White Young Green

Construction Quality Assurance Plan and Specification for the Capping Works to Cells 3, 5 & 6

Leadenham Landfill Site

Waste Recycling Group Limited

December 2007

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thinking beyond construction

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Environmental Consultancy

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APPENDICES

1.0 GENERAL

1.1 Project Description

This document has been prepared to consolidate the details of the Construction Quality Assurance (CQA) procedures and the Specification that will be adopted during the capping works to Cells 3, 5 and 6 at the Leadenham Landfill site. The site is located at National Grid Reference SK 964 524.

The capping system shall comprise a 1mm thick welded LLDPE geomembrane liner and a geotextile/geocomposite protection layer.

1.2 Project Team Members

CQA Project Manager	-	P Ayres
CQA Project Engineer	-	M Holzer
CQA Engineer	-	TBA by White Young Green Environmental
Client Contact	-	Mr I York

1.3 Responsibilities of Team Members

CQA Project Manager

Overall responsibility for the CQA related aspects of the project, together with the review and approval of the Construction Quality Assurance procedures.

CQA Project Engineer

Responsible for the CQA related project and technical management. Will attend pre-contract and progress meetings. Will establish and implement the on-site CQA procedures thereafter responsible for the day-to-day office/site based project liaison work. Certification of the final third party CQA report, a copy of which is to be forwarded to the Environment Agency.

CQA Engineer

Responsible for the daily implementation of the CQA Plan including inspection, verification and documentation. Will attend progress meetings and advise the CQA Project Engineer of any events or occurrences that he considers are likely to have a Quality Assurance related effect on the permanent works. Will monitor and supervise the lining works, together with the co-ordination and/or undertaking of any ancillary materials testing that is required. Typical CQA proforma used by the CQA Engineer on site are shown at Appendix B.

Contractor

The Contractor will undertake the engineering works to develop the capping system in accordance with the Specification and will act as Project Manager.

The Contractor for the development of the capping system at the Leadenham Landfill site will be May Gurney (Construction) Limited.

1.4 Materials Testing

i) LLDPE Geomembrane

Conformance testing and seam destructive testing will be undertaken by an independent testing laboratory.

Any supplementary testing that may be required during the works will be undertaken as directed by the CQA Engineer.

ii) Protector Geotextile/Geocomposite

Conformance testing will be undertaken by an independent testing laboratory.

2.0 OUTLINE DESIGN DETAILS

2.1 Outline of Works

Details of the proposed capping system are presented on Drawing Numbers 2611.CAP.01 and 2611.CAP.02 contained in the Specification which is presented at Appendix A.

The 300mm regulating layer will be developed using site-derived materials in preparation for the installation of the geomembrane liner.

The capping geomembrane will comprise a 1mm thick welded LLDPE product. A double sided textured geomembrane will be used on all areas to be capped.

A Geotextile product will be installed over the capping geomembrane to afford protection during placement of the restoration soils in areas where the slope gradient is less than 1(v):3.5(h) and will be installed with 300mm overlaps and heat bonded seams. In areas where the slope gradient is between 1(v):3(h) and 1(v):3.5(h) then the geotextile will be substituted by the protector geocomposite.

Restoration soils will comprise selected site-derived materials with a maximum particle size of 50mm in the lower 300mm of the soils and 150mm in the remaining 700mm of the soils. The restoration layer will comprise a minimum 1000mm thick layer of site derived materials.

Any changes to the proposed design will be agreed with the Environment Agency, in writing, prior to the commencement of any works.

2.2 Definitions

Final Waste Cover	The term 'Final Waste Cover' will mean the adequately compacted and properly levelled top of the waste, prepared for placement of the regulating layer.
Regulating Layer	The term 'Regulating Layer' will mean the 300mm thick lower protection layer located above the finished waste surface and beneath the LLDPE geomembrane.
LLDPE Geomembrane	The term 'LLDPE Geomembrane' will mean the 1mm thick flexible geomembrane hydraulic barrier comprising high density polyethylene.
Protector Geocomposite	The term 'Protector Geocomposite' will mean the geocomposite installed overlying the LLDPE geomembrane in areas where the slope gradient is between 1(v):3(h) and 1(v):3.5(h) for reasons of protection.

Protector Geotextile	The term ' Protector Geotextile' will mean the geotextile installed overlying the LLDPE geomembrane in areas where the slope gradient is less than 1(v):3.5(h) for reasons of protection.
Restoration Soils	The term 'Restoration Soils' will mean the site derived soils materials overlying the protection layer.

3.0 CAPPING PREPARATORY EARTHWORKS

3.1 Trimming of Final Waste Cover

Prior to the placement of the regulating layer the surface of the final waste cover of the area to be capped will be prepared in accordance with Clause 3.2 of the Specification.

The CQA Engineer will ensure that the Contractor removes any objects from the waste surface that do not comply with Clause 3.2.1 of the Specification. Oversize material shall be removed completely from the area to be capped to avoid possible later inclusion in the works. Any objects that are removed from the works that are deemed to be waste materials will be disposed of in accordance with Clause 3.2.2 of the Specification.

The CQA Engineer will inspect the completed final waste cover to ensure that the area is free from any bumps, hollows or areas that could collect water. Any areas identified by the CQA Engineer will be trimmed off or filled in to the satisfaction of the CQA Engineer. Hollows of any significant depth will be filled in discrete layers as directed by the CQA Engineer to reduce the possibility of differential settlement.

Any waste materials that are removed to the landfill area outside of the site's operational hours or any waste that is exposed in the area to be capped will be covered with general fill materials at the end of the working day to avoid any odour nuisance.

The CQA Engineer will notify the Contractor of his acceptance of the prepared surface of the final cover to waste, prior to the installation of the regulating layer. A record of the acceptance will be made on the Daily Record Sheet to be filled out by the CQA Engineer for each day of the construction period. The CQA Engineer will prepare a sketch of the areas that have been approved, the areas will be designated on the sketch using the date on which approval was given to cross-reference the drawing with the Daily Record Sheets.

3.2 Anchor Trenches

The capping system will be secured into an anchor trench as shown on Drawing No. 2611.CAP.02 .

The anchor trench for the LLDPE geomembrane will be formed in the existing engineered side slope as shown in Section B-B on Drawing Number 2611.CAP.02.

The CQA Engineer will ensure that the anchor and grip trenches will have slightly rounded edges to avoid undue stresses in the geomembrane as required by Clause 3.3.3 of the Specification. If the CQA Engineer is not satisfied that the anchor trenches or grip trenches have been constructed in this manner he shall instruct the Contractor to undertake remedial works prior to allowing the placement of geomembrane in the anchor trench.

The CQA Engineer shall ensure that no ponding of water takes place in the trench while it is open as this may allow the soils around the trench to soften. In the event that any standing water is present in the trench the water will be either pumped out or driven along the trench, away from the working area, using the trench arisings, to an

area from where it can be pumped or removed in a manner acceptable to the CQA Engineer.

During the construction works the CQA Engineer shall ensure that the cap is extended to the back face of the trench. The CQA Engineer will not allow the Contractor to place geomembrane in the trench if he considers that there is an excessive amount of loose material present in the base of the trench. If there is excessive loose material in the base of the trench, the CQA Engineer will instruct the Contractor to remove it before the lining works will be allowed to continue.

The CQA Engineer will document acceptance of the anchor trench on the Daily Record Sheets.

The anchor trench and grip trench will be backfilled in layers in accordance with Clause 3.3.5 of the Specification. The CQA Engineer will ensure that the backfill material is placed in thin layers and that each layer is subject to adequate compaction using hand held vibratory compaction and that the backfill material is not likely to cause any damage to the geomembrane.

Where it is not possible to backfill the anchor trench once the liner has been placed, the CQA Engineer will ensure that the geomembrane panels are temporarily but securely anchored within the trench. Any failure to temporarily anchor the geomembrane in this manner will be noted by the CQA Engineer. In the event that the geomembrane is displaced by wind, it may be necessary to condemn all of the material that has been affected.

3.3 Exposure of Existing Capping Systems

Where the proposed capping system is to be connected to the existing capping system, the CQA Engineer will supervise the removal of the restoration soils to ensure that no damage to the existing cap occurs.

4.0 REGULATING LAYER

4.1 Materials

The 300mm thick regulating layer to be placed and compacted over the final waste surface shall comprise of the materials noted in Clause 4.2 of the Specification.

The CQA Engineer will continually monitor the materials that are to be included in the regulating layer to ensure that material which does not comply with the Specification is not permitted to enter the works.

Unsuitable materials, as defined by Clause 4.2 of the Specification or materials deemed to be unsuitable by the CQA Engineer will be removed from the works and from the area where the works will take place.

Materials that are deemed to be unsuitable because they are in a frozen condition shall be stockpiled away from the working area and may be assessed for suitability by the CQA Engineer once they have been allowed to thaw thoroughly.

Materials which are deemed to be unsuitable due to high moisture content may be stockpiled away from the working area and allowed to dry. The CQA Engineer may assess the material for inclusion within the works once drying has taken place. It is important that if a significant quantity of material has been stockpiled that the complete stockpile is assessed before approval may be given. Stockpiled material should be turned to promote even drying of the material.

Materials which are deemed to be unsuitable, due to oversize particles, may be included in the works if it can be demonstrated to the CQA Engineer that 'stone picking' or removal of the oversize particles will result in the materials being compliant with the Specification.

The CQA Engineer will ensure that all materials with a particle size greater than 10mm will be removed from the prepared surface of the regulating layer.

4.2 Placement

The CQA Engineer will monitor the materials to ensure that the Contractor excavates and handles the material in accordance with Clause 4.3.1 of the Specification. If the CQA Engineer considers that the materials have been adversely affected and are not suitable for inclusion within the works, he will reject the materials.

Where more than one type of material is present in the stockpile the CQA Engineer will record the area of placement for the different materials, as required of the Contractor by Clause 4.3.1 of the Specification.

The CQA Engineer will periodically dig through the compacted regulating layer to check that the thickness is 300mm or greater, as specified in Clause 4.3.2 of the Specification. If the thickness of the regulating layer is less than 300mm, the CQA Engineer shall carry out further investigative excavation to determine the extent of the area over which the shortfall has occurred. The Contractor shall then be instructed to increase the thickness of material in that area so that the resultant thickness is compliant with the Specification. The CQA Engineer will test the depth of the regulating layer at a frequency of 1 test per 625m^2.

The CQA Engineer will ensure that haulage of materials to the working area is undertaken in accordance with Clause 4.3.3 of the Specification. The CQA Engineer may reject any materials that have been adversely affected due to being left stockpiled or uncompacted for use in the works. The CQA Engineer will then supervise the removal of the materials from the works.

The CQA Engineer will ensure that regulating layer materials are not stockpiled on the waste surface, the Contractor will be informed that this is not compliant with the Specification.

The CQA Engineer shall receive a method statement from the Contractor prior to any placement of the regulating layer within 2000mm of any protuberance as required by Clause 4.3.4 of the Specification. The CQA Engineer will assess the method statement and technical information for the proposed plant for compliance with the Specification. Subject to this information being satisfactory, approval for works to proceed will be given and recorded on the Daily Record Sheets.

4.3 Surface Preparation for Geomembrane Deployment

The CQA Engineer will inspect the completed surface of the regulating layer to ensure that it complies with Clause 4.4.1 of the Specification.

Areas that do not comply with Clause 4.4.1 will be remediated to the satisfaction of the CQA Engineer. Remedial measures may include re-rolling of the surface for minor surface defects, removal of the upper surface of the regulating layer to a depth agreed by the CQA Engineer and replacement with suitable material or stone picking as appropriate. The CQA Engineer will record the location and the nature of the remedial works for inclusion in the CQA Report.

Following the preparation of the surface of the regulating layer, the CQA Engineer shall give the Contractor approval to lay the geomembrane on a phased basis. Approval will be noted on the Daily Record Sheets and the panel placement logs.

If the geomembrane is not deployed immediately following approval of the regulating layer, the CQA Engineer will inspect the area again just before deployment is to take place. If any deterioration has occurred in the intervening period, approval will be withdrawn and remedial works will be required as noted above. The location and nature of the remedial works and any approvals will be recorded by the CQA Engineer.

5.0 GEOMEMBRANE CAP

5.1 Geomembrane Materials

The CQA Engineer will ensure that the geomembrane material delivered to site complies with Clause 5.2 of the Specification and Table 1 contained therein. This will be checked by assessing the manufacturer's quality control information, required by Clause 5.4 of the Specification, against the information in Table 1.

If the material delivered to site appears to be unsatisfactory for any reason, the CQA Engineer will inform the Contractor and deployment will not be permitted until the situation has been resolved.

5.2 Delivery, Handling and Storage

Prior to delivery to site, the CQA Engineer will inspect the storage area prepared by the Contractor for compliance with Clause 5.3.5 of the Specification for the storage of the geomembrane. If the area is deemed to be unsatisfactory, then remediation of the area will be required before approval for the storage of geomembrane may be given.

The CQA Engineer will ensure that each roll of geomembrane delivered to site is undamaged and labelled with the information required by Clause 5.3.2 of the Specification. Any damaged materials will be dealt with in accordance with Clause 5.3.4 of the Specification.

The CQA Engineer will ensure that materials are unloaded in accordance with Clause 5.3.3 of the Specification, unless the Contractor can demonstrate the suitability of other methods. The CQA Engineer will not permit the unloading of the geomembrane in any manner that may cause damage to the material.

The unloaded geomembrane rolls will be stored in the approved prepared area only and will be stored no more than three rolls high. The CQA Engineer will prepare an inventory of the materials delivered to site along with a schematic of the location of each roll.

5.3 Manufacturer's Quality Control

The manufacturer's quality control information should be passed to the CQA Engineer on the day that it is delivered to site for use in assessing the compliance of the geomembrane with the Specification. Where the manufacturer's quality control information is not available to the CQA Engineer unloading of the geomembrane and any subsequent use of the material will be entirely at the Contractor's own risk. In the event that the geomembrane deployment is due to commence before the CQA Engineer has received the information, the Employer will be contacted and given the opportunity to halt the works if he feels that this is appropriate.

5.4 Geomembrane Deployment

The CQA Engineer shall receive a proposed panel layout drawing from the Contractor at least 5 working days before it is intended to deploy geomembrane in accordance with Clause 5.6.1 of the Specification.

The CQA Engineer will maintain a record of the layout of the panels using the supplied drawing as a guide. Any departure from the proposed panel layout drawing

will be agreed by the CQA Engineer, ensuring compliance with Clause 5.6.4 is maintained. Any departures will be noted on an amended drawing. The panels will be identified using the method specified in Clause 5.6.2 of the Specification. The CQA Engineer will use this information to prepare an 'as-built' panel layout drawing for inclusion within the CQA report.

While maintaining a record of the deployed geomembrane the CQA Engineer shall ensure that the geomembrane is deployed in accordance with Clause 5.6.5 of the Specification. The Contractor shall demonstrate compliance with this clause by good working practise and where appropriate remedial actions.

The method of placement of the geomembrane will be approved by the CQA Engineer at the start of the works and will be monitored to ensure continued compliance with the Specification.

Where remedial actions have been carried out to ameliorate the regulating layer a record will be made of the areas that have been remediated and the CQA Engineer will record his acceptance of the remediated surface.

5.5 Temporary Surcharge

Temporary surcharge will be applied to the deployed geomembrane as required by Clause 5.7 of the Specification.

The CQA Engineer will ensure that the method of surcharging is not likely to damage the geomembrane in any way. Any damage noted by the CQA Engineer will be repaired in accordance with Clause 5.11 of the Specification and to the satisfaction of the CQA Engineer.

In the event of the geomembrane being displaced by wind, the CQA Engineer may require that all of the affected material is removed from the works due to the stresses and strains that are likely to have been imposed on the liner.

5.6 Seaming Procedure

The CQA Engineer will be provided with details of the experience of the 'master welder' and any other welders working on the contract to demonstrate compliance with Clause 5.8.1 of the Specification. Copies of the relevant certificates will be included in the CQA Report.

Prior to the commencement of any welding trial seams will be carried out in accordance with Clause 5.8.14 to 5.8.17 of the Specification. The trial seams will be witnessed by the CQA Engineer who will record the machine number and time of the tests and the conformance of the tests with Clause 5.8.15 of the Specification.

The CQA Engineer shall ensure that all seams are fusion welded where possible and that extrusion welding is only utilised where double seam welding is not practical, defects in the geomembrane have to be repaired or patches have to be welded over the location of field test seam samples.

The CQA Engineer will ensure that all welding is carried out in accordance with Clause 5.8 of the Specification.

5.7 Sampling and Testing

All on-site sampling and testing will be observed and authenticated by the CQA Engineer.

Conformance Testing

On-site samples (1.0m long and full width of sheet) to be cut from rolls selected at random – ignoring the first 1m length of the sheet – will be taken at a frequency of one every 5,000m^2 and submitted to an independent testing laboratory for the conformance tests specified at Table 1 of the Specification. The sample will be cut in half. Half will be submitted to the testing laboratory, the other half retained by the CQA Engineer.

To prevent the possibility of non-compliant material accidentally entering the permanent works all conformance testing should be undertaken prior to allowing any LLDPE material to be deployed. It is, however, appreciated that this may not be practicable, and any deployment undertaken before results of the conformance testing are known will proceed at the Contractor's risk.

If the conformance test fails to comply with the Specification the sheet sample retained as a back-up, is to be sent to an independent testing laboratory by the CQA Engineer for testing. If this further test fails to meet the Specification (i.e. Quality Control data given in the Roll Data Sheets) and an additional two samples cut from the roll also fail, then that roll will be rejected. Furthermore, rolls from the same LLDPE Resin Lot Number will be subjected to a similar conformance test procedure.

Qualitative Seam Destructive Testing

The CQA Engineer will witness the taking of tab samples as required of the Contractor by Clause 5.9.1 of the Specification. Testing shall be carried out by the Contractor in the presence of the CQA Engineer who will verify and record the test results. The pass / fail criteria is defined in Clause 5.9.2 of the Specification.

If the test fails, the CQA Engineer will witness the additional testing required by Clause 5.9.3 of the Specification. If the CQA Engineer is not satisfied that the area bounded by the two passed test locations is representative of the seam he will instruct the Contractor to take further tab samples outside of the bounded area.

When the bounded area has been agreed by the CQA Engineer the Contractor will repair / reconstruct the seam in accordance with Clause 5.11 of the Specification.

The CQA Engineer will record any areas of failure and repair on the 'as built' panel layout drawing.

Quantitative Seam Destructive Testing

The CQA Engineer will ensure that destructive seam samples are taken at a minimum frequency of 1 per 200m length of seam. If the CQA Engineer suspects that there may be a problem with any seam, due to site test results, the machinery being used to carry out the welding, the weather at the time of welding or for any other reason, he may increase the frequency of testing.

The samples taken shall have the **minimum** dimensions noted in Clause 5.9.6 of the Specification and will be distributed as noted in Clause 5.9.8. The pass / fail criteria is defined in Clause 5.9.9. The CQA Engineer shall ensure that all three sections of the seam test are fully labelled with the date and location from where they were taken and will arrange for the samples to be sent to an independent testing laboratory for testing.

In the event of a failure the Contractor may follow one of the courses of action noted in Clause 5.9.10 of the Specification. If the Contractor opts to take more samples the CQA Engineer will witness and verify that the location of the samples is in accordance with Clause 5.9.10. The CQA Engineer will send these samples to the independent testing laboratory.

If the retest samples pass then the CQA Engineer will instruct the Contractor to repair the area of the seam from where the tabs have been cut. If the retest sample fails then the seam will be replaced or repaired and the CQA Engineer will select another seam which was constructed using the same piece of machinery on the same day to be tested as required by Clause 5.9.11.

If that sample fails as well, the CQA Engineer will refer to his records to identify all other seams that were constructed on that day using the same piece of machinery. All of the seams will then be replaced or repaired. Supervision, record keeping and testing will be carried out as noted in the CQA plan.

The CQA Engineer will record any areas of failure and repair on the 'as built' panel layout drawing.

Non Destructive Seam Testing

All fusion seams will be air pressured tested as detailed in clause 5.9.12 of the Specification.

The CQA Engineer will ensure that the pressure, time and percentage decrease in pressure are accurately recorded. The CQA Engineer will witness all aspects of all air pressure tests and will record the date, time and location of each test.

In the event of a failure the procedure in Clause 5.9.14 will be followed.

It is envisaged that for this contract that spark testing will not be used to check extrusion seams due to the high probability of the presence of landfill gas.

Extrusion seams will be tested using the vacuum box method specified in Clause 5.9.15 and 5.9.16 of the Specification.

The CQA Engineer will witness the entire length of each extrusion seam being tested by the Contractor and will record the date, time and location of each test. If any failures are noted the seam will be repaired in accordance with Clause 5.11 of the Specification.

The CQA Engineer will record any areas of failure and repair on the 'as built' panel layout drawing. Supervision, record keeping and testing will be carried out as noted in the CQA plan.

5.8 Sealing of Protuberances

The CQA Engineer shall ensure that the sealing of protuberances is carried out in accordance with Drawing No. 2611.CAP.02 and Clause 5.10 of the Specification.

5.9 Inspection and Approval

The CQA Engineer shall inspect and approve the installed geomembrane prior to the protector geotextile/geocomposite being laid.

Before approval can be given he will ensure that all aspects of Clause 5.12.1 of the Specification have been complied with and that the panel layout drawing is up to date.

The CQA Engineer will record the approval on the Panel Installation Records.

If there is any change to the condition of the geomembrane between approval for the placement of the protector geotextile and the actual placement approval may be withdrawn until remedial actions have been taken.

6.0 PROTECTOR GEOCOMPOSITE

6.1 Geocomposite Material

The CQA Engineer will ensure that the geocomposite material delivered to site complies with Clause 6.2 of the Specification and Table 3 contained therein. This will be checked by assessing the manufacturer's quality control information, required by Clause 6.4 of the Specification, against the information in Table 3.

If the material delivered to site appears to be unsatisfactory for any reason, the CQA Engineer will inform the Contractor and deployment will not be permitted until the situation has been resolved.

6.2 Delivery, Handling and Storage

Prior to delivery to site, the CQA Engineer will inspect the storage area prepared by the Contractor for compliance with Clause 6.3.6 of the Specification for the storage of the geocomposite.

The CQA Engineer will ensure that the geocomposite has been rolled so that when it is unrolled the band drains are on the upper surface.

The CQA Engineer will ensure that each roll of geocomposite delivered to site is undamaged and labelled with the information required by Clause 6.3.3 of the Specification. Any damaged materials will be dealt with in accordance with Clause 6.3.5 of the Specification. The geocomposite shall be delivered to site in packaging that will protect the rolls from degradation by ultra violet light and the CQA Engineer shall ensure that the packaging is not damaged and the rolls are kept in the wrappings until required for use.

The CQA Engineer will ensure that materials are unloaded in accordance with Clause 6.3.4 of the Specification, unless the Contractor can demonstrate the suitability of other methods. The CQA Engineer will not permit the unloading of the geocomposite in any manner that may cause damage to the material.

The unloaded geocomposite rolls will be stored in the approved prepared area only and will be stored no more than three rolls high. The CQA Engineer will prepare an inventory of the materials delivered to site along with a schematic of the location of each roll.

6.3 Manufacturer's Quality Control

The manufacturer's quality control information should be passed to the CQA Engineer on the day that it is delivered to site for use in assessing the compliance of the geocomposite with the Specification. Where the manufacturer's quality control information is not available to the CQA Engineer unloading of the geocomposite and any subsequent use of the material will be entirely at the Contractor's own risk. In the event that the geocomposite deployment is due to commence before the CQA Engineer has received the information, the Employer will be contacted and given the opportunity to halt the works if he feels that this is appropriate.

6.4 Geocomposite Deployment

The CQA Engineer will maintain a record of the layout of the panels.

The panels will be identified using an identification code (alpha numeric), roll numbers will not be used as a panel identification. The panel identification code shall be used for all site records pertaining to that panel. The CQA Engineer will use this information to prepare an 'as-built' panel layout drawing for inclusion within the CQA report.

While maintaining a record of the deployed geocomposite the CQA Engineer shall ensure that the geocomposite is deployed in accordance with Section 6.6 of the Specification. The CQA Engineer will ensure that the seams are orientated parallel to the line of maximum slope and wherever possible the seams of the geocomposite do not directly overlie the geomembrane seams. The Contractor shall demonstrate compliance with the Specification by good working practise and, where appropriate, remedial actions.

The method of placement of the geocomposite will be approved by the CQA Engineer at the start of the works and will be monitored to ensure continued compliance with the Specification.

6.5 Temporary Surcharge

Temporary surcharge will be applied to the deployed geotextile as required by Clause 6.7 of the Specification.

The CQA Engineer will ensure that the method of surcharging is not likely to damage the geocomposite in any way. Any damage noted by the CQA Engineer will be repaired in accordance with Clause 6.9.1 of the Specification and to the satisfaction of the CQA Engineer.

6.6 Conformance Testing

The CQA Engineer will recover samples of the geocomposite at a rate of 1 per 5000m^2 each sample will be tested for the properties shown in Table 3 of the Specification.

The samples will be taken in accordance with Clause 6.5.1 of the Specification. The samples will be cut into two, with one part being sent to an independent laboratory for testing and the other part being retained by the CQA Engineer on site.

Where a conformance test fails to meet the Specification the part of the sample retained by the CQA Engineer shall be sent to the independent laboratory for testing.

If this sample also fails then further samples from the same roll of material may be taken for testing, if these materials prove to be satisfactory the geocomposite will remain in the permanent works. The CQA Engineer will identify all material that has been used from that roll using the panel records and the panel layout drawing. Where it is not possible to remove further samples of material, in cases where the geocomposite has already been covered, the CQA Engineer will provide a draft copy of the panel layout drawing to the CQA Project Engineer, with the affected panels clearly marked.

The CQA Project Engineer will then assess the test information and panel locations. The course of action to be undertaken will then be discussed with the Client and the Environment Agency. The nature of the action to be taken will depend upon the aspect and magnitude of the failure and the location of the failed materials with the works.

6.7 Protuberances

The CQA Engineer will ensure that all protuberances are laid around as detailed in Clause 6.8.1 of the Specification and as shown on Drawing No. 2611.CAP.02 .

6.8 Damage, Defects and Repairs

The CQA Engineer will inspect the placed geocomposite for any damage or defects. Any areas that require repair will be treated in accordance with Clause 6.9.1 of the Specification.

The CQA Engineer will record the nature and size of the defect and the size of the patch / area that has been replaced, along with the date that the repair is carried. The patch / repaired area will be noted on the panel layout drawing by the CQA Engineer.

7.0 PROTECTOR GEOTEXTILE

7.1 Geotextile Material

The CQA Engineer will ensure that the geotextile material delivered to site complies with Clause 7.2 of the Specification and Table 4 contained therein. This will be checked by assessing the manufacturer's quality control information, required by Clause 7.4 of the Specification, against the information in Table 4.

If the material delivered to site appears to be unsatisfactory for any reason, the CQA Engineer will inform the Contractor and deployment will not be permitted until the situation has been resolved.

7.2 Delivery, Handling and Storage

Prior to delivery to site, the CQA Engineer will inspect the storage area prepared by the Contractor for compliance with Clause 7.3.5 of the Specification for the storage of the geotextile. If the area is deemed to be unsatisfactory, then remediation of the area will be required before approval for the storage of geotextile may be given.

The CQA Engineer will ensure that each roll of geotextile delivered to site is undamaged and labelled with the information required by Clause 7.3.2 of the Specification. Any damaged materials will be dealt with in accordance with Clause 7.3.4 of the Specification.

The CQA Engineer will ensure that materials are unloaded in accordance with Clause 7.3.3 of the Specification, unless the Contractor can demonstrate the suitability of other methods. The CQA Engineer will not permit the unloading of the geotextile in any manner that may cause damage to the material.

The unloaded geotextile rolls will be stored in the approved prepared area only and will be stored no more than three high. The CQA Engineer will prepare an inventory of the materials delivered to site along with a schematic of the location of each roll.

7.3 Manufacturer's Quality Control

The manufacturer's quality control information should be passed to the CQA Engineer on the day that it is delivered to site for use in assessing the compliance of the geotextile with the Specification. Where the manufacturer's quality control information is not available to the CQA Engineer unloading of the geotextile and any subsequent use of the material will be entirely at the Contractor's own risk. In the event that the geotextile deployment is due to commence before the CQA Engineer has received the information, the Employer will be contacted and given the opportunity to halt the works if he feels that this is appropriate.

7.4 Geotextile Deployment

The CQA Engineer will maintain a record of the layout of the panels.

The panels will be identified using an identification code (alpha numeric), roll numbers will not be used as a panel identification. The panel identification code shall be used for all site records pertaining to that panel. The CQA Engineer will use this information to prepare an 'as-built' panel layout drawing for inclusion within the CQA report.

While maintaining a record of the deployed geotextile the CQA Engineer shall ensure that the geotextile is deployed in accordance with Section 7.6 of the Specification. The CQA Engineer will ensure that the Contractor marks the geotextile with the minimum specified overlap of 300mm prior to heat bonding to ensure that the minimum lap is achieved. The Contractor shall demonstrate compliance with the Specification by good working practise and where appropriate remedial actions.

The method of placement of the geotextile will be approved by the CQA Engineer at the start of the works and will be monitored to ensure continued compliance with the Specification.

7.5 Temporary Surcharge

Temporary surcharge will be applied to the deployed geotextile as required by Clause 7.7 of the Specification.

The CQA Engineer will ensure that the method of surcharging is not likely to damage the geotextile in any way. Any damage noted by the CQA Engineer will be repaired in accordance with Clause 7.9.1 of the Specification and to the satisfaction of the CQA Engineer.

7.6 Conformance Testing

The CQA Engineer will recover samples of the geotextile at a rate of 1 per 2500m^2 each sample will be tested for the Physical Properties shown in Table 4 of the Specification. Every second sample will also be tested for the Mechanical Properties noted in Table 4, giving a test rate of 1 per 5000m^2.

The samples will be taken in accordance with Clause 7.5.1 of the Specification. The samples will be cut into two, with one part being sent to an independent laboratory for testing and the other part being retained by the CQA Engineer on site.

Where a conformance test fails to meet the Specification the part of the sample retained by the CQA Engineer shall be sent to the independent laboratory for testing.

If this sample also fails then further samples from the same roll of material may be taken for testing, if these materials prove to be satisfactory the geotextile will remain in the permanent works. The CQA Engineer will identify all material that has been used from that roll using the panel records and the panel layout drawing. Where it is not possible to remove further samples of material, in cases where the geotextile has already been covered, the CQA Engineer will provide a draft copy of the panel layout drawing to the CQA Project Engineer, with the affected panels clearly marked.

The CQA Project Engineer will then assess the test information and panel locations. The course of action to be undertaken will then be discussed with the Client and the Environment Agency. The nature of the action to be taken will depend on the aspect and magnitude of the failure and the location of the failed materials with the works.

7.7 Protuberances

The CQA Engineer will ensure that all protuberances are laid around as detailed in Clause 7.8.1 of the Specification and as shown on Drawing No. 2611.CAP.02.

7.8 Damage, Defects and Repairs

The CQA Engineer will inspect the placed geotextile for any damage or defects. Any areas that require repair will be treated in accordance with Clause 7.9.1 of the Specification.

The CQA Engineer will record the nature and size of the defect and the size of the patch / area that has been replaced, along with the date that the repair is carried. The patch / repaired area will be noted on the panel layout drawing by the CQA Engineer.

8.0 RESTORATION SOILS

8.1 Materials

The restoration soils to be placed over the geocomposite/geotextile protector shall comprise of the materials noted in Clause 8.2 of the Specification.

The CQA Engineer will continually monitor the materials that are to be included in the restoration soils to ensure that material which does not comply with the Specification is not permitted to enter the works.

Unsuitable materials, as defined by Clause 8.2 of the Specification or materials deemed to be unsuitable by the CQA Engineer will be removed from the works and from the area where the works will take place.

Materials that are deemed to be unsuitable because they are in a frozen condition shall be stockpiled away from the working area and may be assessed for suitability by the CQA Engineer once they have been allowed to thaw thoroughly.

Materials which are deemed to be unsuitable due to high moisture content may be stockpiled away from the working area and allowed to dry. The CQA Engineer may assess the material for inclusion within the works once drying has taken place. It is important that if a significant quantity of material has been stockpiled that the complete stockpile is assessed before approval may be given. Stockpiled material should be turned to promote even drying of the material.

Materials which are deemed to be unsuitable due to oversize particles may be included in the works if it can be demonstrated to the CQA Engineer that 'stone picking' or removal of the oversize particles will result in the materials being compliant with the Specification.

The CQA Engineer will ensure that all materials greater than 50mm in the first 300mm of the soils and greater than 150mm thereafter will be removed from the restoration soils.

8.2 Placement

The CQA Engineer will monitor the materials to ensure that the material remains in accordance the Specification.

The CQA Engineer will monitor the materials to ensure that the Contractor excavates and handles the material in accordance with Clause 8.2.2 of the Specification. If the CQA Engineer considers that the materials have been adversely affected and are not suitable for inclusion within the works, he will reject the materials.

Where more than one type of material is present in the stockpile the CQA Engineer will record the area of placement for the different materials, as required of the Contractor by Clause 8.2.2 of the Specification.

The CQA Engineer will ensure that the materials as placed in a careful and systematic manner as stated in Clause 8.3.2 of the Specification.

If there is to be a material utilised for the first 300mm layer that differs to the overlying material the CQA Engineer will monitor the placed material. When the CQA Engineer is satisfied he will give approval for the remainder of the soils to be placed.

The full depth of the restoration soils layer will be monitored at the leading face of the soils by the CQA Engineer, using a moveable profile board.

The CQA Engineer will ensure that plant only travels on the thickness of material specified in Clause 8.3.3 and will monitor the Contractor's method of placement for compliance with Clause 8.3.4 of the Specification. Any methods of placement outside of the list which are employed by the Contractor will be assessed by the CQA Engineer to ensure that they do not damage or disturb the installed geotextile and geomembrane.

Any damage or disturbance to the geotextile or geomembrane will be repaired as detailed herein and recorded by the CQA Engineer for inclusion in the CQA Report.

The CQA Engineer will ensure that minimal compaction is applied to the soils during placement and that the finished surface is prepared in accordance with Clause 8.3.7 of the Specification, before certification for the works can be provided.

8.3 Protuberances

The CQA Engineer will ensure that excess soils are left adjacent to any protuberances as required by Clause 8.4.1.

Protuberances shall be subject to joint inspection by the CQA Engineer and the Contractor before and after the placement of the restoration soils and required by Clause 8.4.2.

9.0 CQA Report and Certification

9.1 CQA Report

A CQA report will be prepared on completion of the works. The CQA report will incorporate the following aspects:-

- details of the design;
- details of any design modification;
- details of the construction works;
- details of the Specification;
- details of the Quality Assurance procedures;
- records of any non-compliance and the solution adopted;
- site records as applicable;
- manufacturer's quality control certificates;
- panel and seam logs from the geomembrane installation;
- panel and seam logs from the geotextile/geocomposite installation
- independent conformance and destructive testing results;
- a panel layout plan for the geomembrane and geotextile/geocomposite;
- a commentary on the works and all results of the field testing;
- appendices combining testing results and certificates; and
- certification.

9.2 Certification

The CQA Report will also include a certificate signed by the CQA Project Engineer detailing the extent of the works which comply with the CQA Plan and Specification details.

A copy of the CQA Report will be presented to the Environment Agency for approval of the works.

APPENDICES

Appendix A	-	Specification
Appendix B	-	Typical CQA Proforma

APPENDIX A

SPECIFICATION

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Drawings

1.0 Introduction

1.1 General

1.1.1 This Specification details the engineering requirements for the construction of the permanent capping to completed landfill cells 3, 5 and 6, at Leadenham Landfill Site, operated by May Gurney.

1.2 Site Location

1.2.1 The landfill is located at National Grid Reference SK 964 524 approximately 750 m east of the village of Leadenham.

1.2.2 A general layout of the landfill showing the extent of the capping to Cells 3, 5 and 6 is shown on Drawing 2611.CAP.01

1.3 Scope of the Works

1.3.1 The Works comprise but are not limited to the following main elements:

- Capping preparatory earthworks;
- Placement of a 300mm regulating layer.
- Installation of a 1mm thick welded LLDPE geomembrane over the capping area;
- Placement of a protector geotextile/protector geocomposite above the geomembrane;
- Placement of 1000mm of restoration soils above the protector geotextile.

1.4 Drawings

Drawing	Title
2611.CAP.01	Existing Site Layout and Topography
2611.CAP.02	Details of Proposed Capping System

2.0 General Items

2.1 Access to the Site

2.1.1 Access to the Site shall be via the main landfill entrance as shown on Drawing 2611.CAP.01. Access to the capping area will be via existing internal access roads as agreed with the Employer.

2.1.2 The Contractor shall not construct any temporary access roads without the approval of the Employer.

2.1.3 The Contractor's vehicles shall give way to landfill traffic and not impede the daily movement of landfill operations traffic.

2.1.4 The Contractor shall carry out jointly with the Supervisor a condition survey of any access roads made available to him under the Contract prior to the commencement of any work at these locations that will affect the condition of these roads.

2.1.5 The Contractor shall repair and make good any damage to the Employer's landfill access roads which occur as a result of the Contractor's activities.

2.2 Compliance with Employer's Safety Requirements

2.2.1 The Contractor shall comply with the safety requirements set out in the following documents:

(i) Waste Recycling Group Plc Health and Safety Policy;

(ii) Waste Recycling Group Plc Site Managers Rules;

(iii) Waste Recycling Group Plc Ltd General Policy Statement for Contractors Conditions of Contract and Safety Rules;

(iv) Waste Recycling Group Plc Safety Instructions for all site users;

(v) The May Gurney Construction Ltd Health & Safety Policy, and;

(vi) The May Gurney Construction Ltd Health & Safety Site Plan.

A copy of these documents is available for inspection at the Employers landfill site office.

2.2.2 The landfill site speed limits shall be observed at all times. Non-compliance may result in expulsion and exclusion of any offender from the Site.

2.2.3 All mobile plant shall be assessed for the risk of impeded rearward vision and, dependant upon the outcome of this assessment, will be fitted with appropriate equipment in order to minimise the risk to within acceptable limits.

2.2.4 The Contractor shall implement a system for signing in and out of the Site which shall apply to all persons present on the Site at any time. This system shall be approved by the Supervisor and the Employer prior to commencement of any work on Site.

2.3 British Standards and British Standard Codes of Practice.

2.3.1 British Standards and British Standard Codes of Practice incorporated in the Contract by a reference which does not include a date shall be the respective editions current 42 days prior

2.0 General Items

to the date of the Works, and incorporating all British Standards Institution amendments current on that date. British Standards and British Standard Codes of Practice incorporated in the Contract by a reference that includes a date shall be deemed to exclude British Standards Institution amendments issued after that date except any such amendments shown in brackets immediately following the stated date.

2.4 Setting Out and Construction Surveys

2.4.1 The Contractor will be given Ordnance Survey or temporary benchmarks on or near the Site to which all setting out shall be referred. The Contractor will be expected to liaise with the Employer's nominated land surveyor in regard to all setting out and construction level control. Prior to Works commencing the Contractor shall establish Works benchmarks at a ratio of one per hectare of the Site and provide a list of the co-ordinates and reduced levels to the Supervisor.

2.4.2 The Contractor shall carry out construction surveys where practicable to determine ground elevations at each of the following stages of earthworks and at other times as may be necessary for record purposes and to measure quantities for evaluation purposes:

i) prior to commencing the Works;

ii) on completion of trimming to the existing waste;

iii) on completion of the placement of the regulating layer

iv) on completion of the geomembrane installation (this survey will be used as the basis for recording the "as built" geomembrane panel and repair locations);

v) on completion of the placement of the restoration soils.

2.4.3 Each survey should be carried out a number of fixed points. The Contractor shall agree the fixed point arrangement with the Supervisor. Further detail such as crests and toes of slopes and the location of protuberances will also be required.

2.4.4 The Contractor shall forward a paper and disc copy in 3D DXF, or other equivalent formats approved by the Supervisor, of each survey undertaken.

2.5 Surface Water Control

2.5.1 The Contractor shall carry out any operations necessary for dealing with flowing water, standing water or surface water run-off within the Site, as necessary to facilitate the construction of the Works, to prevent damage to the Works, the Site, or adjoining properties.

2.5.2 Flowing water, standing water or surface water run-off shall only be discharged to locations as shown on the Drawings, or as otherwise approved by the Employer.

2.6 Materials

2.6.1 Materials and components used in the Works shall, where applicable be in accordance with the relevant British Standard or equivalent standard approved by the Supervisor.

2.0 General Items

Storage of Materials

2.6.2 All materials and components shall be stored and transported in such a manner as to preserve their quality and integrity to the standards required by the Contract.

Handling and Use of Materials

2.6.3 Materials and components shall be handled in such a manner as to avoid any damage or contamination and in accordance with the particular manufacturers' recommendations.

2.6.4 Unless otherwise described in the Contract, the use, installation, application or fixing of materials and components shall be in accordance with the particular manufacturers' recommendations.

2.7 Site Clearance and Waste Disposal

2.7.1 Trees, stumps, bushes, shrubs and fencing shall be grubbed up and long grass, weeds and scrub shall be cut down and all collected for disposal on Site or in the landfill, as directed by the Employer.

2.7.2 All abandoned metal, scrap or other waste, or waste generated by the Contractor, shall be disposed of in the same manner as Section 2.7.1.

2.8 Daily Journal

2.8.1 The Contractor shall maintain a detailed record of work performed and progress made during the course of each working day. The daily journal shall be in a format approved by the Supervisor and shall include the following:

i) date of shift;
ii) names of personnel in attendance during the shift;
iii) weather conditions, including ambient temperature;
iv) type of plant used; plant breakdowns and hours;
v) approximate totals of earthworks carried out including identification of source and destination;
vi) removal of foreign matter and oversize materials;
vii) depth of material placed;
viii) delays;
ix) additional works, reasons and reference; and
x) deliveries.

2.8.2 The Contractor shall submit a copy of the daily journal to the Supervisor at the start of the first working day following the day to which the journal refers.

2.0 General Items

2.9 Permitted Hours of Working

2.9.1 The permitted hours of working are:

Monday to Friday	07.00 – 18.00
Saturday	07.00 – 12.00 noon

Unless approved otherwise beforehand by the Supervisor working on Sundays and Bank Holidays will not be permitted.

2.10 Naked Flames and Smoking

2.10.1 Naked flames are prohibited outdoors on Site at all times. Smoking is not permitted inside any buildings or on site. Smoking is only permitted outside in the allocated smoking area as agreed with the employer.

2.11 Control of Noise and Vibration

2.11.1 The Contractor shall comply with the recommendations for practical measures to reduce noise set out in BS 5228 : Parts 1, 2 and 4 and with the following specific requirements:-

i) During the permitted working hours noise from the operations on site including both fixed plant and mobile machinery will be controlled such that it does not exceed 55 dB LA eq (1 hour) as measured 3.5m from the facade of any residential property within 150m of the site boundary.

ii) Plant and equipment for the control of groundwater may be operated outside the permitted working hours (Clause 2.10). Any such plant and equipment shall be controlled so there is no increase greater than 3.5 dBA (corrected) in accordance with BS 4142 above the ambient noise level at 3.5m from the facade of any residential building within 150m of the site boundary.

iii) Reversing bleepers or other means of warning of reversing vehicles shall be fixed to and used on any mobile site plant and shall comply with the noise limits above except as may be agreed otherwise by the Supervisor in writing.

iv) No work other than the operation of plant and equipment for the control of the groundwater shall take place outside the permitted hours except in case of emergency. The Employer shall be informed of any such emergency immediately.

vi) All mobile plant, equipment and vehicles under the control of the Contractor, his sub-contractors and suppliers, and in use or calling at the Site, shall be fitted with appropriate silencing equipment, which shall be maintained to manufacturers' standards and be in accordance with sub clause (ii).

2.12 Substances Hazardous to Health

2.12.1 In this Clause 'substance hazardous to health', has the same meaning as in:

i) the Control of Substances Hazardous to Health (Amendment) Regulations 2004.

ii) the Control of Lead at Work Regulations 2002.

2.0 General Items

iii) the Control of Asbestos at Work Regulations 2002.

2.12.2 A substance hazardous to health shall only be used or generated in or about the Works where specified in the Contract or with the consent of the Supervisor.

2.12.3 Where any substance hazardous to health is so used or generated the Contractor shall provide the Supervisor with:

i) a copy of the assessment of the risks created by the use of that substance; and

ii) details of the measures to be taken to prevent or adequately control the exposure of those working with or those who may be affected by the substance.

The information required in i) and ii) above shall be provided to the Supervisor at least 14 days prior to the use of or incorporation into the Works of substances hazardous to health or where appropriate at the commencement of the Works where this is less than 14 days.

2.12.4 The Contractor shall, in relation to work with any substance hazardous to health, advise the Supervisor of the information, instruction, training and supervision to be provided for the Contractor's employees and any other person with reason to enter the area in which the hazard exists, and the provision to be made for monitoring health.

2.12.5 Where the measures referred to necessitate the use of protective clothing or other safety apparatus the Contractor shall:

i) provide the Supervisor and his staff with sufficient suitable items of such protective clothing and other safety apparatus so far as they are not otherwise supplied;

ii) arrange for the proper storage, maintenance and, if necessary, regular testing and replacement of the items provided to the Supervisor and his staff; and,

iii) arrange for appropriate training or instruction for the Supervisor and his staff in the use of such items.

2.13 Dangerous Substances and Explosive Atmospheres

2.13.1 In this Clause 'Dangerous Substances', has the same meaning as in:

i) The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)

2.13.2 The major duties associated with DSEAR compliance are found in the DSEAR regulations, 5 to 11.

2.13.3 Where the measures referred to necessitate the use of protective clothing or other safety apparatus the Contractor shall:

i) provide the Supervisor and his staff with sufficient suitable items of such protective clothing and other safety apparatus so far as they are not otherwise supplied;

ii) arrange for the proper storage, maintenance and, if necessary, regular testing and replacement of the items provided to the Supervisor and his staff; and,

iii) arrange for appropriate training or instruction for the Supervisor and his staff in the use of such items.

2.0 General Items

2.14 Contractor's Fuel and Oil Installations

2.14.1 Contractor's fuel and oil installations within the Site shall only be provided at locations approved by the Supervisor.

2.14.2 All fuel and oil installations provided by the Contractor within the site shall be contained within an impermeable bund capable of containing 110% of the tank capacity in the event of a spillage.

2.15 Training Requirement For Contractor's Personnel

2.15.1 Contractors personnel engaged in plant operation shall be CSCS/CPCS certified, or equivalent, for the relevant item(s) of plant. Certification shall be provided for inspection when required by the Supervisor.

2.15.2 All of the Contractors personnel shall receive training in the Rules and Regulations pertaining to operations on the landfill site. This training will be provided by the Employer at the Commencement Date, and at such further times as may be necessary. The Contractor shall be responsible for ensuring that his personnel adhere to these Rules and Regulations.

2.16 Dust and Mud Nuisance

2.16.1 The Contractor shall take all necessary steps to eliminate dust nuisance during the Works.

2.16.2 Existing highways, site and access roads used by vehicles of the Contractor or any of his sub-contractors or suppliers of materials or plant, shall be kept clean and clear of all dust and mud dropped by the said vehicles or their tyres. All dust and mud from the works spreading on these highways, site and access roads shall be immediately cleared by the Contractor by use of mechanical plant to the approval of the Supervisor.

2.16.3 Compliance with this clause shall not relieve the Contractor of any responsibility for complying with the requirements of any Highway Authority in respect of keeping roads clean.

2.17 Landfill Tax

2.17.1 The Contractor will be responsible for all costs which arise as a consequence of Landfill Tax liabilities for materials brought to site, and will be required to prove exemption for all material used in the Works that so qualify.

2.17.2 The Contractor will be responsible for any costs which arise as a consequence of the Landfill Tax and are due in respect of the disposal of arisings from the Works.

2.17.3 Where it is necessary for the Employer to make payments on behalf of the Contractor to HM Customs and Excise as a consequence of the Landfill Tax Regulations, any such payments made by the Employer will be recovered from the Contractor by the deduction of monies from any sums then due or which at any time thereafter may become due to the Contractor under the Contract.

2.0 General Items

2.18 Contractor's Compound and Facilities for the Contractor

2.18.1 The layout of the Contractor's compound is to be agreed with the Supervisor prior to commencement on site.

2.18.2 No lodgings or caravans will be allowed on Site.

2.18.3 The Contractor's personnel shall gain permission from the employer to access to any of the Employer's mess, shower and toilet facilities.

2.18.4 The Contractor shall ensure that adequate provision is made within his compound area for parking of all his plant and any private vehicles owned by operatives / supervisor and visitors at all times. Parking shall not be permitted in any other areas of the landfill site.

2.18.5 The Contractor shall set out an area within his compound for carrying out plant maintenance and repairs. The Contractor shall ensure that all routine maintenance takes place within this area and where possible all repairs also.

2.19 Telephones, Radio Systems and other Communication Devices

2.19.1 The Contractor shall obtain the approval of the Supervisor prior to commissioning any communication equipment and shall ensure that they will not interfere with any existing systems on the site.

2.20 Method Statements and Risk Assessments

2.20.1 The Contractor shall submit for the approval of the Supervisor, prior to commencement of the Works, method statements and risk assessments detailing his proposals for all the works to be undertaken

2.21 Landfill Gas and Leachate Management Systems

2.21.1 The Employer has installed landfill gas and leachate management systems across the Site including areas within and adjacent to the Works. The Contractor shall liaise with the Employer to determine which systems are to remain undisturbed during the period of the Works and which can be, or have been, decommissioned. Should the Contractor damage or disturb any operational system he shall immediately inform the Supervisor and the Employer. The Contractor shall carry out such reasonable remedial measures, as are deemed necessary by the Employer, to re-instate any damaged or disturbed system to the same condition as immediately prior to commencement of the Works.

3.0 Capping Preparatory Earthworks

3.1 General Description

3.1.1 Prior to installation of the proposed capping system, preparatory earthworks shall be undertaken consisting of the trimming of the final waste surface, the excavation of anchor trenches and exposing the outer edges of existing capping systems.

3.2 Trimming of Final Waste Cover

3.2.1 Prior to placement of the regulating layer, the surface of the final waste cover of the area to be capped shall be compacted by the passage of a tracked bulldozer and trimmed to produce an even stable formation without any bumps, hollows or areas which may collect water. Any object greater than 200mm in any dimension, or any object which in the opinion of the Supervisor may potentially cause damage to the capping system through the regulating layer, visible in the final waste surface shall be removed. Any void or hollow created after removal of any object shall be filled with either regulating layer material or excavated waste covered with suitable material.

3.2.2 Where waste materials are required to be excavated from an area during the trimming process, they shall be disposed of in accordance with the Site Licence or Permit within the operational area of the landfill or shall be used to fill any depression or hollows within the final waste profile. The Contractor shall prior to the excavation of any waste liaise with the Employer regarding any special precautions to be taken.

3.3 Anchor Trenches

3.3.1 The proposed capping system is to be secured into the anchor trench of an existing geosynthetic side-slope lining system and this shall be undertaken in accordance with the detail shown on Drawing 2611.CAP.02.

3.3.2 The Contractor shall undertake the excavation of the backfill from the existing geosynthetic side-slope lining system anchor trench in such a manner as to avoid damaging the lining system. Any damage to the lining system shall be repaired in accordance with the Contract.

3.3.3 Anchor trenches constructed as part of these capping works shall have slightly rounded edges to avoid sharp bends in the lining system.

3.3.4 The capping system shall be extended to the back face of the trench and panels shall be temporarily, but securely, anchored within the trench until the corresponding panel of the overlying layer has been installed.

3.3.5 Excessive amounts of loose material shall not be allowed to underlie the capping system in the anchor trench. Once the capping system has been installed the anchor trench shall be backfilled as soon as practicable in layers with suitable material compacted by a hand held vibratory impact plate, or other method approved by the Supervisor.

3.4 Disturbance and Damage

3.4.1 Any disturbance or damage to an existing or newly installed lining system shall be repaired in accordance with the Contract.

4.0 Regulating Layer

4.1 General Details

4.1.1 The regulating layer shall be placed and compacted over the trimmed final waste surface to a thickness of 300mm.

4.2 Materials

4.2.1 The material to be used for the regulating layer shall be sourced from on site stockpiles as directed by the Employer or imported. The material shall be free from any unsuitable material, or any other deleterious materials/objects that may potentially cause damage to the capping system.

Unsuitable material includes:

i) peat, material from swamps, marshes and bogs;

ii) logs, stumps and perishable material;

iii) material in a frozen condition or susceptible to spontaneous combustion;

iv) building rubble or non-ferrous material;

v) any industrial, commercial or domestic waste;

vi) any material having a maximum particle size greater than 10mm.

vii) any material with a high moisture content which when compacted does not provide a firm foundation sufficient to permit the movement of vehicles without causing excessive rutting.

4.3 Placement

4.3.1 The Contractor shall excavate and handle the material from the on site stockpiles in such a manner that the nature and consistency of the material is not adversely affected. Where more than one type of material is encountered the Contractor shall, wherever practicable, excavate the stockpile in such a manner that the materials can be separated.

4.3.2 The regulating layer shall be compacted to thickness of 300mm with sufficient passes of a tracked dozer to provide a firm and even foundation on which to place the capping system.

4.3.3 Haulage of materials to areas of placement shall only proceed when sufficient spreading and compaction plant is operating at the place of deposition. There shall be a minimum delay between placement and compaction. Material shall not be stockpiled on the waste surface.

4.3.4 During placement of the regulating layer the Contractor shall restrict compaction used within 1000mm of any protuberance to the following items:

(i) vibratory roller having a mass per metre width of roll not exceeding 1300kg, with a total mass not exceeding 1000kg;

(ii) vibrating plate compactor having a mass not exceeding 1000kg, or;

(iii) vibro-tamper having a mass not exceeding 75kg.

4.0 Regulating Layer

The Contractor shall provide a method statement for approval by the Supervisor prior to any compaction work being carried out within 1000 mm of any protuberance. The regulating layer may, with the approval of the Supervisor, be thickened around each protuberance so that surface water runoff is directed away from it.

4.4 Surface Preparation for Geomembrane Deployment

4.4.1 The surface of the regulating layer shall meet the following requirements as directed by the Supervisor:

i Smooth, flat, firm without shrinkage cracks or other surface defects, and have no sudden sharp or abrupt changes in grades which exceed ± 10mm when measured with a lath over a length of 1000mm, and no large rounded irregularity should exceed ± 50mm when measured with a lath over a length of 3000mm.

ii Free from any unsuitable material.

iii Free from areas excessively wetted or softened by high water content.

4.4.2 The Contractor's attention is drawn to the fact that, in order for the surface of the regulating layer to meet the requirement of Section 4.4.1, the layer may require stone picking after placement, or other methods approved by the Supervisor.

4.4.3 The Contractor shall not place any geomembrane on the regulating layer at any location until that location has been approved by the Supervisor.

4.4.4 The Contractor shall discuss and agree the appropriate remedial measures with the Supervisor for areas unacceptable to receive the geomembrane. These measures may include re-trimming and re-rolling of the surface, the removal of any soft spots and objects from the surface.

4.4.5 Should the Contractor delay placement of the geomembrane over the approved surface, and as a result the condition of the surface deteriorates, approval may be withdrawn until the surface has been remediated.

5.0 Geomembrane Cap

5.1 General Description

5.1.1 The geomembrane cap shall be placed over the approved regulating layer as soon as practicable. Adjacent panels of geomembrane material shall be overlapped and welded together to provide a continuous cap. Details of the geomembrane cap installation are shown on Drawing 2611.CAP.02.

5.1.2 Dependent upon the slopes in the area to be capped, the following combinations of geosynthetics shall be used as determined by the Supervisor:

Slope Gradient	Geomembrane	Protector
1(v):3(h) –1(v):3.5(h)	Textured	Geocomposite
< 1(v):3.5(h)	Textured	Geotextile

5.1.3 The Capping system shall not be placed on any slope steeper than 1(v):3(h).

5.2 Geomembrane Material

5.2.1 The geomembrane material to be used in the capping system shall be 1mm thick double textured Linear Low Density Polyethylene (LLDPE) geomembrane and shall meet the requirements of Table 1.

5.2.2 All geomembrane material supplied and installed shall be produced from new resin and shall not contain any fillers, plasticisers or additives of any kind, with the sole exception of carbon black. The geomembrane material shall be free from cuts, holes, blisters, blemishes, abrasions, or other surface imperfections.

5.0 Geomembrane Cap

Table 1 – Geomembrane Material Requirements

PARAMETER	TEST METHOD	MINIMUM VALUE
Thickness (mm)	ASTM D5994 (Textured)	1mm (-5%, nom.) 1mm (-10%, 8 out of 10) 1mm (-15%, lowest value of 10 values)
Carbon Black Content (%)	ASTM D1603	2 – 3
Carbon Black Dispersion	ASTM D5596 (10 views)	Min. 9 of 10 in Categories 1 or 2 and 1 in Category 3
Density (g/ml)	ASTM D1505A /D792	0.94
Tensile Properties: Break Stress (kN/m) Break Elongation (%)	ASTM D638 Type IV dumbbell (GRI GM13)	 11 250
Tear Resistance (N)	ASTM D1004	100
Puncture Resistance (N)	ASTM D4833	200
Oxidation Induction (OIT) (High Pressure)	ASTM D5885	400

5.3 Delivery, Handling and Storage

5.3.1 The geomembrane shall be delivered to site in the form of a roll, prepared, packed and loaded in a manner so as to prevent any damage during handling.

5.3.2 Each roll of geomembrane delivered shall be clearly labelled with the name of the manufacturer, product name and type, batch and roll number, roll length, width and roll weight and date of manufacture.

5.3.3 On delivery to site rolls shall be off-loaded to storage using a crane or suitable available construction equipment. Each roll should be equipped with canvas slings to facilitate unloading.

5.3.4 Any damaged or defective rolls shall be marked by the Contractor and then segregated before removal from site.

5.3.5 The rolls shall be stacked not more than three high and stored in accordance with the manufacturers recommendations in a storage area which shall be clean, firm, dry, and free of rocks or other detritus, and located so as to preclude damage from impact or puncture by working plant, vandals or such like. The location of the storage area shall be agreed with the Employer.

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5.4 Manufacturer's Quality Control

5.4.1 The Contractor shall forward to the Supervisor a copy of the manufacturers quality control documentation for the rolls delivered to site. The documentation shall include at least the following details:

i) the manufacturers name;
ii) date of manufacture;
iii) batch number;
iv) product name and type, and;
v) values for those parameters listed in Table 1.

5.5 Conformance Testing

5.5.1 The Contractor shall provide access for the Supervisor to recover samples from the geomembrane rolls for conformance testing in accordance with the parameters given in Table 1. Samples will be 1.0m long and the full width of the roll. More than one sample may be recovered from any particular roll. The Supervisor will send a copy of the results of the testing to the Contractor but this shall not relieve the Contractor from any of his obligations under the Contract.

5.6 Geomembrane Deployment

5.6.1 The Contractor shall submit an installation plan and method statement to the Supervisor for approval at least five working days before he intends to commence installation. The plan shall illustrate the location of each panel and have been developed with the principal objectives of minimising the number of panels and maximising installation speed. The plan shall not be amended without the prior approval of the Supervisor.

5.6.2 Each geomembrane panel shall be given an identification code (alpha numeric) consistent with the installation plan. Roll numbers shall not be used as a panel identification code. The panel identification code shall be used for all site records pertaining to that panel.

5.6.3 The first 1m length of each geomembrane roll shall be discarded and not incorporated within the Works.

5.6.4 The geomembrane shall be installed in direct contact with the surface of approved regulating layer. Individual panels shall be positioned with a minimum overlap of 100mm between adjacent panels and welded. All geomembrane panels shall, whenever practicable, be arranged so that seams are oriented parallel to the line of maximum slope. In corners and odd-shaped geometric locations the panel layout should be such that the number of seam is minimised.

5.6.5 The Contractors method of deployment shall be such that:

i) equipment, plant and tools used will not damage the geomembrane by handling, trafficking, leakage of hydrocarbons or by other means;

ii) personnel working on the geomembrane will not smoke, wear shoes likely to cause damage, or otherwise engage in any activity that could damage the geomembrane;

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iii) stresses and strains likely to cause damage to the geomembrane and underlying layers are avoided;

iv) the geomembrane will be in continuous contact with the surface on which it is placed without stretching or bridging over humps and hollows;

v) the method of deployment will minimise wrinkles;

vi) surface water will be prevented from flowing beneath the geomembrane;

vii) deployment will not take place during periods of precipitation or in the presence of excessive moisture (fog, rain, snow, and heavy dew) or in the presence wind likely to cause damage;

viii) geomembrane will not be placed over areas of ponded water;

ix) direct contact with the geomembrane is minimised;

x) construction plant will not traverse over any area of geomembrane until sufficient depth of cover has been placed over it in accordance with the Contract.

5.7 Temporary Surcharge

5.7.1 The Contractor will be responsible for providing adequate temporary loading and/or anchoring measures (e.g. in the form of durable sandbags, tyres or similar weights without sharp edges and not likely to damage the geomembrane) on the geomembrane immediately after deployment to protect the geomembrane from damage by the wind or to prevent slippage during the Works. These measures shall remain in place until the overlying layers are placed over the geomembrane, unless otherwise directed by the Supervisor. On steep embankments, suspension of sandbags or tyres by ropes may be required. If tyres are used as temporary loading measures the Contractor shall remove them off site at the completion of the Works.

5.8 Seaming Procedure

General

5.8.1 The installation and welding of the geomembrane liner shall be undertaken by suitably qualified and experienced staff. Welding staff will hold a current third party certificate for welding and installation of flexible membrane liners to a recognised standard such as that of the British Geomembrane Association (BGA) or Thermal Welding Institutes (TWI) third party accreditation schemes.

5.8.2 The Contractor shall only perform field seams on each working day after trial seams have been carried out on that day to the satisfaction of the Supervisor.

5.8.3 The general seaming procedure shall be such that:

(i) the equipment used for seaming does not damage the geomembrane;

(ii) all surfaces of the geomembrane to be seamed are clean, dry and free of all moisture, dust, dirt, debris and foreign material of any kind prior to seaming;

(iii) where seam overlap grinding is required prior to seaming it will not remove more than 10% of the nominal geomembrane thickness and shall not extend more than 12mm on

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either side of any proposed extrusion seam. Grinding shall not take place more than one hour before seaming;

(iv) temporary bonding of adjacent panels, or any pre-heating during seaming, will not cause any damage or overheating to the geomembrane. Temporary bonding using adhesives will not be permitted;

(v) where a seam runs into an anchor trench it shall be completed to the back edge of the trench. Any seam defects falling within the anchor trench shall be repaired in accordance with the Contract;

(vi) where the geomembrane has one or both faces textured, and the manufacturer has not left a plain strip on the edges, the Contractor shall remove the texture in accordance with the manufacturer's instructions so that it does not affect the seaming process;

(vii) seams will be aligned to minimise the number of wrinkles and "fishmouths". Any wrinkles/fishmouths that cannot be eliminated by pulling the sheet shall be cut along their ridge, overlapped and extrusion welded. Where the overlap does not meet the requirements of the Contract it shall be patched in accordance with the Contract.

5.8.4 Seaming shall not take place:

i) during any period of rain or snow unless the Supervisor is satisfied that measures have been implemented to allow the seam to be made on dry geomembrane materials;

ii) at ambient temperatures outside the range of 5°C to 35°C, unless approved by the Supervisor;

iii) during periods of high relative humidity or wind speed;

iv) above frozen or saturated ground;

v) over ponded water; and

vi) during the hours of darkness unless approved by the Supervisor and subject to the Contractor providing adequate illumination.

5.8.5 If the Contractor wishes to seam at ambient temperatures below 5°C or above 35°C, he shall demonstrate by trial seaming that the seam is equivalent to those produced under approved conditions and that the overall quality of the geomembrane is not adversely affected.

5.8.6 The minimum overlap shall be clearly marked on the edge of the underlying geomembrane panel prior to seaming.

5.8.7 At the start and end of each seam, and at 10m intervals along the seam, the Contractor shall check the settings on the welding equipment. He shall then mark on the geomembrane in an indelible manner at each location the operating temperature and speed of the equipment.

Fusion Seaming

5.8.8 All the seams in the geomembrane shall be fusion welded with a double seam with exceptions as stated in clause 5.8.9. Fusion weld seams shall be formed by working in one direction only.

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Extrusion Seaming

5.8.9 Extrusion seaming shall only be used with the approval of the Supervisor where;

i) double seam welding is not practicable;

ii) defects in the geomembrane have to be repaired;

iii) patches have to be welded over the location of field seam test samples.

5.8.10 The width of extrusion seams shall not be less than 30mm.

5.8.11 Prior to forming an extrusion seam, adjacent panels shall be temporarily secured by heat bonding and the seam surfaces roughened by grinding to provide a key and to remove surface oxidation.

5.8.12 The extrudate material used for extrusion welding shall be identical in composition to that of the geomembrane.

5.8.13 The extruder shall be purged prior to the commencement of any extrusion seaming or after any stoppage in seaming until all heat degraded extrudate has been removed from the barrel.

Trial Seams

5.8.14 Trial seams shall be carried out by the Contractor immediately prior to the commencement of seaming on each working day to confirm the set up of the seaming equipment for the ambient conditions and that the equipment is working satisfactorily. Trial seams shall be produced under the same conditions as the installation seams and shall be performed with the geomembrane in contact with the same subgrade type.

5.8.15 A separate trial seam shall be carried out by the Contractor for each piece of seaming equipment and operator:

i) at the beginning of each seaming period;

ii) after every four hours of operation;

iii) following any period of shut down in excess of half an hour;

iv) if, in the opinion of the Supervisor, there has been a significant change in the ambient conditions.

5.8.16 For a fusion weld the trial seam shall be 4m long and for an extrusion weld it shall be 1.5m long. From each trial seam six tab samples of length 200mm by 25mm shall be extracted at random along the length of the seam. The tabs shall be examined to confirm that the seam exhibits a homogenous fusing of the two panels with no definable boundary or layer. Three tabs shall be tested for shear failure and three for peel failure in the field by the Contractor. The mode of failure for all the tabs shall be yield of the sheet material outside the seam.

5.8.17 If the field testing of the trial seams proves unsatisfactory, further trial seams shall be performed and the procedure repeated until the Supervisor is satisfied with the set up of the particular item of seaming equipment or operator.

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5.9 Sampling and Testing

Qualitative Destructive Testing

5.9.1 The Contractor shall take a tab sample from the start and end of each completed seam. The tabs shall be 25mm wide and at least 200mm long with one tab being tested for shear failure and the other for peel adhesion failure on site by the Contractor.

5.9.2 The seam will be deemed to have passed qualitative destructive testing if the failure occurs solely in the geomembrane and does not enter the seam. The seam will be deemed to have failed qualitative destructive testing if any of the failure enters the seam.

5.9.3 If the tab sample fails field qualitative destructive testing the Contractor shall:

i) take the welding equipment out of service until it has passed a trial seam;

ii) take additional tabs at 3m distance to each side of the failed tab and carry out qualitative destructive testing on these. If either sample fails, the Contractor may cut and test further tabs until he can identify an area bounded by two passed locations.

The failed seam shall then be reconstructed in accordance with the Contract.

5.9.4 The Supervisor may direct the taking of additional tab samples and qualitative destructive testing at any location along the length of a seam.

Quantitative Destructive Testing

5.9.5 The Contractor shall recover samples for quantitative destructive testing from completed field seams as the seaming work progresses, at locations as directed by the Supervisor.

5.9.6 Each sample shall be at least 0.3 metres wide by 1.2 metres long with the seam centred lengthways. One 25mm wide tab shall be cut from each end of the sample. The remaining sample will be cut into three parts with one additional 25mm wide tab being cut from each end of the central portion. The tabs shall be tested in the field for failure in peel and shear in accordance with the Contract.

5.9.7 The three sample parts shall be distributed as follows:

i) one part measuring 300mm x 300mm, to the Contractor;

ii) one part measuring 300mm x 500mm, to the Supervisor, and;

iii) one part measuring 300mm x 300mm, to the Employer.

The Supervisor will forward his sample to the testing laboratory for quantitative destructive testing in accordance with ASTM D4437 (as modified by NSF 54-1993). In total 10 tabs will be tested from the sample, 5 in peel mode and 5 in shear mode, taken alternately throughout the sample. Copies of the results of the testing will be forwarded to the Contractor but this shall not relieve him of any of his obligations under the Contract.

5.9.8 The seam will be deemed to have passed quantitative destructive testing if in at least four out of the five tabs:

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i) failure occurs solely on the parent material and does not enter the seam;

ii) the peel and shear strength exceeds these requirements specified in Table 2;

Where the fifth tab fails to meet the requirements of (i) above then its peel and shear strength must exceed 80% of the requirements specified in Table 2.

Table 2 –1mm Thick LLDPE Geomembrane Seam Strength Properties

PARAMETER	TEST METHOD	MINIMUM VALUE
Peel Adhesion		
Fusion	ASTM D4437 (As modified by NSF54-1993)	9 N/mm
Extrusion	ASTM D4437 (As modified by NSF54-1993)	8 N/mm
Shear Strength		
Fusion	ASTM D4437 (As modified by NSF54-1993)	11 N/mm
Extrusion	ASTM D4437 (As modified by NSF54-1993)	11 N/mm

5.9.9 In the event of a failed destructive test the Contractor may either:

i) replace or cap the entire seam i.e. remove the seam and re-seam, or extrusion weld a strip of additional geomembrane over the seam, or;

ii) extract further samples for destructive testing a minimum of 3m in both directions (if applicable) from the location of the failed test. If these samples pass destructive testing, the seam shall be reconstructed between these locations by capping in accordance with the Contract.

5.9.10 If there is a failure of a destructive laboratorty test regardless of whether 5.9.9 i) or ii) is followed, the Contractor shall extract an additional test sample from a seam produced on the same day by the same item of seaming equipment and/or operator, at a location to be agreed with the Supervisor, to confirm that the failure was an isolated occurrence. If this sample fails destructive testing, all seams produced by the particular item of equipment will not be approved.

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Non-Destructive Seam Testing

5.9.11 All seams shall be non-destructively tested by the Contractor in the presence of the Supervisor.

Air Pressure Testing

5.9.12 All fusion seams shall be air pressure tested. The air cavity formed between the twin tracks shall be sealed at its ends and an inlet valve and pressure gauge fitted to one end. The cavity shall then be pressurised to a maximum pressure of 2.05 bar (30 psi, 200 kPa) and a minimum pressure of 1.38 bar (20 psi, 140kPa). Following removal of the pressure source the pressure shall be allowed to equalise for two minutes to allow for temperature effects to stabilise. The change in pressure shall then be recorded over the next five minutes. If the pressure decreases by more than 10% (0.205 bar, 3.0 psi, 20 kPa) over the 5 minute period then the fusion seam will be deemed to have failed the test.

5.9.13 On completion of the test, the cavity shall be deflated from the opposite end to which the pressure source was applied to confirm that the full length of seam had been pressurised.

5.9.14 If a seam fails the test, or indicates a blockage in the cavity, the test length shall be incrementally reduced until the failure area has been clearly identified. In the case of identifiable points of failure, the seam shall be repaired using an extrusion fillet weld and the test repeated. If specific points of failure cannot be identified to the satisfaction of the Supervisor the whole seam shall be repaired in accordance with the Contract.

Vacuum Box Testing

5.9.15 The Supervisor may instruct vacuum box testing of any extrusion welded seam.

5.9.16 Extrusion seams shall be tested over the lengths instructed by the Supervisor using purpose made equipment which produces a vacuum over the tested area. A detergent/water solution shall be applied to the full test area prior to application of the test equipment. Upon application of the vacuum, bubbling of the solution should indicate the location of a leak in the seam. The vacuum shall be applied for a period of not less than 10 seconds. The location of any leaks shall be marked in an indelible manner and then the seam repaired in accordance with the Contract.

5.10 Sealing of Protuberances

5.10.1 The protuberances shall be sealed with bentonite in accordance with the detail shown on Drawing 2611.CAP.02.

5.10.2 All bentonite to be used in the construction of the seals shall be in granule form, pellets will not be permitted.

5.10.3 The bentonite seal shall be built up in 50mm layers of saturated bentonite granules and the following methodology adopted:

i) a suitable form shall be used to maintain the annulus between the protuberance and surrounding material;

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ii) an approximate 50mm thick layer of dry bentonite granules shall be placed in the annulus as the form is withdrawn;

iii) clean potable water shall then be added such that the granules form a seal and water no longer drains away, to the satisfaction of the Supervisor;

iv) steps (ii) and (iii) shall be repeated until the specified depth of the seal is achieved ensuring that at all times the water level is maintained above the bentonite granules.

5.11 Damage, Defects and Repairs

5.11.1 The Contractor shall repair any visible damage or defects in the geomembrane using one of the following techniques:

Patching	Used to repair large holes, tears, destructive test sample locations, difficult to repair sections of failed weld and areas contaminated by foreign matter.
Buffing and re-welding	Used to repair small sections of extruded seams.
Spot welding and seaming	Used to repair very small tears, pinholes or other minor, localised flaws.
Capping	The application of long narrow patches to repair large lengths of failed seams.
Topping	The application of extrudate to repair areas of inadequate seams which have an adequate exposed edge to prevent re-heating of previously welded areas.

5.11.2 The Contractor shall discuss and agree with the Supervisor his proposed repair procedures, materials and techniques prior to the commencement of repair work. In addition:

i) all surfaces shall be clean and dry at the time of repair;

ii) all abraded areas shall be completely covered by the weld or patch;

iv) patches or caps shall extend at least 150mm beyond the edge of the defect and all corners of patches shall be rounded to a radius not less than 75mm.

5.12 Inspection and Approval

5.12.1 Before the placement of any protector geocomposite at any location the Contractor shall make sure that:

i) all stones, sandbags or any other material liable to cause damage to the geomembrane have been removed;

ii) there are no visible defects e.g. small tear holes, and;

iii) all repairs have been completed.

5.12.2 The Contractor shall prepare an updated copy of the installation plan showing the as-built details. Details shall include the identification of each panel, together with the position of all repairs.

5.0 Geomembrane Cap

5.12.3 The protector geocomposite shall not be placed at any location until the geomembrane at that location has been approved by the Supervisor.

6.0 Protector Geocomposite

6.1 General Description

6.1.1 Where applicable, see section 5.1.2, a protector geocomposite shall be installed directly above the approved geomembrane cap as soon as practicable and itself overlain by restoration soils. Adjacent panels shall be overlapped and joined together. Details of the protector geocomposite are shown on Drawing 2611.CAP.02.

6.2 Protector Geocomposite Material

6.2.1 The protector geocomposite shall comprise of a non-woven geotextile with integral longitudinal band drains or a non-woven geotextile bonded on both sides (upper and lower) to a drainage medium. The drainage geocomposite shall meet the requirements of Table 3.

Table 3 - Protector Geocomposite Material Requirements

PARAMETER	TEST METHOD	TYPICAL MANUFACTURERS VALUE
Geotextile		
Mass per unit area (g/m^2)	BS EN 965	250
Puncture Resistance (kN)	BS EN ISO 12236	2
Geocomposite		
In plane flow (l/s/m)	EN ISO 12958: 1997 Hydraulic Gradient = 1.0 20 kPa 200 kPa	 0.08 0.07

6.2.1 Each roll of geocomposite material supplied shall be free of joints throughout and certified as needle free by the manufacturer

6.2.2 The Contractor shall provide the Supervisor with full details for approval of the proposed material to be used prior to any material being delivered to site. The Contractor shall also provide the Supervisor with a copy of the manufacturer's recommendations and installation instructions for the material.

6.3 Delivery, Handling and Storage

6.3.1 The geocomposite shall be rolled so that when it is unrolled on site the band drains are on the upper surface so that handling is minimal.

6.3.2 The geocomposite will be delivered to site in the form of a roll, prepared, packed and loaded in a manner, so as to prevent any damage during handling. The geocomposite shall be

6.0 Protector Geocomposite

delivered to site in packaging which will protect the rolls from degradation by ultra violet light. The geocomposite shall be kept in the wrappings provided by the manufacturer until required for use in the Works.

6.3.3 Each roll of geocomposite delivered shall be clearly labelled with the name of the manufacturer, product name and type, batch and roll number, batch number, roll length, width and roll weight and date of manufacture.

6.3.4 On delivery to site, rolls will be off-loaded to storage using a crane or suitable available construction equipment. Each roll should be equipped with canvas slings to facilitate unloading.

6.3.5 The Contractor shall mark any damaged or defective rolls and then segregate them for further investigation, as necessary.

6.3.6 The rolls shall be stacked not more than three high on a clean, firm, dry, and free of rocks or other detritus, and located so as to preclude damage from impact or puncture by working plant, vandals and such like.

6.4 Manufacturers Quality Control

6.4.1 The Contractor shall forward to the Supervisor a copy of either the manufacturers' quality control documentation or CE marked test certificate where appropriate for the rolls delivered to site. The documentation shall include at least the following details:

i) the manufacturer's name;
ii) date of manufacture;
iii) batch number;
iv) product name and type, and;
v) values for those parameters listed in Table 3.

6.5 Conformance Testing

6.5.1 The Contractor shall provide access for the Supervisor to recover samples from the protector geocomposite rolls for conformance testing in accordance with the parameters given in Table 3. Samples will be 1.0m long and the full width of the roll. More than one sample may be recovered from any particular roll. The Supervisor will send a copy of the results of the testing to the Contractor but this shall not relieve the Contractor from any of his obligations under the Contract.

6.6 Protector Geocomposite Deployment

6.6.1 The protector geocomposite shall be deployed as soon is practicable over the geomembrane at each location as determined by the Supervisor, see section 5.1.2.

6.6.2 The geocomposite shall be installed in direct contact with the surface of the geomembrane. The Contractor shall ensure that the surface of the geomembrane liner is free from deleterious material that may damage the geocomposite and/or the geomembrane liner.

6.0 Protector Geocomposite

6.6.3 The geocomposite panels shall be arranged so that the seams are oriented parallel to the line of maximum slope with uphill panels overlapping downhill panels. Wherever practicable the seams of the geocomposite should not directly overlie a seam in the geomembrane. Where seams cross the slope and can not be avoided adjacent panels shall be laid so that the hydraulic continuity of the band drains of drainage element of the geocomposite is maintained to the satisfaction of the Supervisor

6.6.4 The geocomposite be loose laid with a minimum overlap of 300mm between adjacent panels and joined together All such joints will be either thermal bonded or sewn together using a method approved by the Supervisor.

6.6.5 The Contractors method of deployment shall be such that:

i) equipment, plant and tools used will not damage the geocomposite by handling, trafficking, leakage of hydrocarbons or by other means;

ii) personnel working on the geocomposite will not smoke, wear shoes likely to cause damage, or otherwise engage in any activity that could damage the geocomposite;

iii) stresses and strains likely to cause damage to the geocomposite and underlying layers are avoided;

iv) the geocomposite will be in continuous contact with the surface on which it is placed without stretching or bridging over humps and hollows;

v) the method of deployment will minimise wrinkles;

vi) deployment will not take place in the presence wind likely to cause damage;

vii) geocomposite will not be placed over areas of ponded water;

viii) direct contact with the geocomposite is minimised, and;

ix) construction plant will not traverse over any area of geocomposite until sufficient depth of cover has been placed over it in accordance with the Contract.

6.6.6 The geocomposite shall be extended down the front face of the anchor trench and panels shall be temporarily, but securely, anchored within the trench. Once the geocomposite has been installed the trench shall be backfilled as soon as practicable in layers with drainage material. The drainage material shall comprise a well graded granular fill with a maximum particle size of 20mm and a permeability of not less than 1.0×10^{-4} m/s. The result of a recent particle size grading and permeability test on the drainage material shall be submitted to the Supervisor for approval not less than five working days before the material is to be brought onto site.

6.6.7 The geocomposite shall be covered with at least 300mm of restoration soils within three working days of its deployment at any location.

6.7 Temporary Surcharge

6.7.1 The Contractor shall be responsible for providing adequate temporary loading and/or anchoring measures (e.g. in the form of durable sandbags, tyres or similar weights without sharp edge not likely to damage the geomembrane), on the protector geocomposite immediately after deployment and before to protect the protector geocomposite from damage by the wind or to prevent slippage during the Works. These measures shall remain in place

6.0 Protector Geocomposite

until the overlying layers are placed over the protector geocomposite, unless otherwise directed by the Supervisor. On steep embankments, suspension of sandbags or tyres by ropes may be required. If tyres are used as temporary loading measure the Contractor shall remove them off site at the completion of the Works.

6.8 Protuberances

6.8.1 Where the geocomposite is required to be tailored around the pipework for leachate collection chambers, monitoring points and gas extraction wells this shall be achieved by the minimum cutting of the fabric. The geocomposite shall have an upstand around the protuberances as shown on Drawing 2611.CAP.02.

6.9 Damage, Defects and Repairs

6.9.1 The Contractor shall repair any damage or defects in the geocomposite by installing a patch of the same geocomposite, which has an overlap of at least 300mm around the damaged area, or defect and is securely thermally bonded or sewn into place to the satisfaction of the Supervisor. The Contactor shall where ever practicable ensure that that hydraulic continuity of the band drains of the drainage element of the geocomposite in the repair area is maintained to the satisfaction of the Supervisor.

6.9.2 The Supervisor may direct the whole of a panel to be replaced depending upon the nature and extent of the damage or defect.

7.0 Protector Geotextile

7.1 General Description

7.1.1 A protector geotextile shall be installed over geomembrane as directed by the Supervisor as soon as practicable. Adjacent panels shall be overlapped and heat bonded together. Details of the protector geotextile are shown on Drawing No. 2611.CAP.02.

7.2 Geotextile Material

7.2.1 The protector geotextile shall be a non-woven fabric constructed by needle punching virgin staple fibres of polypropylene. The geotextile shall be new material constructed from fibres of not more than one polymer and meet the requirements of Table 4.

Table 4 - Properties of Protector Geotextile

PARAMETER	TEST METHOD	MINIMUM VALUE
Mass per unit area (g/m^2)	BS EN 965	250
Puncture Resistance (kN)	BS EN ISO 12236	2
Tensile Strength – MD/TD (kN/m)	BS ISO 10319	13.5/13.5

7.2.2 Each roll of geotextile material supplied shall be free of joints throughout and certified as needle free by the manufacturer

7.2.3 The Contractor shall provide the Supervisor with full details for approval of the proposed material to be used prior to any material being delivered to site. The Contractor shall also provide the Supervisor with a copy of the manufacturer's recommendations and installation instructions for the material.

7.3 Delivery, Handling and Storage

7.3.1 The geotextile shall be delivered to site in the form of a roll, prepared, packed and loaded in a manner, so as to prevent any damage during handling. The geotextile shall be delivered to site in packaging which will protect the rolls from degradation by ultra violet light. The geotextile shall be kept in the wrappings provided by the manufacturer until required for use in the Works.

7.3.2 Each roll of geotextile delivered shall be clearly labelled with the name of the manufacturer, product name and type, batch and roll number, batch number, roll length, width and roll weight and date of manufacture.

7.3.3 On delivery to site, rolls will be off-loaded to storage using a crane or suitable available construction equipment. Each roll should be equipped with canvas slings to facilitate unloading.

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7.3.4 The Contractor shall mark any damaged or defective rolls and then segregate them for further investigation, as necessary.

7.3.5 The rolls shall be stacked not more than three high on a clean, firm, dry, and free of rocks or other detritus, and located so as to preclude damage from impact or puncture by working plant, vandals and such like.

7.4 Manufacturers Quality Control

7.4.1 The Contractor shall forward to the Supervisor a copy of either the manufacturers' quality control documentation or CE marked test certificate where appropriate for the rolls delivered to site. The documentation shall include at least the following details

i) the manufacturer's name;
ii) date of manufacture;
iii) batch number;
iv) product name and type, and;
v) values for those parameters listed in Table 4.

7.5 Conformance Testing

7.5.1 The Contractor shall provide access for the Supervisor to recover samples from the protector geotextile rolls for conformance testing in accordance with the parameters given in Table 4. Samples will be 1.0m long and the full width of the roll. More than one sample may be recovered from any particular roll. The Supervisor will send a copy of the results of the testing to the Contractor but this shall not relieve the Contractor from any of his obligations under the Contract.

7.6 Protector Geotextile Deployment

7.6.1 The protector geotextile shall be installed in direct contact with the geomembrane.

7.6.2 The geotextile panels shall be arranged so that the seams are oriented parallel to the line of maximum slope.

7.6.3 The protector geotextile shall be laid with a minimum overlap of 300mm between adjacent panels and joined together All such joints will be either thermal bonded or sewn together using a method approved by the Supervisor.

7.6.4 The Contractors method of deployment shall be such that:

i) equipment, plant and tools used will not damage the geotextile by handling, trafficking, leakage of hydrocarbons or by other means;

ii) personnel working on the geotextile will not smoke, wear shoes likely to cause damage, or otherwise engage in any activity that could damage the geotextile;

iii) stresses and strains likely to cause damage to the geotextile and underlying layers will be avoided;

iv) the geotextile will be in continuous contact with the surface on which it is placed without stretching or bridging over humps and hollows;

7.0 Protector Geotextile

v) the method of deployment will minimise wrinkles;

vi) deployment will not take place in the presence wind likely to cause damage;

vii) geotextile will not be placed over areas of ponded water;

viii) direct contact with the geotextile is minimised, and;

ix) construction plant will not traverse over any area of geotextile until sufficient depth of cover has been placed over it in accordance with the Contract.

7.7 Temporary Surcharge

7.7.1 The Contractor will be responsible for providing adequate temporary loading and/or anchoring measures (e.g. in the form of durable sandbags, tyres or similar weights without sharp edge not likely to damage the geomembrane), on the protector geotextile immediately after deployment and before seaming to protect the protector geotextile from damage by wind or during the construction works. These measures shall remain in place until the overlying layers are placed over the protector geotextile, unless otherwise directed by the Supervisor. On steep embankments, suspension of sandbags or tyres by ropes may be required. If tyres are used as temporary loading measure the Contractor shall remove them off site at the completion of the Works.

7.8 Protuberances

7.8.1 Where the geotextile is required to be tailored around the pipework for leachate collection chambers, monitoring points and gas extraction wells this shall be achieved by the minimum cutting of the fabric. The geotextile shall have an upstand around the protuberances as shown on Drawing 2611.CAP.02.

7.9 Damage, Defects and Repairs

7.9.1 The Contractor shall repair any damage or defects in the geotextile by installing a patch of the same geotextile, which has an overlap of at least 300mm around the damaged area, or defect and is securely thermally bonded or sewn into place to the satisfaction of the Supervisor.

7.9.2 The Supervisor may direct the whole of a panel to be replaced depending upon the nature and extent of the damage or defect.

8.0 Restoration Soils

8.1 General Description

8.1.1 The restoration soils shall comprise 800mm of sub-soil and 200mm of topsoil placed above the capping system.

8.2 Materials

8.2.1 The material to be used for the restoration layer shall be sourced from on site stockpiles as directed by the Employer or imported. The material shall be free from any unsuitable material, or any other deleterious materials/objects that may potentially cause damage to the capping system.

Unsuitable material shall include:

i) Material in a frozen condition or susceptible to spontaneous combustion.

ii) Any industrial, commercial or domestic waste.

iii) Any excessively wet material which does not provide a firm surface sufficient to permit the movement of plant or vehicles without causing excessive rutting

iv) Any material greater than 50mm in any dimension in the first 300mm of the restoration soils above the protector geotextile and in the remaining soils any material greater than 150mm in any dimension.

8.2.2 The Contractor shall excavate and handle the material from on site stockpiles in such a manner that the nature and consistency of the material is not adversely affected. Where more than one type of material is encountered the Contractor shall, wherever practicable, excavate the stockpile in such a manner that the materials can be separated.

8.3 Placement

8.3.1 The restoration soils shall be placed as soon as practicable after the protector geotextile has been placed. The restoration soils shall be spread in layers to the required thickness to form a smooth even profile without undulations, hollows or depressions.

8.3.2 The Contractor shall undertake the placement of the restoration soils in a careful and systematic manner that does not affect the integrity, cause damage or displacement, and prevents the formation of any wrinkles and creases and/or any "folding over" in the capping system. Other than as required in clause 8.4.1, soils shall not be stockpiled over the capping system.

8.3.3 Under no circumstances other than for the safety of the Works shall plant be driven directly on the capping system. A minimum thickness of 300mm of material shall be placed at any location over the capping system before any of the Contractor's tracked plant is allowed to traverse over the capping area. A minimum thickness of 1000mm of material at any location shall be maintained between the capping system and wheeled haulage vehicles.

8.3.4 The Contractor's placement method shall ensure that no lateral stresses are induced in the underlying layers of the capping system. In general, the methods employed shall comprise the following:

8.0 Restoration Soils

i) placing restoration soils working upslope;

ii) tipping of fresh material on previously placed material;

iii) casting material by 360° excavator (using a bucket without teeth);

iv) pushing of material up and over the face of the tipped load allowing it to fall vertically onto the underlying layers, and;

v) pre-loading of the underlying layers with discrete mounds of material, to prevent the generation of excessive wrinkles or folds, and in-filling between mounds.

8.3.5 The Contractor shall control the depth of restoration soils placement by using free standing profile boards/travellers. The Contractor shall ensure that the bases of the profile boards/ traveller are flat and of such construction that they do not cause damage to the underlying geosynthetic capping system.

8.3.6 Any damage or disturbance to the capping system during the placement of the soils shall be repaired by the Contractor in accordance with the Contract.

8.3.7 The restoration soils shall not be compacted except by the passage of construction plant. The final surface of the soils shall be graded to achieve the required levels and profile and shall, to the satisfaction of the Supervisor, be free from any bumps and hollows.

8.4 Protuberances

8.4.1 During placement of the restoration soils around any protuberance the Contractor shall batter back the soils to allow for future installation of any headworks by the Employer, unless otherwise directed by the Supervisor. A stockpile of restoration soils shall be left adjacent to each protuberance to allow backfilling at a later date.

8.4.2 The Contractor shall take all reasonable precautions against causing damage or disturbance to protuberances and any associated installations; and, at the start of the Contract the Contractor shall inspect the condition and alignment of these with the Supervisor. A similar inspection shall be carried out following the completion of the work around each protuberance. Should the Contractor cause any damage or disturbance he shall immediately carry out remedial works in accordance with the Contract.

Drawings

2611.CAP.01 – Existing Site Layout and Topography

2611.CAP.02 – Details of Proposed Capping System

APPENDIX B

TYPICAL CQA PROFORMA

DAILY RECORD SHEET

Client:	Site:	Project:
Date:	Weather:	
Start:	Finish:	

Activities Undertaken (Tick Box)

Subgrade/Formation Preparation		Compaction of Clay		Protection Layer Placement	
Clay Conditioning		Geomembrane Placement		Restoration Soils Placement	
Engineered Clay Placement		Geotextile Placement		GCL Placement	
BES Placement		Drainage Blanket Installation		Leachate Sump & Collection Pipework	

Area of Site Where Works are Being Undertaken:

Layer Numbers Placed:

Commentary on Activities Undertaken *(Comment should be made on all noted items):*

Specification Parameters

Subgrade/Formation Protrusion:	mm	Compaction:	Passes		
Layer Thickness:	mm	Overlap:	mm	Particles Size:	mm

Other:

Do All Works Comply With the Specification:	Yes		No	

Comments:

Plant Working:

Samples Taken (Including Lab Reference No.):

Photographs Taken:

Visitors to Site:

Planned Works for the following Day:

Signed: **(CQA Engineer)** **Dated:**

DAILY GEOMEMBRANE SEAMING RECORDS
Fusion Welding and Extrusion Welding (Panels Only)

Client:	Site:	Project:	Contract:	QA Plan:

Test Weld Details:

DATE	Machine:	Time:	Machine:	Time:	Machine:	Time:
		Ambient: °C		Ambient: °C		Ambient: °C
	Operator:	Preheat: °C	Operator:	Preheat: °C	Operator:	Preheat: °C
	Speed:	Nozzle: °C	Speed:	Nozzle: °C	Speed:	Nozzle: °C

Panel No's	Ambient Temp °C	Weld Type	Seam Length m	Inspection Date	Defects	Field Test		3rd Party DS Test	Result	Comments
						Result	Bar			
TOTAL WELDING FOR DAY										

CQA Engineer: **Date:**

waste recycling GROUP

White Young Green

GEOMEMBRANE LINER THICKNESS RECORDS

Roll No.	Panel No.	Chainage (m)	Thickness (m)	Date Tested

CQA Engineer:

Date:

GEOMEMBRANE PANEL INSTALLATION RECORDS

Client:	Site:	Contract:	QA Plan:

Panel No.							
Subgrade Accepted							
Location							
Date of Installation							
Material							
Material Roll No.							
Panel Size (m)							
Panel Shape							
No. of Defects							
Repairs							
Approval to Cover							
Cover Material							
Date Covered							

CQA Engineer: **Date:**

waste recycling GROUP

White Young Green

LOG OF GEOMEMBRANE RECEIVED

Client:		Site:	Project:		Contract:
Date	**Roll No / Batch No**	**Supplier**	**Size (m)**	**Condition**	**Comments**

CQA Engineer: **Date:**

LOG OF GEOTEXTILE RECEIVED

Client: | **Site:** | **Project:** | **Contract:**

Date	Roll No./ Batch No.	Supplier	Size (m)	Condition	Comments

CQA Engineer:

Date:

DAILY GEOMEMBRANE PATCH RECORDS
Extrusion Welding - Patches

Client:	Site:	Project:	Contract:	QA Plan:

Test Weld Details:

DATE	Machine:	Time:	Machine:	Time:	Machine:	Time:
		Ambient: °C		Ambient: °C		Ambient: °C
	Operator:	Preheat: °C	Operator:	Preheat: °C	Operator:	Preheat: °C
		Nozzle: °C		Nozzle: °C		Nozzle: °C

Patch No's	Patch Location	Ambient Temp °C	Patch Size	Patch Shape	Inspection Date	Field Test		3rd Party DS Test	Result	Comments / Defects
						Type	Result			

CQA Engineer: **Date:**

RECORD OF COMMUNICATION	
CONTRACT NUMBER	DATE
CQA ENGINEER	TIME
OTHER PARTY	
SUMMARY DISCUSSION	
AGREEMENT/CONCLUSION	
FURTHER ACTION REQUIRED	
SIGNED	DATE

THIRD PARTY DESTRUCTIVE SEAM TESTING

Client:	Site:	Project:	Contract:

DS No	Date of Weld	Panel Ref	Type of Weld	Result

Notes:

CQA Engineer: **Date:**