections 1 and 2 were constructed using re-worked on-site clay bands excavated as part of the quarrying operations which had been selectively dug and stored separately from the sand. The accepted placement specification was a target permeability of $1x10^{-7}$m/s achieved between a moisture wet of optimum. The minimum clay fraction limit was set at 10% and minimum shear strength of 50kPa, and placed at 5% air voids. The mineral liner was to be placed to a thickness of 1000mm.

4.2 Compaction Testing

The initial Lift 1 was used as the compaction trial on the clay with the results faxed through from the soils laboratory prior to commencement of the next lift, to ensure that the compaction

had been achieved, and that the use of the hydraulic excavator tracking over the clay would achieve the necessary compaction of the liner.

The excavator was a 30 tonne Doosan DX300 and the lifts were placed at 300mm and compacted to 250mm using the tracks.

The same method of compaction was used for all of the Section 1 and 2 works detailed in this report.

4.3 Site Visits and Control Testing

Full time monitoring of the works was carried out during the construction of the engineered low permeability geological barrier mineral liner to check working procedures and to undertake quality control testing to ensure compliance with the approved Construction Quality Assurance Plan. The barrier was divided into two sections, each approximately 35 metres x 10 metres, giving each section a total surface area of 350m^2 and a placed volume of 350m^3, and a total placement of 700m3 on the base and 280m3 on the side walls. The initial phases have been over tested against the CQA Plan to ensure that the compaction methodology was acceptable and to account for unknown variance in the clay.

The approximate test locations on each section on each lift are presented on the Daily Log sheets presented at Appendix 9. Drawing No 1 shows the test locations for the geological barrier on each lift.

The clay was placed at natural moisture content as this demonstrated natural moulding parameters from basic on site puddling tests.

On site moisture compliance testing was carried out as a way of Construction Quality Control for the works, using an Ashworth Speedy Moisture Gauge and temperature control for placement was using an Environment Meter.

All testing was undertaken in accordance with BS 1377: 1990 and BS 5930:1999 at frequencies listed in Construction Quality Assurance Plan for Phase 3. In-situ tests using core cutters were undertaken to ensure that the material was placed with less than 5% air voids and at the correct moisture content.

The total volume was calculated at 980m^3. The total testing required per lift was therefore as follows:

Table 1 Test Schedule

Test	Number Required	Actual taken
Core Cutters	2	12
Shear Vanes	4	20
Atterberg Limits	1	4
Specific Gravity	1	2
Permeability	2	6
Particle Size Distribution	1	4

The corroborative core cutters were taken in accordance with BS1377: 1999 and submitted to Ground Investigation and Piling Limited UKAS soils laboratory in Wolverhampton.

Ground Investigation and Piling Limited are UKAS accredited for Density, Moisture Content, Particle Size Gradings, Compactions and Specific Gravity, Atterberg Limits. The UKAS Certificates are presented at Appendix 2, Ref 1897, Issue 007, October 2007.

Permeability testing was carried out at Terra Tek soils laboratory, which is UKAS accredited for these particular tests, Ref 0126, Issue 030, June 2007. Certificates for this laboratory are presented at Appendix 2.

All testing has been carried out in accordance with BS1377;1990, and reported in accordance with BS1377:1990 UKAS requirements.

Daily log sheets were completed for each working day by the site engineer and are presented in full at Appendix 8.

The excavator was observed traversing each lift with a minimum number of eight passes prior to any testing being carried out. In general the excavator did on average 10 passes on each lift.

4.4 Field Test Results

All field samples were taken by the Engineer during each day of works.

All testing carried out with the Speedy Moisture Gauge to control the moisture content of the conditioned material both at the processing area and placed in Sections 1 and 2 are reported in the daily log sheets presented at Appendix 8.

No clay was placed in a freezing condition or when temperatures were below 0°C. Temperature was monitored using an environment meter. The clay was clean and had been stored

separately from the sand and had been previously selectively excavated. All of the material used was from on site out of the Phase 3 footprint.

Core Cutter Assessment

Core Cutter tests were carried out on each of the four lifts on the base and side wall at a rate of one test per 82m^3, opposed to the required one test per 250m^3 plus the permeability cores. The testing frequency and pass-fail results are presented at Appendix 3.

The results of the cores on each sheet have been correlated against the upper specific gravity test value obtained on all of the sections. All of the results are presented at Appendix 3. The results from each section have been presented as the laboratory sheets, followed by graphical plots.

All of the plots were above the 5% air voids line.

The holes produced taking the Core Cutters were sealed using additional clay which was tampered into the hole using the core puner and then additional clay placed on top and subject to compaction with the compaction plant with a minimum 8 passes.

Specific Gravity Tests

The specific gravity or particle density value is presented at Appendix 4.

The test reported value was 2.69.

All of the holes produced taking the specific gravity bulk bag tests were sealed using additional clay which was tampered into the hole using the core puner and then additional clay placed on top and subject to compaction with the compaction plant with a minimum 8 passes.

Atterbrg Limits

One Atterberg test was taken at a frequency of one test in 245m^3 as opposed to one test per 1000m^3.

The clay used for the mineral liner would be classified as CM-clays of medium plasticity.

Placement of the clay at and above 13% showed the clay to deform plastically during compaction.

The results are presented at Appendix 4.

The only specifications set for plastic limit and classification criteria was that the plastic limit should not be greater than 65% and a plasticity index less than 10%, and that the test frequency should be not greater than one test per 1000m^3. Both of these criteria were complied with and exceeded.

No tests results were reported outside the British Standard. The plastic limit, liquid limit and therefore the plasticity index tests were reported correctly in accordance with the British Standard. The clay was placed at a moisture content of between a 13% and 16%. Corroborative bulk tests were taken for Natural Moisture Content with the Atterberg Limit determinations.

Control of moisture was carried out throughout the works using an Ashworth Speedy Moisture Tester.

The holes produced taking the Atterberg Limits and Natural Moisture Content bulk bag test were sealed using additional clay which was tampered into the hole using the core puner and then additional clay placed on top and subject to compaction with the compaction plant with a minimum 8 passes.

Permeability Tests

The results of the triaxial permeability tests undertaken on undisturbed cores taken from the compacted material are presented at Appendix 5. 6 permeability determinations have been carried out on the Sections 1 and 2 including the side walls. Based on 980m^3 of placed liner the total number of tests required would have been 1 from the placed liner. The testing has therefore exceeded the CQA Plan testing requirement. The results of the permeability results showed permeability values ranging from 1.6 x 10^{-10}m/s to 3.7 x 10^{-10}m/s. The average permeability for the geological barrier on the base and sides on Sections 1 and 2 is 2.66 x10^{-10}m/s.

The permeability is between two and three orders of magnitude lower than required. The triaxial permeability test determinations were carried out at Terra Tek UKAS Accredited soils laboratory, (Ref 0126, see Appendix 2), in Chesham, Buckinghamshire. Effective pressure and effective stress was set at 100kPa.

All of the holes produced taking the Permeability cores were sealed using additional clay which was tampered into the hole using the core puner and then additional clay placed on top and subject to compaction with the compaction plant with a minimum 8 passes.

Particle Size Grading

A particle size grading was carried out at a frequency of approximately 1 per 245m^3 as opposed to the CQA test frequency of one test per 1000m^3. The clay content was in excess of 20% and silt content in excess of 30%. Gravel was less than 1%. The results are presented at Appendix 6. GIP is UKAS accredited for particle size gradings as presented at Appendix 2.

The holes produced taking the grading bulk bag tests were sealed using additional clay which was tampered into the hole using the core puner and then additional clay placed on top and subject to compaction with the compaction plant with a minimum 8 passes.

Shear Strength Tests

20 shear strength tests were undertaken at a rate of at least one test per 49m^3 using an EDECO/Pilcon hand shear vane at random locations on the base and sides of each lift, within each section of geological barrier mineral liner placed, and are presented on summary sheets Appendix 7.

All of the results are well in excess of 50kPa.

The test locations together with the layer on which each test was taken are shown the daily log sheets at Appendix 8.

4.5 Assessment of Earthworks Construction

The Section 1 and 2 of Phase 3 and the two wall seal locations are presented on Drawing CLQP3.1.

Section 1

Placement of the clay was carried out in four lifts between 30th June and 8th July. The plastic limit was reported at 16% and had a natural moisture content of 15%. The permeability result was reported at 16% and the core cutter tests were 15% to16%.

Section 2

Section 2 permeability values were 15 and 16%. The Section 1/2 core cutter was reported at 16%. Section 2 plastic limits were reported at 15%. The Section 2 basal lining works were completed on the 29th July 2008.

South Wall

The south wall permeability value of 2.8 x 10^{-10}m/s was reported with a moisture content of 14% and the core cutters ranged from 13% to 16% all reported wet of optimum. The south wall lining works were completed on the 29th July 2008.

West Wall

The west wall core cutters were placed at 14 to 16%. The west wall permeability was at 14% with a permeability of 3.6 x 10^{-10}m/s. The south wall lining works were completed on the 29th July 2008.

General

All moisture controls on site were by use of the Ashworth Speedy Moisture Gauge which had been calibrated on site against core cutters. The moisture gauge readings were found to be within 0.2% of laboratory tests. In addition the feel of the clay was easy to determine the plasticity.

Plate 1: Speedy Moisture Gauge readout in use on site.

4.6 Non-Conformance

No non-conformances were reported during the placement of the geological barrier.

5. CONCLUSIONS

The procedures carried out on site were in accordance with the Construction Quality Assurance Plan with appropriate layer thickness and the number of passes of the compaction plant. All materials incorporated within the earthworks were therefore placed satisfactorily.

The results of the permeability tests on undisturbed core samples taken from the lining works indicate that the target permeability of 3.7×10^{-10}m/s or less has been achieved with all results over a magnitude lower than required.

The mineral liner had in excess of 20% clay fraction, and a fines content in excess of 50%. The mineral liner was over 1 metre in thickness as proved by physical measurements by the engineer on site.

The testing carried out on the geological barrier mineral liner both by independent laboratory testing at UKAS accredited soils laboratories and field tests exceeded the required test frequencies in the agreed CQA Plan and showed that the geological barrier had achieved and exceeded the required minimum standards on all testing.

Detailed and full comprehensive engineers daily logs have recorded the entire construction and testing carried out.

In conclusion all of the materials have been tested to and above the required frequency and all of the materials have exceeded the minimum standard requirements.

The Phase 3 Sections 1 and 2 are therefore acceptable for the receipt of inert waste as it has been constructed in accordance with the approved Construction Quality Assurance Plan.

Report prepared by……. Date……..
A.R.Morris