

# **Appendix P**

Construction Quality Assurance Plan  
Revised November 2013

**Ameren Missouri Labadie Energy Center  
Construction Quality Assurance Plan  
Utility Waste Landfill  
Franklin County, Missouri**

**December 2012**

Revised November 2013

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## 1.0 INTRODUCTION

The Missouri Department of Natural Resources Solid Waste Management Program (MDNR-SWMP) requires construction quality assurance (CQA) and construction quality control (CQC) on landfill components to ensure quality landfill construction. Manufacturing Quality Control (MQC) and Manufacturing Quality Assurance (MQA) are also typically completed for the manufactured components of a landfill such as HDPE liners and pipe. CQA is typically performed by a party independent of the Owner/Operator (Owner) and contractor to document the quality of construction on key landfill components. CQC procedures are typically performed by the contractor and/or owner throughout construction to ensure that landfill components are constructed in accordance with applicable construction standards and specifications. MQA is typically performed by the contractor and may also be performed by a party independent of the Owner, while MQC is typically performed by the manufacturer. The technical guidance document entitled Quality Assurance and Quality Control for Waste Containment Facilities (EPA/600/R-93/182) produced by the U.S. Environmental Protection Agency specifically defines the roles that CQA, CQC, MQA, and MQC play during landfill construction:

- CQA: Construction Quality Assurance is a planned system of activities that provides the owner and permitting agencies assurance that the facility was constructed as specified in the design. CQA includes field inspections, verifications, audits, and evaluations of materials and workmanship necessary to determine and document the quality of the constructed facility. CQA refers to the measures taken by the CQA agent to assess if the contractor or installer is in compliance with the plans and specifications for a project.
- CQC: Construction Quality Control is a planned system of inspections and materials testing that are used to directly monitor and control the quality of a construction project. CQC is frequently performed by the owner, earthwork contractor and/or geosynthetics installer and is necessary to achieve quality in the constructed or installed system. CQC refers to measures taken to determine compliance with the requirements for material and workmanship as stated in the plans and specifications for the project.
- MQC: Manufacturing Quality Control is a planned system of inspections that is used to directly monitor and control the manufacture of a material. MQC is normally performed by the manufacturer of geosynthetic materials to determine compliance with the requirements for materials and workmanship.
- MQA: Manufacturing Quality Assurance is a planned system of activities that provides assurance that the materials were constructed as specified, and refers to measures taken by the MQA organization, such as manufacturing facility inspections, verifications, audits, and evaluation of raw materials and geosynthetic products.

Typical landfill components that require CQA and/or CQC procedures are:

- Subgrade Excavation and/or Backfilling

- Low Permeability Soil Liner/Cover
- Geomembrane Liner
- Geotextiles and/or Geocomposites
- Drainage Materials

The manufacturer(s) of geosynthetic materials will be required to furnish with their bids documentation of a written, effective MQC program. One component of the manufacturer's MQC program will be a MQA program by an independent, qualified testing agency that will provide documentation with certifications that the manufactured products comply with the requirements for material and workmanship as stated in the plans and specifications for the project.

This Plan is specific to the CQA activities to be completed by an independent third-party and addresses the soil, geosynthetic, and drainage components of the composite liner, leachate drainage and collection and final cover systems to be constructed for the Utility Waste Landfill (UWL) at the Ameren Missouri Labadie Energy Center site in Franklin County, Missouri. This plan has been prepared in general conformance with the State of Missouri Solid Waste Management Rules, and Franklin County Regulations.

This document outlines methods of construction, quality assurance testing procedures, safety and reporting requirements to be followed during construction of the earthwork, liner, and final cover systems at the Labadie UWL. The specific CQC program that will be followed during installation of the landfill components is not included with this document. However, the CQA agent for earthwork, liner and final cover construction for the UWL will coordinate with the contractor(s) and CQC personnel to ensure that construction is in accordance with the approved permit documents, materials' manufacturers and suppliers standards and specifications and other available plans and specifications. If the CQC efforts appear to be insufficient, the CQA agent will coordinate with the contractor(s) to ensure that the permit documents, and plans and specifications are adhered to. The CQA procedures outlined in this document fulfill all requirements of the Missouri Solid Waste Management and Franklin County Regulations and will, by themselves, provide the information and documentation necessary to certify that landfill components were constructed in accordance with the approved permit documents.

A copy of this plan will be maintained at the UWL for use during landfill phase development and final cover construction. Any revisions to the CQA Plan shall require a permit modification to be reviewed by the MDNR-SWMP. The MDNR-SWMP must be kept informed throughout all phases of construction. The MDNR-SWMP and Franklin County Independent Registered Professional Engineer (IRPE) will review all records and results from the implementation of the CQA Plan as part of any Operating Permit Application and request for approval to operate any previously unconstructed area or phase of the UWL.

## **2.0 GENERAL CONDITIONS**

### **2.1 Responsibility and Authority**

Ameren Missouri is ultimately responsible for the implementation of this CQA Plan. The following is a list of responsible personnel:

#### **Owner's Representative**

A representative of Ameren Missouri shall be responsible for coordination between the Owner, the construction crew, and the third party CQA Engineer. With the MDNR-SWMP's prior approval, the Owner may delegate this authority, and correspondingly, be responsible to see that the CQA Plan is followed.

#### **CQA Engineer**

A professional engineer licensed to practice in Missouri shall be retained by the Ameren Missouri to provide on-site Construction Quality Assurance observations and testing. The CQA Engineer will prepare a final report demonstrating that the substantial requirements of this CQA Plan were implemented. The final report will include the MQC submittals from the manufacturer(s) and the MQA submittals from the independent MQA agencies. In addition, the CQA Engineer or his designee will coordinate, through Ameren Missouri, with the contractor(s) and/or installer(s) and their CQC personnel for the purposes of sharing MQC, MQA, CQA and CQC information. Should it become apparent to the CQA Engineer or his designee that construction quality does not meet the standards established in the Construction Permit; the CQA Engineer will inform the Owner's Representative of the apparent deficiencies so appropriate adjustments can be made. The CQA Engineer will be employed by an organization that operates independently of the Owner, construction contractor(s), landfill operator, and/or permit holder. The CQA Engineer will be responsible for certifying that construction was completed in substantial compliance with the engineering plans and specifications approved by the Construction Permit. Components of the bottom composite liner system, leachate drainage and collection system or final cap system will be not constructed unless the CQA Engineer or the CQA Inspector is present.

#### **CQA Inspector**

The CQA Engineer will designate one or more CQA Inspector(s) to perform the duties of the CQA Engineer when they are not present on site or when the extent of the project requires inspection by more than one person. A CQA Inspector shall be a qualified, experienced individual who is able to act for the CQA Engineer to provide necessary on-site CQA observations and testing. The CQA Inspector will document on-site construction activities in a Daily Field Activities Report. An example of this report is included in Appendix A. No component of the bottom composite liner system, leachate drainage and collection system or final cover system will be constructed unless the CQA engineer or CQA inspector is present.

## 2.2 Inspection and Testing

This CQA Plan describes the inspection and testing of eight critical components of the landfill containment system:

1. Test pad construction and testing
2. Subgrade preparation
3. Compacted soil liner (bottom)
4. Geomembrane liner
5. Geotextile
6. Leachate Drainage and collection system components
7. Geocomposites
8. Protective Aggregate Layer
9. Final Cover system

The following sections outline minimum requirements and guidelines to be followed during execution of the CQA Plan. Information pertaining to the specific tests, testing frequency, level of detail and consistency in reports is presented in each section.

Throughout the construction activities, communication will play a major role in completing a successful construction project and achieving the requirements of the approved plans, specifications, and permit documents. At a minimum, the following communications guidelines will be met:

- **Pre-Construction Meeting:** A meeting involving the Owner, CQA personnel, and the contractor(s) will take place prior to the start of construction. This meeting should include discussion of each party's responsibilities, lines or means of communication, procedures for changes or problems, CQA procedures and requirements, level of the MDNR-SWMP and IRPE involvement, and other issues as they pertain to the construction project.
- **Weekly Progress Meetings:** Regularly scheduled meetings between CQA personnel and the contractor(s) will take place during project construction to review and discuss such topics as previous work, future work, construction problems, schedule revisions, and other issues that require attention.
- **Other Meetings:** Unscheduled meetings will take place as required to address issues such as construction progress and changed conditions as circumstances dictate.

Under all circumstances, the MDNR-SWMP and the IRPE will be given seven days advance notification prior to the start of any test pad construction; excavation of subgrade; placement of soil liner components; and placement of geosynthetic materials. It is understood that the MDNR-SWMP reserves the right to inspect the compacted soil liner during the initial placement of liner and during placement of the geomembrane.

## 2.3 Floodplain Issues Related to Construction

If a flooding event occurs during cell liner construction, the contractor will be required to monitor the flood conditions and levels outside the cell being constructed. The contractor will be required to monitor the excess hydrostatic uplift pressures on the composite liner. If required by the Owner's Representative, the contractor will be required to mitigate heave due to excess hydrostatic uplift pressures on the composite liner either by placing ballast material on the liner or by flooding the lined area as directed by the Owner's Representative. The contractor will be required to remove the ballast material or water and to restore the Work to the pre-flood condition prior to continuing with construction.



### **3.0 SOIL LINER CONSTRUCTION**

The compacted soil portion of the UWL composite bottom liner system is to be constructed and tested in accordance with the approved permit documents and this CQA Plan. This section covers material conformance testing, general construction procedures, testing during construction, and frequency requirements.

- A test pad will be constructed for soils that will be used for liner construction. For the Ameren Missouri Labadie Energy Center utility waste landfill conformance testing of available soil materials will be performed prior to test pad construction to demonstrate that the soils meet the required specifications. This will include direct shear analysis of the interface between the compacted clay soil to be used for the liner and the geomembrane to verify the friction angles for both smooth and textured geomembrane samples.

#### **3.1 Materials Conformance Testing**

Soils to be used for liner construction, regardless of the source, will be classified, excavated, segregated, and stockpiled under the observation of an experienced soils technician.

Prior to construction of the compacted soil component of the liner system, representative samples of the stockpiled materials proposed for use will be collected and tested. This testing will verify that the soils to be used for construction meet project specifications as determined by this pre-qualification testing. The following tests may be performed as prescribed by the CQA Engineer (ASTM standards and tests designations refer to the latest approved version):

<b><u>Test Method</u></b>	<b><u>Test Description</u></b>
ASTM D 2216	Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 2487	Standard Practice for Classification of Soils for Engineering Purposes
ASTM D 4318	Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits)
ASTM D 422	Particle Size Analysis of Soils
ASTM D 1140	Amount of Soils Finer than the No. 200 Sieve
ASTM D 698	Laboratory Compaction Characteristics of Soil using Standard Effort (Note: The Modified or Reduced Proctor Tests may be substituted or added to the Standard Proctor Test as necessary.)
ASTM D 4767	Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils

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ASTM D 5084	Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D 2487	Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 5321	Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear Method

Soil selected for liner construction must have a group symbol of CL, CH, or SC according to the Unified Soil Classification System. In addition, each soil used for construction must meet the following criteria:

- Allow more than 30 percent passage through a No. 200 sieve
- Have a liquid limit equal to or greater than 20
- Have a plasticity index equal to or greater than 10
- Have a coefficient of permeability equal to or less than that specified in the Project documents, that is  $1 \times 10^{-5}$  or  $1 \times 10^{-7}$  centimeters per second (cm/sec) or less when compacted to a density and moisture content deemed acceptable by preconstruction testing and test pad construction
- Shall meet or exceed the minimum shear strength properties, both internal and interface with other materials, utilized in the geotechnical design (reference Appendix J of the Construction Permit Application).

Soils meeting all of the above requirements will be used to construct a test pad in accordance with Section 3.2 of the CQA Plan.

After completing the conformance testing described above, the CQA Engineer will complete the appropriate testing and data evaluation needed to develop a compacted soil placement range for the selected borrow material. The placement range will be developed based on previous laboratory testing of the borrow material, if available, as well as the test results obtained from preconstruction testing. The placement range (i.e., "acceptable zone") shall be developed in accordance with the method developed by D.E. Daniel and C.H. Benson (1990), "Water content-density criteria for compacted soil liners", *J. Geotech. Engrg.* ASCE, 116 (12), 1811-130, and soil placement based on the appropriate moisture and dry unit weight values related to the maximum specified hydraulic conductivity. It will be used in conjunction with quality assurance testing during soil liner/final cover construction to achieve the required permeability.

### 3.2 Test Pad

10 CSR 80-4.010 (10) (C) of the Missouri Solid Waste Regulations requires that a test pad be constructed prior to compacted soil liner construction. Test pad(s) will be constructed following the bottom liner construction techniques. The test pad(s) will verify that the construction and CQA procedures to be used for actual compacted soil liner will provide an adequate liner system. Tests will be completed in a manner that allows evaluation of soil types, construction methods, and/or soil amendments required to achieve the installed liner characteristics

approved in the construction permit. Results from test pad construction and changes to proposed construction methods will be submitted to the MDNR-SWMP and IRPE as a Test Pad Construction Report.

MDNR-SWMP and the IRPE will be notified at least 7 days prior to commencing test pad construction activities. Construction procedures for the test pad shall be in accordance with Section 3.4 of this CQA Plan. The test pad will be constructed using the same methods and with the same equipment that will be used to construct the compacted soil liner. The test pad will be large enough to allow construction equipment the room to successfully complete required passes and compaction. Since the test pad will evaluate the construction means and methods to be used during compacted soil liner construction, the procedures used to construct the test pad must be thoroughly documented. The CQA Engineer or their designee will observe all activities completed during test pad construction. Documentation information will include at least the following:

- Source of liner material and associated prequalification testing data
- Make, model, weight, and any other unique information (e.g., compactor pad foot height) for the equipment used during test pad construction (e.g., CAT 815F compactor)
- Methods of soil material placement and compaction including soil hauling and unloading operations, soil spreading, and number of compactor passes
- Description of scarification methods, if utilized
- Moisture conditioning methods used, including equipment, frequency of procedures, and apparent results
- Survey control methods for documenting compacted lift thickness and final pad thickness
- Methods used to prevent damage to completed lifts
- Methods used to prevent placement of deleterious materials
- Methods used to prevent placement of frozen material or the placement of material on frozen ground, if appropriate
- Frequency and methods used for calibrating testing equipment
- Testing results including test pad location, test locations, moisture and density results, and their relationship to hydraulic conductivity based on prequalification testing

At the completion of test pad construction, verification testing will be completed in accordance with the following testing schedule:

- Two laboratory hydraulic conductivity tests will be performed utilizing the Flexible Wall Permeameter Test (ASTM D 5084) on undisturbed samples obtained from the completed test pad. Soil samples will be collected by pushing Shelby tubes at random locations on the test pad
- Bulk samples will be taken to the laboratory for Liquid Limit (LL) and Plasticity Index (PI) and Standard Proctor Compaction tests

- One in-situ hydraulic conductivity test will be performed on the completed test pad using a Sealed Double Ring Infiltrometer Test (ASTM D 5093) or a series of 5 Boutwell Permeameter Tests (ASTM D 6391-99)
- Two test pits will be excavated in the test pad to observe interlift bonding of the test pad. The test pits will be located at random locations in an effort to view representative test pad soil profiles
- Laboratory consolidated-undrained triaxial compression tests will be performed on Shelby tube samples obtained from the test pad to verify the shear strength properties.
- Direct shear analysis will be performed on laboratory compacted samples to determine the friction angle of the interface between the compacted clay soil and both smooth and textured geomembrane samples.

Photographs of the verification testing procedures and locations will be taken for visual documentation of the testing.

Should the tests described above indicate that the construction procedures resulted in an insufficient liner system, a new test pad will be constructed using modified procedures and/or materials as agreed to by the CQA Engineer and contractor, and approved by the MDNR-SWMP and the IRPE.

Should the tests described above indicate that the construction procedures resulted in an acceptable liner system; a summary report shall be prepared and submitted to the MDNR-SWMP and IRPE that describes the construction and testing procedures that were used. The report will include the documentation information described above as well as related test results and photographs. The CQA Engineer will certify the report prior to submittal to the MDNR-SWMP. The report will be approved by the MDNR-SWMP and IRPE prior to the construction of additional portions of the liner system.

### 3.3 Compacted Soil Liner Subgrade Preparation

The CQA Engineer and/or designated CQA Inspector will ensure that the compacted soil liner subgrade preparation/construction is completed in accordance with the approved plans and specifications. In addition, the CQA Inspector will identify unexpected conditions encountered during subgrade construction/preparation and record changes to the plans and construction procedures on the as-built drawings. At a minimum, the designated personnel will complete the following:

- Observe and record the placement of subgrade fill on a regular basis
- Verify that soft, organic or other unacceptable materials are removed prior to fill placement
- Verify that subgrade construction is in accordance with the applicable sampling, testing, and survey program(s)
- Prior to soil liner placement, inspect the subgrade for soft spots, pumping, or deleterious materials and verify recompaction or removal and replacement of identified areas

- Verify that all debris, including plant materials such as trees, stumps, and roots, and rocks of size large enough to interfere with proper placement/compaction are removed prior to subgrade construction and preparation
- Prevent the placement of frozen material or the placement of material on frozen ground
- Record the types of compaction equipment utilized for subgrade construction
- Periodically photograph the subgrade construction and finished subgrade surface
- Verify that prior to compacted soil liner placement, the upper 6 inches of subgrade material is disked, recompact, and graded to provide a workable surface
- Ensure the finished subgrade is surveyed on a maximum interval of 100 feet center to center, and a maximum interval of 100 feet along each line where a break in slope occurs. Sumps or other similar features shall also be identified. The survey shall be completed by a Missouri registered surveyor to confirm and document subgrade elevations and to establish break-line and other design features of the landfill. The purpose is to ensure that the soil liner, when constructed, is continuous over the bottom footprint of the permitted waste disposal boundary and meets the minimum thickness specified for the project.

### 3.4 Compacted Soil Liner Construction Procedures

Prior to construction of the soil liner, the subgrade will be graded to the elevations specified on the project plans +/- 0.1 foot. The soil liner material will be placed in accordance with the criteria and procedures developed during preconstruction soil testing, test pad construction, and/or in accordance with project specific guidelines. Construction progress shall be monitored with the initial subgrade survey in combination intermediate surveying during construction, as necessary.

The liner will be placed in accordance with the project specifications, geotechnical report, and approved test pad procedures. Generally, soils will be placed in 6" to 8" thick lifts and compacted to the approved moisture and density tolerances. The soils will be compacted with equipment that kneads, compacts, and interbonds the soil from the bottom of the lift up. Material conditioning procedures and compaction equipment rolling patterns will be consistent with those used in the approved test pad construction, but may be evaluated and modified as necessary to yield a workable, consistent, and suitable liner material placement.

### 3.5 Quality Assurance Monitoring and Testing

A CQA Inspector, under the supervision of the CQA Engineer, will be present on site to monitor the placement and compaction of the soil liner. A qualified CQA Inspector or CQA Engineer will provide visual classification of borrow soils during landfill construction.

Field moisture and density tests will be performed at a minimum frequency of one per 10,000 square feet per lift and will be completed with a nuclear density gauge in substantial compliance with ASTM D 2922 and 3017. Moisture and density test locations will be selected randomly; however, tests will not be grouped together horizontally or vertically from one lift to another. Results of the moisture and density tests will be recorded on a Nuclear Density Gauge Test

Record, similar to the one provided in Appendix A. The nuclear density gauge shall be calibrated in accordance with manufacturer's instructions and ASTM 3017-88 requirements. Nuclear density gauges will be standardized in accordance with manufacturer's recommendations daily or more frequently. Unstable or erratic gauges will not be used for quality assurance testing.

Should the results of field moisture and density tests fall outside the placement range or "acceptable zone", as determined in the test pad construction report, the lift in question will be reworked and retested. The area to be reworked will be bounded by the nearest passing moisture/density test locations as delineated by the CQA Inspectors. Drying, wetting, additional compaction, or a combination thereof will be used to bring the nonconforming area to an acceptable level.

The final liner surface will be smooth and free of large angular particles or foreign objects that may damage the geomembrane liner or prevent contact between the geomembrane and soil liner. The final liner surface will also meet other conditions required by the geomembrane manufacturer or installer for installation of the geomembrane component of the composite liner system.

During soil liner construction, verification testing will be completed to ensure that the borrow material being used for construction has not changed in a manner that greatly affects its engineering properties. The following table indicates the prescribed tests and their approximate frequencies for completion during construction. If the clay liner material is stockpiled prior to construction, then these tests may be completed prior to the start of construction. A bulk sample for each 5000 cubic yards used from the stockpile will be collected and the Atterberg Limits will be determined to verify that the clay liner material is homogeneous. If the Atterberg Limits are outside the range of the previous samples, then a new series of all four tests will be completed on the bulk sample.

Test Method	Frequency
Atterberg Limits (ASTM D 4318)	1 test per 5,000 cubic yards of material placed and for each change of material type
Particle Size (ASTM D 422)	1 test per 5,000 cubic yards of material placed and for each change of material type
Moisture-Density Relationship (ASTM D 698)	1 test per 10,000 cubic yards of material placed and for each change of material type
Hydraulic Conductivity (ASTM D 5084)	1 test per 5,000 cubic yards of material placed and for each change of material type.

If the borrow material does not meet the criteria for the testing described in the table above, additional laboratory soil tests will be completed to define an acceptable placement range for the non-conforming material. Alternatively, a new test pad can be constructed as described in Section 3.2 to verify that the soils are liner grade materials and the proper placement range. If

liner quality soils are stockpiled on site prior to the beginning of placement, a reduced frequency of verification testing will be requested.

To maintain the integrity of the compacted soil component of the liner or final cover system, thin walled steel tube samples (e.g., Shelby tube) for laboratory hydraulic conductivity testing through the completed liner will be avoided whenever possible. Instead, documentation of the required hydraulic conductivity will be provided by the initial materials conformance testing, including development of an acceptable placement range, and quality control/quality assurance monitoring, observation, and testing during construction, most notably moisture and density testing.

Prior to geomembrane installation over the compacted bottom soil liner or final cover, the moisture content of the compacted soil will be maintained to control desiccation cracking. If desiccation cracks are observed in excess of 1 inch deep, the surface will be lightly scarified, moisture conditioned, recompact, regraded, and rolled to provide a smooth surface for geomembrane installation.

### 3.6 Thickness Verification

An independent surveyor licensed to practice in the State of Missouri will verify the thickness of the compacted soil portion of the liner after completion. The independent surveyor will operate independently of the landfill operator, construction contractor, Owner, and permit holder. The surveyor may be employed by the CQA Engineer. Prior to construction of the compacted soil liner, a survey will be completed on a minimum of 100-foot grid system. Additional survey shots will be taken at 100-foot intervals along each line where a break in slope occurs to document the top of subgrade elevations. At the completion of compacted soil liner construction, a survey will be completed at the same approximate locations to verify the required soil component thickness was achieved. Acceptable tolerances for surveying shall be  $\pm 0.1$  foot for elevations and  $\pm 1.0$  foot for horizontal coordinates. All results must indicate a liner thickness equal to or greater than that required by the plans and specifications.

## **4.0 FLEXIBLE MEMBRANE LINER**

The geomembrane portion of the composite liner and final cover systems will be constructed and tested in accordance with the approved permit documents, this CQA Plan, and the manufacturer's recommendations and specifications. This section covers material conformance testing, construction methods, and testing requirements.

### **4.1 Materials Conformance Testing**

Prior to construction of the geomembrane portion of the bottom liner or final cover system, the CQA Engineer will obtain one geomembrane sample per 100,000 square feet of geomembrane to be installed. The following tests will be performed by the CQA Engineer to verify that the geomembrane conforms to the project specifications and the manufacturer's MQC/MQA documentation:

- Thickness (ASTM D 5199)
- Density (ASTM D 1505)
- Tensile Properties (e.g., strength, elongation) (ASTM D 638, Type IV)
- Tear Resistance (ASTM D 1004)
- Puncture Resistance (ASTM D 4833)
- Notched Constant Tensile Load (ASTM D 5397)
- Carbon Black Dispersion (ASTM D 5596)
- Carbon Black Content (ASTM D 1603).

For each of the properties listed above, the material will meet current industry standards for the geomembrane material type (e.g., HDPE, smooth) and thickness. Deviations from this testing protocol due to changes in test methods or industry standards may be approved by the CQA Engineer with prior approval by the MDNR-SWMP and IRPE.

For the bottom liner system in the Labadie UWL (Cells I through 4), 60-mil textured (both sides) HDPE will be used for the bottom inside slopes of the perimeter and interior berms. Smooth 60-mil HDPE will be used in the center of each cell from the interior toe of the perimeter berm of each disposal area.

For the final cover system construction, single textured (smooth top side) 40-mil HDPE will be used on the top or crown of the landfill. Textured (both sides) 40-mil HDPE will be used on the side slopes.

The CQA Engineer or their representative will log all rolls of geomembrane material that arrive on site and review the manufacturer's MQC certification documentation. Each roll will be documented on a Material Inventory Log similar to that found in Appendix A. Storage of geomembrane material will be in a manner that reasonably protects the material from puncture, denting, deformation of rolls, and other damaging situations, in accordance with the manufacturer's recommendations, prior to its deployment. UV sensitive geosynthetics should be stored in undamaged opaque coverings and protected from standing water during storage.



## 4.2 Construction Procedures

At the conclusion of soil liner or cover construction, the geomembrane liner will be installed by a third-party geosynthetics contractor in accordance with acceptable industry standards and the manufacturer's recommendations, standards, guidelines, and specifications. The geomembrane supplier or installer will develop a panel layout diagram in accordance with industry standards. The panel layout diagram will be designed so that the majority of the geomembrane seams run perpendicular not parallel with the side slopes, so that no horizontal (parallel with slopes) geomembrane seams are within five (5) feet of grade breaks, such as the toe and top of slopes. The manufacturer will provide the panel diagram to the CQA Engineer.

The subgrade will be compacted to provide a firm, unyielding foundation sufficient for all deployment vehicles to move about the construction area without rutting and pumping. The geomembrane installer will complete a Subgrade Acceptance Form for inclusion in the construction documentation report.

Anchor trenches will be excavated to the lines and widths shown on the construction documents developed in accordance with the approved permit documents. Sharp bends and edges in the anchor trench will be minimized to avoid potential stresses to the geomembrane.

Geomembrane panels will be installed and immediately assigned a number according to a panel numbering system. Panels will be physically identified in the field with a grease pencil or other durable material for reference during seaming and testing operations and project records. Destructive and nondestructive test locations as well as repair locations will be appropriately identified for documentation purposes. Panels will be deployed with a rubber-tired, front loader and special roller bar to assist with unrolling the geomembrane panels at specified locations. Care will be taken to minimize traffic and prevent equipment from damaging the geomembrane or supporting subgrade surface. Sandbags or other approved loading shall be used as necessary to prevent uplift of panels by the wind. Panels will not be deployed in areas of standing water or on frozen subgrade. Any damage to panels during deployment will be noted and repaired by patching and/or spot welding as approved by the CQA Engineer. No more panels will be deployed than can be seamed during that day, unless securely ballasted to prevent movement prior to seaming. A Panel Placement Form will be completed by the CQA Inspector for all panels deployed (see Appendix A).

Steps will be taken to prevent water from getting under the geomembrane during and after deployment. "Shingling" of the panels or completion of seaming for those panels deployed prior to the end of the workday will be used as appropriate to minimize the potential for such occurrence. Additionally, temporary or permanent berms will be constructed where necessary to redirect surface water away from the construction area.

## 4.3 Quality Assurance Monitoring and Testing

The CQA Inspector will visually inspect the panels for direct contact between the clay liner and the panel surface. It is imperative that the geomembrane maintain intimate contact with the compacted soil liner surface. The CQA Inspector will monitor for panel and seam defects or damage and mark any location of concern for follow-up repair. The geomembrane panels will be seamed together using double wedge fusion welding equipment supported by extrusion welding equipment where conditions make fusion welding impractical. Photo documentation of geomembrane installation and repair procedures will be included in the final CQA Report. Quality assurance monitoring and testing will follow the manufacturer's recommendations or industry standards for installation and seaming.

### 4.3.1 Trial Welds

Prior to seaming the geomembrane panels, trial welds will be made by the welding equipment to be used during that day's work and tested. The trial welds will be made by the same machine/operator combination and under the same conditions as will be encountered during actual seaming operations for that day. Trial welds will be made at the beginning of each workday, at approximately 4 to 5 hour intervals thereafter, and whenever a new welding machine/operator combination begins work.

For fusion trial welds, testing will include "shear" tests on five samples and top and bottom "peel" tests on five samples each. For extrusion trial welds, five samples will be tested for shear strength and five samples shall be tested for bottom peel strength. The trial welds shall meet or exceed the requirements of Geosynthetic Research Institute (GRI) Test Method GM19 (latest approved edition) for 60-mil HDPE.

### 4.3.2 Panel Seaming

The CQA Inspector will observe typical panel welding to assure the welding area is kept generally clean and free of moisture, dirt, and debris. "Fish mouths" and wrinkles at seam overlaps that cannot be welded will be cut out and patched with an extrusion welded patch that is approximately round or rectangular with rounded corners. A seam number will be assigned to each seam that reflects the two panels being joined. The CQA Inspector will measure the seams and record the measurements on a Panel Seaming Form similar to the one found in Appendix A. Alternatively, seam layout and dimensions may be determined by locating the corners with Global Positioning System (GPS) equipment capable of identifying locations to an accuracy of  $\pm 1$ -foot. Additional information to be documented includes date and time of seaming, the welder's initials, machine number, machine speed, and set temperature.

### 4.3.3 Non-Destructive Testing

All seams that are welded during installation of the geomembrane liner will be non-destructively tested by the Geomembrane Contractor and overseen by the CQA Inspector to check the integrity of the seams. Non-destructive tests will be conducted using the air pressure test or the vacuum test.

#### **Air Pressure Test**

Air pressure testing will be completed on seams that have been welded with a fusion welder (wedge welder) using an air pump capable of sustaining 25 to 30 pounds per square inch (psi) of pressure. The Geomembrane Contractor will follow the following procedures:

- Seal one end of the seam channel to be tested
- Insert sharp, hollow needle or other approved pressure feed device with a pressure gauge into the sealed end of the seam
- Energize the air pump to verify the unobstructed passage of air through the seam channel. Should the verification fail, locate the obstruction and test the seam on both sides of the obstruction
- Seal the other end of the seam channel
- Energize the air pump to a pressure of between 25 and 30 psi, close valve, and allow 2 minutes for the injected air to reach equilibrium in the channel prior to recording the initial pressure reading
- Sustain pressure for 5 minutes and note the final pressure reading
- If the air pressure decreases by more than 2 psi during the initial 5-minute test period (or more than 10% of the equalized pressure of at least 25 psi), locate the faulty area of the seam, make repairs, and retest
- If the air pressure test passes, the air channel should be cut at the opposite end of the seam from the gauge to deflate the seam channel. Keep a record of appropriate test information on a Non-Destructive Test Log similar to the one included in Appendix A.

#### **Vacuum Test**

Vacuum testing will be completed on seams that have been welded with an extrusion welder or when the geometry of a seam makes it impossible or impractical to test using the air pressure test. The Geomembrane Contractor shall follow the following procedures:

- If testing a fusion weld trim excess overlap from the seam edges
- Wet the area to be tested with a soapy liquid solution
- Place the vacuum box assembly over the wetted area and apply sufficient pressure to "seat" the box on the test area
- Create a vacuum of 3 to 5 psi to the box, using the pressure gauge on the box to observe pressure readings
- Once a tight seal is verified, observe the area for approximately 15 seconds looking for recurring soap bubbles on the seam

- If leaks (bubbles) are observed, mark the location of each leak for repair
- If no leaks are detected, release the pressure on the vacuum box and move to the next adjacent test location maintaining a minimum 3-inch overlap if applicable
- Maintain a record of appropriate test information on a Non-Destructive Test Log similar to the one included in Appendix A

If specific locations exist where non-destructive testing is not possible or practical, seams will be tested by an alternate method accepted by the CQA Engineer.

#### 4.3.4 Destructive Testing

Destructive testing is conducted to evaluate the strength of welded seams. Destructive testing should be minimized to preserve the integrity of the liner system. Destructive test samples will be taken at an average of once per 500 feet of seam length. The Geomembrane Contractor will follow the following procedures:

- The CQA Inspector will identify seam locations to be sampled and tested. All destructive sample locations will be marked on the geomembrane liner, indicating appropriate information including test number, seams tested and date.
- The Geomembrane Contractor will cut three samples at the selected location: one each for the Geomembrane Contractor, the CQA Inspector, and the Owner's archive. Each sample will be a minimum of 12 inches wide by 18 inches long (or according to minimum laboratory requirements) with the seam centered lengthwise. For fusion welded seams the geomembrane contractor will field test fifteen (15) 1-inch wide test specimens, ten (10) for peel strength and five (5) for shear strength per UWL cell. Five (5) of the peel specimens must come from the top weld, and five (5) must come from the bottom weld. For extrusion welded seams the geomembrane contractor will field test ten (10) 1-inch wide test specimens, five (5) for peel strength and five (5) for shear strength. Welded seam tested strengths must equal or exceed the requirements of the GRI Test Method GM19 (latest approved edition) for 60-mil HDPE component of the composite liner and the 40 mil HDPE component of the final cover system. The Owner or CQA Inspector will coordinate with an independent third-party laboratory to perform the same test procedures on the samples retained by the CQA Inspector.
- Failing tests will be addressed by the procedures outlined below. Such criteria will apply to both the field tests and the third-party laboratory tests. Should environmental conditions during testing detrimentally affect field test results, the laboratory tests will govern
- The CQA Inspector will document pertinent destructive test information on a Destructive Test Log similar to the one in Appendix A.

##### **Procedures for Destructive Test Failure:**

- Two additional destructive samples will be taken one on each side of the failed test location at least 10 feet from its location

- The same testing procedures as described above will be followed to determine whether the additional samples pass or fail
- If the additional tests pass, the portion of the seam between two passing test locations will either be reconstructed or cap stripped
- If either of the additional tests fails, the process will be repeated until a seam length is bounded by two passing tests. At that point, the seam between the two passing test locations will either be reconstructed or cap stripped
- All repaired or replaced seams will be non-destructively tested to verify their integrity. Repairs will be noted on a Repair Report Form similar to the one found in Appendix A

#### 4.3.5 Defects and Repairs

The CQA Inspector and Geomembrane Contractor will monitor the geomembrane liner and seams for defects, holes, blisters, and signs of damage during installation. Portions of the geomembrane or seams that show flaws, destructive test locations, and portions of seams that fail destructive or non-destructive tests will be repaired. Repairs will be completed using patching, extrusion welding, cap stripping, or other means approved by the CQA Inspector. Repairs will be non-destructively tested using methods described in Section 4.3.3 and documented on a Repair Report Form similar to the one in Appendix A.

## 5.0 GEOTEXTILE

Geotextile fabric required for the project will be installed by a qualified third-party contractor.

Geotextile fabric required for the project will be installed and tested in accordance with the approved permit documents and the manufacturer's guidelines, standards and specifications. Care will be used during construction to ensure that geotextile materials are not damaged. Geotextile filter fabric panels that are placed will be overlapped and bonded together to maintain placement in accordance with the manufacturers or suppliers standard for bonding of adjacent panels of geotextile.

The CQA Engineer or his representative will log all rolls of geotextile material that arrives on site and review the manufacturer's QC certification documentation. Each roll will be documented on a Material Inventory Log similar to that found in Appendix A. Storage of geotextile material will be in a manner that reasonably protects the material from puncture, denting, deformation of rolls, and other damaging situations prior to its deployment. UV sensitive geosynthetics will be stored in undamaged opaque coverings and protected from standing water during storage. Photo documentation of geotextile storage, installation, and repair procedures will be included in the final CQA Report.

### 5.1 Materials Conformance Testing

Prior to installation the contractor will supply the CQA Engineer with MQC and MQA information and testing documentation on the supplied materials conformance with the design specifications for geotextiles or the CQA Engineer shall obtain one geotextile sample per 100,000 square feet of material to be installed for MQA testing. The following MQC and MQA tests will be performed to verify that the geotextile conforms to the project specifications:

- Mass per unit area (ASTM D 5261/ASTM D 3776); Thickness (ASTM D 5199)
- Grab Tensile (ASTM D 4632)
- Permittivity (ASTM D 4491) (if material is to be used as a filter layer)
- Apparent Opening Size (ASTM D 4751) (if material is to be used as a filter layer)
- Shear strength properties of interface with other geosynthetics, CCPs and soils

For each of the properties listed above, the material shall meet current industry standards for the geotextile material type (e.g., woven, non-woven) and unit weight. Deviations from this testing protocol due to changes in test methods or industry standards shall be allowed with the approval of the CQA Engineer.

### 5.2 Construction Procedures

In general, the geotextile will be installed according to the manufacturer's recommendations and the project specifications. Proper documentation of the installation will be provided. At a minimum, the following guidelines shall be followed:

- Deployed geotextile will be weighted at its edges during times of excessive wind
- Care will be taken when cutting geotextile in place to not cut or damage other associated geosynthetic materials
- Care will be taken to avoid trapping rocks or other sharp objects between geotextile and geomembrane layers
- Tears or rips in geotextile materials will be patched with like geotextile material
- Geotextiles may be overlapped, stapled, sewn or fusion welded in accordance with the manufacturer's instructions and project specifications

## **6.0 LEACHATE COLLECTION SYSTEM**

The two primary components of the leachate collection system include the aggregate drainage layer or geocomposite drainage net and associated leachate collection pipes. This section covers material conformance testing and general CQA requirements to ensure the leachate collection system is constructed in accordance with the construction and permit documents. Material conformance testing and general CQA observations required for the geocomposite drainage net are discussed in Section 7.0 of this report.

### **6.1 Aggregate Drainage Layer**

Aggregate to be used in the drainage layer will be non-carbonate, well-graded aggregate with a minimum permeability of 0.25 cm/sec and particle diameter of 0.425 mm to 13.0 mm. Aggregate placement/spreading techniques that minimize the potential for damage to the underlying geomembrane liner will be used. Specifically, aggregate will be placed by advancing the aggregate in fingers across the geotextile cushion layer overlying the geomembrane. Low ground pressure equipment such as a lightweight, wide-tracked dozer will be used for spreading the aggregate. During aggregate drainage layer installation, periodic visits to the site will be made by the CQA Inspector to observe and document installation procedures.

Prior to placement of the aggregate, representative samples of the stockpiled materials proposed for use will be collected and tested. One sample shall be taken from for every 5,000 CY of aggregate. This testing shall verify that the aggregates to be used for construction meet project specifications as determined by this pre-qualification testing. The following tests may be performed as prescribed by the CQA Engineer:

<b><u>Test Method</u></b>	<b><u>Test Description</u></b>
ASTM C 136	Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 117	Standard Test Method for Materials Finer than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM D 5084	Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

An independent surveyor licensed to practice in the state of Missouri will verify the thickness of the aggregate drainage layer. The surveyor will be independent of the landfill contract operator, construction contractor, Owner, or permit holder. The surveyor may be employed by the CQA Engineer. Following completion of the aggregate drainage layer, a final survey shall be completed on a minimum 100-foot grid system and at 100 foot intervals at along the perimeter to document the top of aggregate elevations. These survey points will be in the same general locations as the subgrade and top-of-clay-liner surveys to allow calculation of drainage layer thickness. Acceptable tolerances for surveying shall be  $\pm 0.1$  foot for elevations and  $\pm 1.0$  foot for



horizontal coordinates. All results must indicate an aggregate drainage layer thickness equal to or greater than that required by the plans and specifications.

Once the non-carbonate gravel is in place, a geotextile filter will be laid over the top of the gravel and then covered with a single 12 inch layer of aggregate protective cover, to protect the liner, drainage layer, and pipes from damage during construction and initial filling operations.

## 6.2 Leachate Collection Piping

Leachate collection piping will be installed in accordance with the approved permit documents. The CQA Inspector will observe the placement of the piping to verify that the appropriate slope on the pipe has been achieved. Additionally, visual observation of piping connections will be made to document proper connection of pipe segments and orientation of perforated pipe, where applicable. The placement location of the leachate collection system piping will be documented by a survey by the CQA Engineer or Independent Surveyor at minimum intervals of 100 feet laterally along the pipe length and at changes in horizontal or vertical direction. Acceptable tolerances for surveying shall be  $\pm 0.1$  foot for elevations and  $\pm 1.0$  foot for horizontal coordinates. The survey locations will be used to verify the pipe has the appropriate slope.

## **7.0 GEOCOMPOSITE**

Geocomposite material may be installed as an alternate leachate drainage layer instead of the aggregate drainage layer over the geomembrane liner. Geocomposite material will be installed by a qualified contractor. The geocomposite manufacturer will develop a panel layout diagram in accordance with industry standards for the leachate drainage layer as shown on the plan sheets. The manufacturer will provide the panel layout diagram of the geocomposite drainage layer to the CQA Engineer.

Geocomposite material will be tested and installed in accordance with the approved permit documents and manufacturer's installation instructions. Care must be used during construction to ensure that geocomposite materials and geomembrane layer are not damaged.

The CQA Engineer or his representative will log all rolls of geocomposite material that arrive on site and review the manufacturer's QC certification documentation. Each roll will be documented on a Material Inventory Log similar to that found in Appendix A. Storage of geocomposite material will be in a manner that reasonably protects the material from puncture, denting, deformation of rolls, and other damaging situations prior to its deployment. UV sensitive geosynthetics will be stored in undamaged opaque coverings and protected from standing water during storage. Photo documentation of the geocomposite drainage layer storage, installation, and repair procedures will be included in the final CQA Report.

### **7.1 Materials Conformance Testing**

Prior to installation of the geocomposite, the CQA Engineer shall obtain one geocomposite sample per 100,000 square feet of material to be installed for materials conformance testing or obtain equivalent MQA and MQC materials conformance testing from the supplier or installer. The following materials conformance tests and results shall verify that the geocomposite material conforms to the project specifications:

- Ply Adhesion (ASTM D 413)
- Thickness (ASTM D 5199)
- Transmissivity (every fifth sample) (ASTM D 4716)

For each of the properties listed above, the material shall meet current industry standards for the geocomposite material type. Deviations from this testing protocol due to changes in test methods or industry standards will be approved by the CQA Engineer.

### **7.2 Construction Procedures**

In general, the geocomposite will be installed in compliance with the manufacturer's requirements and the project specifications. Proper documentation of the installation will be required. At a minimum, the following guidelines will be followed:

- Deployed geocomposite will be weighted at its edges during times of excessive wind

- Geocomposite to be deployed on slopes will first be anchored and rolled down the slope in a controlled manner
- Geocomposite will not be deployed horizontally across slopes unless approved by the CQA Engineer
- Care will be taken when cutting geocomposite in place to not cut or damage other associated geosynthetic materials
- Care will be taken to avoid trapping rocks or other sharp objects between geocomposite and geomembrane layers
- Tears or rips in the geotextile portion of the geocomposite will be patched with like geocomposite material. Patches will be a minimum of 2 feet beyond the edges of the hole or tear

Adjacent geocomposite rolls will be joined according to project specifications and manufacturer's instructions. At a minimum the following procedures will be followed:

- Tears or rips in geotextile portion of the geocomposite will be patched with like geocomposite material
- Adjacent edges of the geonet along the length of the geocomposite roll will be placed with the edges of each geonet overlapping each other by 4 inches minimum
- The adjacent edges will be joined by tying the geonet structure with plastic (not metal) cable ties spaced every 5 feet along the roll length
- Adjoining geocomposite rolls (end to end) across the roll width should be shingled down in the direction of the slope, with the geonet portion of the top overlapping the geonet portion of the bottom geocomposite a minimum of 12 inches across the roll width
- Where the geocomposite is anchored in an anchor trench, the geonet portion should be tied every 6 inches along the geocomposite edges

## **8.0 PROTECTIVE COVER**

This section covers material conformance testing and general CQA requirements to ensure the aggregate protective cover layer is constructed in accordance with the construction and permit documents.

### **8.1 Aggregate Protective Cover Layer**

The aggregate protective cover layer shall consist of well-graded non-carbonate aggregate with a particle size between 9.5 mm and 0.075 mm, with 0 to 10 percent passing the No. 100 U.S. Sieve, a  $d_{50}$  particle size of approximately 0.5 to 0.9 mm, and a  $d_{15}$  particle size of approximately 0.2 to 0.4 mm. Aggregate protective cover placement/spreading techniques that minimize the potential for damage to the underlying geotextile layer and aggregate drainage layer will be used. Specifically, aggregate protective cover will be placed by advancing the aggregate in fingers across the underlying geotextile filter layer. Low ground pressure equipment such as a lightweight, wide-tracked dozer will be used for spreading the aggregate. During aggregate protective cover layer installation, periodic visits to the site will be made by the CQA Inspector to observe and document installation procedures.

Prior to placement of the protective cover layer aggregate, representative samples of the stockpiled materials proposed for use will be collected and tested. One sample will be taken from for every 5,000 CY of aggregate. Testing will verify that the aggregates meet project specifications as determined by this pre-qualification testing. The following tests may be performed as prescribed by the CQA Engineer:

<b><u>Test Method</u></b>	<b><u>Test Description</u></b>
ASTM C 136	Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 117	Standard Test Method for Materials Finer than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM D 5084	Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

An independent surveyor licensed to practice in the state of Missouri will verify the thickness of the aggregate protective cover layer. The surveyor will be independent of the landfill contract operator, construction contractor, Owner, or permit holder. The surveyor may be employed by the CQA Engineer. Following completion of the aggregate protective cover layer, a final survey will be completed on a minimum 100-foot grid system and at 100 foot intervals along the perimeter to document the top of aggregate protective cover layer elevations. These survey points will be in the same general locations as the subgrade and top-of-clay-liner surveys to allow calculation of protective cover layer thickness. Acceptable tolerances for surveying shall be  $\pm 0.1$  foot for elevations and  $\pm 1.0$  foot for horizontal coordinates. . All results should show an

aggregate protective layer thickness equal to or greater than that required by the plans and specifications.

## **9.0 FINAL COVER CONSTRUCTION**

The final cover system will consist of two (2) feet of soil cover overlying a geotextile layer overlying a 40 mil thick HDPE geomembrane layer on the final top and side slopes of the UWL. The two feet of nominally compacted soil of the final cover system will be constructed and tested in accordance with the approved permit documents and this CQA Plan. This section covers material conformance testing, general construction procedures, and testing requirements.

### **9.1 Materials Conformance Testing**

Prior to construction of the nominally compacted soil component of the side slope final cover system, representative samples of the soil materials proposed for use will be collected and tested to verify that the soils meet the project specifications determined by the pre-qualification testing. The soils utilized for the final cover system shall consist of soils classified as CH, CL, ML, SC, and MH soils types according to the Unified Soil Classification System. The CQA Engineer will verify that the soil selected for use in the final cover and the associated placement ranges are capable of meeting the minimum shear strength properties, both internal and interface with geosynthetics and soils, utilized in the geotechnical design (reference Appendix J of the Construction Permit Application). Soil used for the nominally compacted soil layer on the side slopes and top should be adequate to establish and support vegetation.

### **9.2 Nominally Compacted Soil Construction Procedures**

The nominally compacted soil layer of the final cover system will be placed over the geotextile cushion layer above the 40-mil smooth and textured HDPE geomembranes on the final top portion and the side slopes of the UWL. The soil used for the nominally compacted layer should be adequate to establish and support vegetation.

### **9.3 Quality Assurance**

The quality assurance monitoring and testing program for the nominally compacted layer of the final cover system utilizes the same program as that of the compacted clay liner (see Section 3.5). Thickness verification will be completed for the nominally compacted soil portions of the final cover as described in Section 3.6.

## **10.0 MISCELLANEOUS HDPE PIPING**

This section applies to miscellaneous HDPE piping, including stormwater and leachate transport lines and pump intake lines.

### **10.1 Butt, Heat Fusion Welds**

All HDPE pipe and fittings shall be joined using butt, heat fusion welds. All joints will be made in compliance with the manufacturer's recommended practice for heater surface temperature, heating time, applied pressure and cooling time, subject to the CQA Engineer's approval. All joints will be made by trained technicians qualified by the manufacturer and using equipment and controlled procedures approved by the manufacturer.

Pipe joints will be stronger than the pipe itself under both tension and hydrostatic loading conditions. The joints will be leak-tight, homogeneous and uniform throughout. The contractor will submit written documentation certifying compliance with the manufacturer's standard specifications and CQA plan for the butt, heat fusion technique.

## 11.0 REPORTING

Proper documentation of the CQA process is an important aspect of construction documentation. In addition to the completion of the forms and logs mentioned previously, the following reports will be completed.

### 11.1 Daily Reports

The CQA Inspector will provide daily written reports to the CQA Engineer during the days when inspections are made. These reports will include information about the work accomplished each day; tests and observations that were made; and descriptions of the adequacy of the work performed. The reports will include the following as appropriate:

- Date, project name, location, cell involved in construction, equipment utilized, and personnel involved in major activities
- Description of weather conditions, including temperature, cloud cover, and precipitation
- Description of the type of construction, inspection, and testing activity for the day
- Location of construction activity for the day
- Location of tests completed
- Discussion of construction methods (i.e., equipment make/model, number of compactor passes, etc.) as they relate to the previous cell or test pad construction
- Results of construction activity (i.e., first lift completed, sump completed, etc.)
- Description of construction materials used including reference to certifications, test results, etc.
- Location of observation activity or location from which the sample(s) were obtained; Standard methods and frequency used for tests
- Results of testing performed (passing or failing); Equipment calibration results
- Construction or testing problems and required actions
- Photographic documentation of construction progress including time, date, location, and name of photographer
- Signature of the CQA Inspector

Appendix A includes example CQA forms, which provide an acceptable format the required information that may be used by the CQA Engineer, including:

- Daily Activities Field Report
- Nuclear Density Gauge Test Record
- Material Inventory Log
- Panel Placement Log
- Trial Weld Log
- Panel Seaming Log
- Non-Destructive Test Log
- Destructive Test Log



- Repair Log

These forms may be modified based on the final project features requiring CQA/CQC oversight.

## 11.2 Design Change Documentation

On occasion it may be necessary to modify the design during construction activities. The Owner, MDNR-SWMP, and IRPE must approve changes to the design or deviation from the permit documents.

## 11.3 Deviation from CQA Plan

During the course of construction, deviations from the CQA Plan may be necessary due to various construction issues, permit modifications, regulatory changes, new technology, or changes to accepted standards. Deviations from this CQA Plan will be documented and approved by the Owner and the CQA Engineer.

## 11.4 Final Documentation Report

At the completion of each cell's liner and leachate collection system construction, or closure of specified area of the landfill, the CQA Engineer will prepare a final CQA Report for submittal with the initial cell's Operating Permit Application (or the Request for Authorization to Operate for subsequent cells) to the MDNR-SWMP and Franklin County. This report will bear the CQA Engineer's Missouri Professional Engineer's seal and date. The CQA Report will contain the following information:

- A certification (signed, sealed, and dated) by the CQA Engineer stating that the construction of the cell has been completed in substantial compliance with the engineering design, CQA Plan and the facility Construction Permit
- As-built drawings (signed, sealed, and dated) by the CQA Engineer or the licensed survey certification (signed, sealed, and dated) by a Missouri registered land surveyor or a Missouri Professional Engineer
- CQA field data and laboratory test results
- CQA inspection records and photographs

The final CQA Report and Operating Permit Application will be submitted to the MDNR-SWMP prior to the cell receiving its first load of waste.

# APPENDICES

# **APPENDIX A**

## **Example CQA Forms**

## DAILY FIELD ACTIVITIES REPORT

Client Name: \_\_\_\_\_

Date: \_\_\_\_\_

Start Time: \_\_\_\_\_

Stop Time: \_\_\_\_\_

Project Location: \_\_\_\_\_

Task: \_\_\_\_\_

### Weather Information

### Contractors, Personnel, and Equipment On Site

### Work Areas/Boundaries

### Testing Equipment Used/Observed and Calibration/Re-Calibration Documentation

### Tests Completed/Observed

### Work Comments/Observations and Test Results

### Material(s) Delivered to Site

\_\_\_\_\_  
CQA Monitoring Technician

SAMPLE

# Nuclear Density Gauge Test Record

Date \_\_\_\_\_ Page \_\_\_\_\_ of \_\_\_\_\_  
CQA Technician \_\_\_\_\_

Client Name: \_\_\_\_\_  
Project Name: \_\_\_\_\_  
Project Number: \_\_\_\_\_  
Project Location: \_\_\_\_\_

Material Designation: \_\_\_\_\_  
 Target Dry Density: \_\_\_\_\_  
 Target Moisture Range: \_\_\_\_\_  
 Target Percent Compaction: \_\_\_\_\_

Standard Density: \_\_\_\_\_  
Standard Moisture: \_\_\_\_\_

[illegible]

# Material Inventory Record

Date \_\_\_\_\_ Page \_\_\_\_\_ of \_\_\_\_\_  
CQA Technician \_\_\_\_\_

Client Name: \_\_\_\_\_  
Project Location: \_\_\_\_\_  
\_\_\_\_\_

Project Name: \_\_\_\_\_

Project Number: \_\_\_\_\_

Material Type: \_\_\_\_\_

[illegible]

## Panel Placement Record

Date \_\_\_\_\_ Page \_\_\_\_\_ of \_\_\_\_\_  
CQA Technician \_\_\_\_\_

Client Name: \_\_\_\_\_  
Project Location: \_\_\_\_\_  
\_\_\_\_\_

Project Name: \_\_\_\_\_

Project Number: \_\_\_\_\_

[illegible]

# Trial Weld Record

Date \_\_\_\_\_ Page \_\_\_\_\_ of \_\_\_\_\_  
CQA Technician \_\_\_\_\_

Client Name: \_\_\_\_\_  
Project Name: \_\_\_\_\_  
Project Number: \_\_\_\_\_  
Project Location: \_\_\_\_\_

Specifications: \_\_\_\_\_ mil

Wedge Extrusion  
Peel (P)  $\geq$  \_\_\_\_\_  
Shear (S)  $\geq$  \_\_\_\_\_  
\_\_\_\_\_ of \_\_\_\_\_ bones

Trial Weld Number	Time	Ambient Temp	Installer's QC	Machine Number	Machine Properties	Weld Type	Seamer Initials	Test Values lbs/inch					Pass/ Fail	Type of Material	Comments
								P							
								S							
								P							
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## Seam/Non-Destructive Test Record

Date \_\_\_\_\_ Page \_\_\_\_\_ of \_\_\_\_\_  
CQA Technician \_\_\_\_\_

Client Name: \_\_\_\_\_  
Project Location: \_\_\_\_\_  
\_\_\_\_\_

Project Name: \_\_\_\_\_  
Project Number: \_\_\_\_\_

[illegible]

# Non-Destructive Test Record

Date \_\_\_\_\_ Page \_\_\_\_\_ of \_\_\_\_\_  
CQA Technician \_\_\_\_\_

Client Name: \_\_\_\_\_  
Project Location: \_\_\_\_\_  
\_\_\_\_\_

Project Name: \_\_\_\_\_

Project Number: \_\_\_\_\_

[illegible]

# Destructive Test Record

Date \_\_\_\_\_ Page \_\_\_\_\_ of \_\_\_\_\_  
CQA Technician \_\_\_\_\_

Client Name: \_\_\_\_\_  
Project Name: \_\_\_\_\_  
Project Number: \_\_\_\_\_  
Project Location: \_\_\_\_\_

Specifications: \_\_\_\_\_ mil  
Wedge                      Extrusion  
Peel (P)     $\geq$                        $\geq$   
Shear (S)     $\geq$                        $\geq$   
\_\_\_\_\_ of \_\_\_\_\_ bones

Sample ID	Installer's QC	Seam Number	Weld Type	Machine Number	Seamer Initials	Test Values lbs/inch					Field Pass/Fail	Lab Pass/Fail	Location
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# Repair Record

Date \_\_\_\_\_ Page \_\_\_\_\_ of \_\_\_\_\_  
CQA Technician \_\_\_\_\_

Client Name: \_\_\_\_\_  
Project Location: \_\_\_\_\_  
\_\_\_\_\_

Project Name: \_\_\_\_\_

Project Number: \_\_\_\_\_

[illegible]