WEAVER
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Project No.: 0120-131-17-02
May 7, 2013

Mr. Craig Almanza
Area Environmental Manager
Republic Services, Inc.
12978 St. Charles Rock Road
Bridgeton, MO 63044

Re: Response to Comments
Temporary Cap & Cap Integrity System CQA Plan
Bridgeton Landfill

Dear Mr. Almanza:

The following are responses to MDNR and the St. Louis County Health Department comments regarding the Temporary Cap and Cap Integrity System CQA Plan for the Bridgeton Landfill. The MDNR and the St. Louis County Health Department comments were received via email on May 1, 2013.

Comment 1: Section 3.1.1 Manufacturing, please verify if there will be specific manufacturing testing and requirements for the EVOH material/resin itself in addition to the product as a whole.

As part of the manufacturing process, the EVOH material source resin is tested to verify and document conformance with the material specifications. The CQA Manager shall be provided with this testing data to verify conformance with the CQA Plan. Section 3.1.1 of the CQA Plan has been revised accordingly.

Comment 2: Section 3.1.5 Surface Preparation, due to the proposed design of the cap, standard surface preparation and approval as specified may not be plausible. If necessary, please include more site specific preparation plans for your CQA Monitor.

The subgrade for the temporary cap area shall be "tracked-in" and "back-dragged" with a bulldozer to provide a smooth surface. Prior to installation of FML, a cushion geotextile will be installed on the subgrade surface. Section 3.1.5 of the CQA plan has been revised accordingly.

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Comment 3: Section 3.1.8.3 Overlapping, please specify the minimum panel overlap for the flexible membrane liner (FML).

The FML panels shall have a minimum overlap of 4 to 6 inches for fusion welding. For extrusion welding, the FML shall overlap a minimum of 6 inches on each side. Section 3.1.8.3 of the CQA plan has been revised accordingly.

Comment 4: Section 3.1.8.7 Test Seams, states "Test seams will be made at the beginning of each seaming period and a minimum of once every five hours of continuous welding for each seaming apparatus used that day." Please specify if the test seams will be each seaming apparatus/operator combination.

Section 3.1.8.7 of the CQA plan has been revised to specify that tests seams are required for each seaming apparatus/operator combination.

Comment 5: Section 3.4.6 Perimeter Collection Sumps/Rock Chimneys, please remove rock chimneys from the section title.

Rock Chimneys have been removed from section title. Section 3.4.6 of the CQA Plan has been revised accordingly.

Comment 6: The literature provided in Appendix A states the testing requirements and specifications for the selected FML material is a 50 mil textured LLDPE. Previous submittals and correspondences have indicated that the outer layers of the FML will consist of 60 mil textured HDPE. Please explicitly state what the FML cap material will be made of and submit the accompanying testing information accordingly. This information must be consistent with each submittal.

During the preliminary material selection discussions for the geomembrane to be utilized on this project, an EVOH geomembrane with a "nominal" thickness of 60 mil was discussed. The final product chosen for this project consists of a geomembrane with an EVOH core layer for vapor control and outer layers of HDPE for UV protection in an exposed application. This geomembrane will have a minimum average thickness of 50 mil which includes the EVOH layer and the

other layers of HDPE. There was an incorrect identification in the Raven Industries correspondence for this material in the previous submission. Appendix A contains the revised letter along with the testing requirements for the EVOH with HDPE outer layers (X60FC1).

We trust that the information provided in this response is sufficient for your needs. For your convenience, an updated copy of the proposed CQA plan has been attached.

Sincerely,

Weaver Boos Consultants

Mark A. Moyer
Senior Project Manager

Ali Hashimi, P.E.
Certifying Engineer

Encl: Temporary Cap and Cap Integrity System CQA Plan, Revision No. 1

TEMPORARY CAP AND CAP INTEGRITY SYSTEM CONSTRUCTION QUALITY ASSURANCE PLAN

BRIDGETON LANDFILL
Bridgeton, Missouri

APRIL 2013
REVISION 1: MAY 7, 2013

Prepared For:
Bridgeton Landfill, LLC
12978 St. Charles Rock Road
Bridgeton, Missouri 63044

TEMPORARY CAP AND CAP INTEGRITY SYSTEM
CQA PLAN
BRIDGETON REGIONAL LANDFILL

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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 document quality landfill construction. CQA is typically performed by a third-party independent to the 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 document that landfill components are constructed in accordance with applicable construction standards and specifications. The technical guidance document entitled Quality Assurance and Quality Control for Waste Containment Facilities (EPN600/R-93/182) produced by the U.S. Environmental Protection Agency specifically defines the roles that CQA and CQC play during landfill construction:

- CQA: A planned system of activities that provides the owner and permitting agency assurance that the facility was constructed as specified in the design. CQA includes 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 organization to assess if the contractor or installer is in compliance with the plans and specifications for a project.
- CQC: A planned system of inspections that is used to directly monitor and control the quality of a construction project. CQC is normally performed by the contractor and is necessary to achieve quality in the constructed system. CQC refers to measures taken by the contractor or installer to determine compliance with the requirements for material and workmanship as stated in the plans and specifications for the project.

This CQA Plan is specific to the CQA activities to be completed by an independent third- party, and addresses the temporary cover integrity system to be constructed for the Bridgeton Landfill in Bridgeton, Missouri. The facility is owned and operated by Bridgeton Landfill, LLC. This CQA Plan has been prepared in general conformance with the Missouri Solid Waste Management Rules.

A copy of this CQA Plan is to be maintained at the Bridgeton Landfill for use during landfill temporary cover construction. Any revisions to the design or the approved CQA Plan shall require a permit modification to be reviewed by the MDNR-SWMP and St. Louis County Department of Health (DOH). The MDNR-SWMP and St. Louis County DOH must be kept

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informed throughout landfill construction projects. The MDNR-SWMP and St. Louis County DOH will review all records and results from the implementation of the CQA Plan.

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2.0 GENERAL CONDITIONS

2.1 Responsibility and Authority

Bridgeton Landfill, LLC will be responsible for the implementation of this CQA Plan. The following is a list of responsible personnel:

Owner's Representative

A representative of Bridgeton Landfill, LLC shall be responsible for coordination between the landfill owner, Bridgeton Landfill, LLC, the construction crew, and the third-party CQA Engineer. With the MDNR-SWMP's prior approval, the owner/operator shall delegate authority, and correspondingly, shall be responsible to see that the CQA Plan is followed.

CQA Engineer

A professional engineer licensed to practice in Missouri shall be retained by Bridgeton Landfill, LLC to perform on-site construction oversight and quality assurance testing, and to prepare a final report demonstrating that the requirements of this CQA Plan are met. In addition, the CQA Engineer or his designee shall coordinate with the contractor(s) and/or installer(s) and their CQC personnel for the purposes of sharing CQA and CQC information. Should it become apparent to the CQA Engineer or his designee that construction quality is substandard, the CQA Engineer shall inform the Owner's Representative of the apparent deficiencies such that adjustments can be made. The CQA Engineer must be employed by an organization that operates independently of the landfill contract operator, construction contractor, Bridgeton Landfill, LLC, and the permit holder. The CQA Engineer will be responsible for certifying that construction was completed in general accordance with the permit requirements and the construction engineering design plans and specifications.

CQA Inspector

If the CQA Engineer cannot serve to provide on-site inspection of the temporary cover construction activities and reporting, the CQA Engineer shall designate a CQA Inspector to perform those duties. The CQA Inspector shall be an individual that represents the CQA Engineer and provides on-site construction oversight, quality assurance testing, and general observance and documentation of construction. The CQA Inspector will document on-site construction activities on a Daily Field Activities Report. An example of this report form is included in Appendix A.

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2.2 Inspection and Testing

This CQA Plan describes the inspection and testing requirements for the construction of the landfill temporary cover system. Section 3.0 outlines the minimum requirements and guidelines to be followed to execute the CQA Plan.

2.3 Project Meetings

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

Pre-Construction Meeting: A meeting involving Bridgeton Landfill, LLC and the Owner's Representative, CQA personnel including the CQA Engineer and CQA Inspector, and the contractor(s) shall take place prior to the start of construction. This meeting should include discussion of the following:

- Each party's responsibilities;
- Lines or means of communication;
- Procedures for changes or problems;
- CQA procedures and requirements;
- Level of the MDNR-SWMP's involvement; and
- Other issues as they pertain to the construction project.

Daily Progress Meetings: Regularly scheduled, daily meetings between CQA personnel and the contractor(s) shall take place to review and discuss such topics as previous work, future work, construction problems, schedule revisions, and other issues that require attention on a frequent basis.

- Other Meetings: Unscheduled meetings shall take place as required to address issues such as construction progress and changed conditions as circumstances dictate.

Under all circumstances, the MDNR-SWMP and St. Louis County DOH will be given seven (7) days advance notification prior to the initiation of landfill temporary cover system construction.

3.0 CONSTRUCTION QUALITY ASSURANCE PROCEDURES

3.1 Temporary Cover Flexible Membrane Liners (FML)

3.1.1 Manufacturing

The Manufacturer will provide the CQA Manager with the following information for the FML to be used at the Bridgeton Landfill:

- Written certification accompanying all material shipments stating that their product meets manufacturing specifications and passes QA/QC requirements as identified by the manufacturer. The Manufacturer shall also provide Quality Control documentation and results of testing that the resin supplied for the production of this material specified in this section shall meet or exceed the requirements of the specifications and CQA Plan.
- A copy of the quality control certificates issued by the Resin Supplier;
- Summary reports of the test results, including the test frequency used by the manufacturer to verify the quality of each resin batch used to manufacture FML rolls assigned to the project. At a minimum, one series of tests will be conducted for each resin batch.

Based on the data supplied by the Manufacturer, the CQA Manager will notify the Owner of any deviation from the project specifications or CQA Plan.

3.1.2 FML Rolls

The Manufacturer will provide the Owner or CQA Manager with a written certification accompanying all material shipments stating that their product meets manufacturing specifications and passes QA/QC requirements as identified by the manufacturer for the geomembrane produced, and that the geomembrane supplied under this plan will meet the requirements shown in Appendix A.

The Manufacturer will provide the Owner or CQA Manager with a quality control certificate for all the FML rolls shipped to the site. The quality control certificate should be signed by a responsible party employed by the Manufacturer. The quality control certificate shall include:

- Roll number, identification, and;
- Sampling procedures and testing frequency of quality control tests as well as test results shall be in accordance with the requirements of Appendix A.

The CQA Manager will:

- Obtain conformance test samples, at the place of manufacture or as the rolls are delivered to the site, if required by Owner,
- Review the quality control certificates, test methods used, and the measured roll properties for conformance to the specifications; and,
- Verify that the quality control certificates have been provided for all rolls.

3.1.3 Acceptance Criteria

Acceptable criteria for tests to be performed on geomembrane rolls are shown in Appendix A and only the Owner or the CQA Manager can authorize retesting of geomembrane rolls because of failure to meet any of the requirements.

For those tests where results are reported for both machine and cross direction, each result will be compared to the listed specification to determine acceptance. The following procedure will be used for interpreting results:

- If the value meets the stated specification, then the roll and the lot will be accepted for use in the liners for the job site.
- If the result does not meet the specification, then the roll and the lot may be retested on samples either from the original roll sample or from another sample collected by the CQA Consultant and forwarded to the Manufacturer. Two additional tests must be performed for the failed test procedure. If both of the retests are acceptable, then the roll and lot will be considered acceptable. If either of the two additional tests fail, then both the roll and lot are unsuitable and shall be rejected.

The Manufacturer may request that another round of tests be performed on samples collected by the CQA Consultant and tested by the Manufacturer. Under this procedure, the average value used for the purpose of determining acceptance will be based on the average value of all specimens tested, including those from the failed round.

3.1.4 Transportation, Handling, and Storage

Transportation of the FML is the responsibility of the Manufacturer, the Installer, or other party as decided by the Owner. All handling on-site after unloading is the responsibility of the Installer. The CQA Monitor will monitor and document the following with regard to the geomembrane:

- Each FML roll is labeled with an identification number and a batch (lot) number;
- FML delivered to the site is free from defects and/or damage.
    - The FML must have no striations, roughness (except for where the textured geomembrane is specified), or bubbles on the surface.
    - The FML must be free of holes, blisters, undispersed raw materials, or any other sign of contamination by foreign matter.
- The adequacy of on-site handling of equipment to minimize risk of damage to both the FML and underlying geosynthetic or subgrade materials; and,
- The careful handling of the FML by the Installer's personnel.

The CQA Monitor will indicate/report to the Owner any FML or portions thereof, which in the opinion of the CQA Monitor should be rejected and removed from the site because of visually obvious flaws; or rolls that include flaws, which may be repairable.

Selected samples of the FML material may be obtained by the CQA Manager for physical testing to document that the FML material tested satisfies the minimum material property requirements established in Section 5.1.3.

3.1.5 Surface Preparation

The Owner or Contractor will be responsible for preparing the supporting soil according to the plans and specifications. The CQA Monitor will document that:

- A qualified Professional Engineer or Land Surveyor has determined that lines and grades are in substantial conformance with design plan and allow for drainage from the area;
- The surfaces to be lined will be inspected for conditions that could be damaging to the overlying geosynthetics;
- The surface of the supporting soil does not contain stones which may be damaging to the geomembrane; and
- There are no areas excessively softened by high water content.
- The subgrade for the temporary cap area shall be “tracked-in” and “back-dragged” with a bulldozer to provide a smooth surface. Prior to installation of FML, a cushion geotextile will be installed on the subgrade surface.

The FML Installer will certify in writing that the surface on which the geomembrane will be installed is acceptable. This certification of acceptance will be reported daily by the FML Installer to the CQA Monitor prior to commencement of the FML installation.

After the surface has been accepted by the FML Installer, it will be the FML Installer's responsibility to indicate to the Owner or CQA Monitor any change in the surface conditions that may require repair work. If the CQA Monitor concurs with the FML Installer, then the CQA Monitor will identify the necessary repair work to be performed by the Owner or Contractor.

At any time prior to or during the FML installation, the CQA Monitor will notify the Owner or Contractor of locations, which, in the opinion of the CQA Monitor, will require corrective action prior to the geomembrane installation.

3.1.6 Anchorage System

The anchor trenches will be excavated to the lines and depth shown on the temporary cap and corer integrity system construction drawings prior to the FML placement. The CQA Monitor will document the anchor trench construction.

Rounded corners shall be provided in the trenches where the FML enters the trench to allow the FML to be uniformly supported by the subgrade and to avoid sharp bends in the FML. Precautions shall be taken to minimize loose soil in the anchor trenches. FML should be seamed completely to the ends of all panels to minimize the potential for tear propagation along the seam. Backfilling of the anchor trenches will be conducted using soils that will not damage the underlying geosynthetics and shall be placed with compactive effort.

3.1.7 FML Placement

3.1.7.1 Panel Identification

A panel is the unit area of FML that is seamed in the field. The unit area can consist of a full roll or a portion of the roll cut in the field.

Prior to or during the initial meeting, the FML Installer will provide the Owner and CQA Manager with a drawing of the cell to be lined showing the orientation of the FML panels. The CQA Manager will review the panel layout and document that it is consistent with the accepted state of practice.

Each panel will be given an "identification code" (number or letter-number) consistent with the layout plan. This identification code will be agreed upon by the FML Installer and the CQA

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Monitor. This identification code shall be simple and logical (note that roll numbers established in the manufacturing plant may be cumbersome and are unrelated to location in the field).

The CQA Monitor will establish a table or chart showing correspondence between roll numbers and panel identification codes. The panel identification codes will be used for all quality assurance records.

3.1.7.2 Panel Placement

The CQA Monitor will document that panel installation is consistent with regard to locations indicated in the FML Installer's layout plan, as approved or modified at the initial meeting.

Installation:

- Only those panels that can be reasonably expected to be anchored or seamed together in one day are to be unrolled. Panels may be installed using any of the following schedules:
    - All panels placed prior to field seaming;
    - Panels placed one at a time and each panel seamed immediately after its placement;
    - Any combination of the above.
- The CQA Monitor will record on a drawing the identification code, location, and date of installation of each FML panel. The location of FML panels and intersections will be surveyed in for certification.
- Deployment of the FML can be accomplished through the use of lightweight, rubber tired equipment such as a 4-wheel all terrain vehicle (ATV), provided the ATV makes no sudden stops, starts, or turns on the geosynthetic. ATV traffic on the geosynthetics shall be minimized.

If a decision is reached to place all panels prior to field seaming, care should be taken to facilitate drainage in the event of precipitation and anchoring for winds. Scheduling decisions must be made during placement in accordance with varying conditions. The CQA Monitor will evaluate changes in the schedule proposed by the Installer and will advise the Owner and the CQA Manager on the acceptability of that change. The CQA Monitor will document that the condition of the supporting soil has not changed detrimentally during installation.

Weather Conditions:

- FML panel deployment or seaming shall not take place during any precipitation, in the presence of excessive moisture (e.g. fog, dew), in an area of ponded water, or in the presence of high winds.
- The CQA Monitor will inform the Owner when the above conditions are not fulfilled or has observed subgrade damage caused by adverse weather conditions.
- The FML Installer will inform the Owner if the weather conditions are not acceptable for FML deployment or seaming.
- The Installer shall provide suitable wind protection as necessary to maintain the integrity of the installation.

The CQA Monitor will:

- Observe equipment damage to the FML as a result of handling, traffic, leakage of hydrocarbons, or other means;
- Observe deviations from the requirement that no one is permitted to smoke, wear damaging shoes, or engage in other activities which could damage the FML;
- Observe scratches, crimps, or wrinkles in the FML and any damage to the subgrade; and,
- Observe damage caused by loading necessary to prevent uplift by wind.

The CQA Monitor will inform the Owner of the above conditions.

After placement, the CQA Monitor will observe each panel for damage. The CQA Monitor will advise the FML Installer and Owner which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels that have been rejected will be marked and their removal from the work area recorded by the CQA Monitor. Repairs should be made according to procedures described in Section 3.1.10.

3.1.8 Field Seaming

3.1.8.1 Seam Layout

The FML Installer will provide the Owner and CQA Manager with drawings of the cell to be lined showing field seams in a manner which differentiates the seam types, if any. The CQA Manager will review the seam layouts.

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In general, seams shall be oriented parallel to the line of maximum slope; i.e., oriented up and down, not across, the slope.

It is anticipated that cross seams on the slope will be required. Cross seams on adjacent panels should be staggered so that they are separated a distance greater than the width of a panel.

A seam numbering system compatible with the panel numbering system should be agreed upon at the initial meeting.

3.1.8.2 Requirement of Personnel

All personnel performing seaming operations must be qualified by experience or by successfully passing seaming tests. At least one seamer will have a minimum of 1,000,000 ft² of FML seaming experience using the same type of seaming apparatus in use at the site. The Owner or CQA Monitor has the right to reject a seamer if they cannot demonstrate suitable experience and qualifications.

3.1.8.3 Overlapping

The CQA Monitor will observe that FML panels were properly overlapped for fusion welding and extrusion welding. The FML panels shall have a minimum overlap of 4 to 6 inches for fusion welding. For extrusion welding, the FML shall overlap a minimum of 6 inches on each side.

3.1.8.4 Seam Preparation

Seams must be prepared so that:

- Prior to seaming, the seam area will be clean and free of moisture, dust, dirt, debris of any kind, and foreign material.
- Seam overlap grinding (for extrusion welding only) will be completed according to the Manufacturer's instructions and in a way that does not damage the FML.
- Seams will be aligned with the fewest possible number of wrinkles and "fishmouths".

3.1.8.5 Seaming Equipment

The approved processes for field seaming of the FML is double track fusion or extrusion welding. Proposed alternate processes will be documented and submitted to the Owner or CQA Consultant for concurrence.

The apparatus used for welding the major seams will be equipped with gauges indicating the temperature in the apparatus or at the application point. The CQA Monitor will observe apparatus temperatures and ambient temperatures prior to the machine beginning a new seam.

The CQA Monitor will observe that:

- Equipment used for seaming is not likely to damage the FML;
- The extruder is purged prior to beginning a seam until the heat-degraded extrudate has been removed from the barrel;
- The electric generator is placed on a smooth base such that minimal damage occurs to the FML;
- A smooth insulating plate or fabric is placed beneath the welding apparatus after usage;
- The FML is protected from damage in heavily trafficked areas.
- One spare operable seaming device shall be maintained on site at all times.
- A small movable piece of FML may be used directly below the FML overlap that is to be seamed to prevent buildup of water and/or moisture between the FML sheets. The FML piece is slid along the overlap as the seaming progresses. This piece is removed when the seam is completed.

3.1.8.6 Weather Conditions for Seaming

The typical weather conditions required for seaming are as follows:

- No seaming shall be attempted above 104º F ambient air temperature or below 32º F ambient air temperature, without approval. Ambient temperature shall be measured 12 inches above the liner.
- In all cases, the FML shall be dry and protected from wind damage.
- The CQA Monitor will observe the seaming techniques appropriate for the prevailing weather conditions are employed and will advise the Owner or CQA Manager of deviations. The final decision as to whether or not seaming may be performed will be made by the Owner or CQA Manager.
- Seaming shall not be performed during any precipitation event unless the Installer erects satisfactory shelter to protect the FML areas for seaming from water and/or moisture.

- Seaming shall not be performed in areas where ponded water has collected above or below the surface of the FML.

If the Installer wishes to use methods which may allow seaming at ambient temperatures below 32°F or above 104°F, the Installer will demonstrate and certify that the methods and techniques used to perform the seaming produce seams which are entirely equivalent to seams produced at temperatures above 32°F and below 104°F, and that the overall quality of the FML is not adversely affected.

The CQA Monitor will document the following items:

- Ambient temperature at which seaming is performed.
- Any precipitation events occurring at the site, including the time of such occurrences, the intensity, and the amount of the event.

The CQA Manager will inform the Owner if seaming during unsuitable weather conditions is being performed. The Owner will stop or postpone the FML seaming when conditions are unacceptable.

3.1.8.7 Test Seams

Test seams will be prepared each day prior to commencing FML field seaming. Test seams will be made at the beginning of each seaming period and a minimum of once every five hours of continuous welding for each seaming apparatus/operator combination used that day. Additional test seams may be required at the discretion of the CQA Manager.

The test seam sample will be at least three feet long by one foot wide with the seam centered lengthwise. Six adjoining one-inch wide specimens will be die cut from the seam sample. The specimens will be immediately tested by the FML installer with a tensiometer in the field for both peel (3 specimens) and shear (3 specimens). If any of the test seam specimens for FML fail to meet the acceptance requirement in Appendix A then the entire operation will be repeated. If the additional test seam fails, the seaming apparatus will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive successful full test seams are achieved. Test seam failure is defined as failure of any one of the specimens tested in shear or peel. The CQA Monitor will observe all test seam procedures.

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3.1.8.8 General Seaming Procedure

Unless otherwise specified, the general seaming procedure used by the FML Installer shall be as follows:

- If required, a moveable protective layer of plastic may be placed directly below each overlap of FML that is to be seamed. The purpose of the protective layer is to prevent any moisture build-up between the sheets to be welded. No protective layers may be left beneath the FML
- Seaming shall extend to the outside edge of panels to be placed in anchor trenches.
- If required, a firm substratum should be provided by using a flat board or similar hard surface directly under the seam overlap to achieve proper support.
- Fish mouths or large differential wrinkles at the seam overlaps should be cut along the ridge of the wrinkle to achieve a flat overlap. The cut fishmouths or wrinkles will be seamed over the entire length and will then be patched with an oval or round patch of the same type of FML extending a minimum of 6 inches beyond the cut in all directions.
- If seaming operations are to be conducted at night, adequate illumination will be provided.

The CQA Monitor will observe that the above seaming procedures (or any other procedures agreed upon) are followed, and will inform the Owner and CQA Manager if they are not.

3.1.9 Seam Testing

The FML Installer will non-destructively test all field seams over their full length for continuity. Continuity testing shall be performed ASTM D5820 using seam pressure tests for double track fusion welded seams in accordance with. Vacuum box tests shall be performed for single track fusion welded seams, and extrusion welded seams in accordance with ASTM D5641. The purpose of this testing is to check the continuity of seams; it does not provide information on seam strength. Continuity testing will be done as the seaming work progresses. The CQA Monitor will:

- Observe all continuity testing;
- Record location, date, test unit number, name of tester, and outcome of all testing; and,
- Inform the FML Installer of any required repairs.

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The FML Installer will complete any required repairs in accordance with Section 3.1.10. If repairs are required, the CQA Monitor will:

- Observe the repair and the retesting of the repair;
- Mark on the FML that the repair has been made; and,
- Document the repair, location and retesting results.

All seams must be constructed in a fashion that allows them to be non-destructively tested. Any patches, seams around liner penetrations, or seams near sharp corners must be capped or patched with FML of sufficient size to allow non-destructive testing of the seams. Boots and collars may be inspected visually.

The seam number, date of observation, name of tester, and outcome of the test or observation will be recorded by the CQA Monitor.

Seam Pressure Test Procedure:

- The seam pressure test is designed to detect leaks of double-wedge thermally welded seams where an air chamber exists between the seams. After the seam has been fabricated for a given length, both ends of the air chamber are sealed. A needle attached to a pressure gauge/air valve assembly is inserted into the air chamber and air pressure is applied. The gauge is monitored for drop in air pressure over time as an indicator of seam leaks. Seams shall be tested using the minimum acceptance criteria listed in Appendix A.
- The initial starting pressure may be read after a two minute "relaxing" period, which will allow the air within the chamber to reach ambient liner temperature. The final pressure will then be read at the conclusion of the test. If the pressure loss does not exceed the acceptance criteria listed in Appendix A, then the seam is considered to have passed the nondestructive test. The end of the seam opposite the pressure gauge will then be cut open to observe that the entire seam length has been tested. If the pressure does not drop upon the opposing end being cut the blockage will be found to identify the section of seam tested. The remainder of the seam will then be tested as stated above.
- If failure occurs (i.e., pressure reduction over the scheduled time period is greater than the maximum allowable), the end seals will be checked and the seam retested. If failure recurs, the exposed fusion area will be visually observed and a soapy solution shall be

applied over the pressurized seams to locate leaks. If leak areas are located, these areas will be patched and pressure tested on both sides of the patched area. The patched area will be vacuum tested.

Vacuum Box Test Equipment consists of:

- A vacuum box assembly of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a port hole or valve assembly, and a vacuum gauge;
- A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections;
- A rubber pressure/vacuum hose with fittings and connections; and,
- A soapy solution (mild detergent).

The following procedures shall be performed for vacuum testing:

- Energize the vacuum pump.
- Wet a strip of FML to be tested with the soapy solution.
- Place the vacuum box over the wetted area.
- Close the bleed valve and open the vacuum valve.
- Maintain a vacuum pressure of at least 5 psig.
- Check that a leak tight seal is created.
- For a period of not less than 10 seconds, examine the FML through the viewing window for the presence of soap bubbles.
- If no bubble(s) appears after 10 seconds, close the vacuum valve and open the bleed valve. Move the box over the next adjoining area with a minimum 3-inch overlap, and repeat the process.
- All areas where leaks are observed will be marked and repaired in accordance with Section 3.1.10.

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3.1.9.1 Destructive Seam Strength Testing

Locations and Frequency:

- The CQA Monitor will select the locations where seam samples are to be cut for laboratory testing. The sampling should be established as follows:
    - A minimum frequency of one test location per 500 feet of production seam length per welding machine.
    - Additional test locations may be selected during seaming at the discretion of the CQA Manager. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of inadequate welding.
- The FML Installer will not be informed in advance of the locations where the seam samples will be taken.

Sampling Procedures:

- Samples will be die cut by the FML Installer as the seaming progresses to have laboratory test results before completion of liner installation. The CQA Monitor will:
    - Observe sample cutting;
    - Assign a number to each sample and mark it accordingly;
    - Record the sample location on a layout drawing; and,
    - Observe field tensiometer testing performed by the FML Installer and record test data.
- Holes in the FML resulting from destructive seam sampling will be immediately repaired by the FML Installer in accordance with repair procedures described in Section 3.1.10. The continuity of the new seams in the repaired area will be tested according to Section 3.1.9.

Size of Samples:

- The samples will be a minimum of 12 inches wide by approximately 42 inches long with the seam centered lengthwise. The sample will be cut into three parts and distributed as follows:
    - One portion to the FML Installer for testing, 12 in. x 12 in.

- One portion for CQA Manager for laboratory testing, 12 in. x 18 in.
- One portion to the Owner for archive storage, 12 in. x 12. in.
- Samples will be cut by the FML Installer at the locations designated by, and under the observation of, the CQA Monitor as the seaming progresses to obtain laboratory test results prior to completion of liner installation.

- The CQA Monitor will witness field tests and mark samples with their number. The CQA Monitor will also log the date, number of seaming unit, and pass or fail description.

Testing Requirements:

- Laboratory testing of seams will commence as soon as possible after the destructive seam samples are received. A minimum of five specimens should be tested each for shear and peel, for a total of ten destructive tests per destructive sample. The shear and peel testing of the seams should be conducted according to ASTM D-6392.
- Pass/Fail Criteria for FML for destructive samples can be found in Appendix A.

Procedures for Destructive Test Failure:

- The following procedures will apply whenever a sample fails the field destructive test. The FML Installer shall cap strip the seam between the failed location and two passed laboratory test locations using the procedures described in Section 3.1.10. Cap-stripping involves applying a strip of FML, a minimum distance of 6 inches on all sides of the defective seams, and seaming it to the sheet material by extrusion welding.
- All acceptable reconstructed seams must be bounded by two passing laboratory test locations, (i.e., the above procedure should be followed in both directions from the original failed location). The only exception is if all seams produced by the defective welder have been reconstructed to a point it can no longer be followed in the failing direction. One laboratory test must be taken within the reconstructed area if the failed length exceeds 250 feet.
- The CQA Monitor will observe and note actions taken in conjunction with destructive test failures.

3.1.10 Defects and Repairs

3.1.10.1 Identification

Seams and non-seam areas of the FML will be evaluated by the CQA Monitor for identification of defects, holes, blisters, undispersed raw materials, and signs of contamination by foreign matter. Because light reflected by the FML aids in the detection of defects, the surface of the FML shall be clean at the time of visual observation. The FML surface should be broomed or washed if the amount of dust or mud inhibits observation and testing.

3.1.10.2 Evaluation

Each suspect location, both in seam and non-seam areas, will be non-destructively tested. Each location that fails the non-destructive testing will be marked by the CQA Monitor and repaired by the FML Installer.

3.1.10.3 Repair Procedures

Any portion of the FML exhibiting a flaw, or failing a destructive or nondestructive test shall be repaired. Repair procedures should be agreed upon between the Owner, the FML Installer, and the CQA Manager. Unless otherwise agreed, the repair procedures will be as follows:

- Defective seams will be repaired by reconstruction.
- Tears or holes will be repaired by patching.
- Pinholes will be repaired by applying an extrudate bead to the prepared surface.
- Blisters, larger holes, undispersed raw materials, and contamination by foreign matter will be repaired by patching.
- Patches shall be round or oval in shape, made of the same material as the FML, and extend a minimum of 6 inches beyond all edges of the defect. Patches will be applied using the approved method as required in the specifications.
- All seams made in repairing defects will be subjected to the same non-destructive test procedures as outlined for all other seams.

3.1.10.4 Seam Reconstruction Procedures

Seam sections that need repair due to overheating, burn holes, and unseamed areas shall be reconstructed by cap stripping with the same FML material. Cap stripping involves applying a strip of FML, respectively, a minimum distance of 6 inches on all sides of the defective seams, and seaming it to the sheet material by extrusion welding. Large caps may be of sufficient extent

to require destructive seam sampling and testing, at the discretion of the CQA Monitor. The FML below large caps should be appropriately cut to avoid water or gas collection between the two sheets.

3.1.10.5 Documentation of Repairs

Each repair will be non-destructively tested using the methods described in Section 3.1.9, as appropriate. Repairs, which pass the non-destructive test, will be taken as an indication of an adequate repair. Repairs, which fail, will be redone and retested until a passing test is achieved. The CQA Monitor will observe all non-destructive testing of repairs.

3.2 Non-Woven Geotextile

Every roll of geotextile delivered to the site must be manufactured and inspected by the Geotextile Manufacturer, according to the following requirements:

- The geotextile must be properly labeled.
- The geotextile must be free of holes and any other sign of contamination by foreign matter.

Each geotextile roll, for use at the landfill facility, shall be marked by the Geotextile Manufacturer with the following information and in the following manner:

- Name of Manufacturer (or supplier)
- Style and type number
- Roll length and width
- Batch (or lot) number
- Date of manufacture
- Roll number

The Geotextile Manufacturer must provide a written certification accompanying all material shipments stating that their product meets all manufacturing specifications and passes all requirements and specifications listed in this CQA Plan. The Manufacturer shall also provide Quality Control documentation and results of testing that the material specified in this section meets or exceeds the requirements of the specifications and CQA Plan.

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3.2.1 Transportation, Handling, and Storage

Transportation of the geotextile is the responsibility of the Manufacturer, the Installer, or other party as decided by the Owner. All handling on-site after unloading is the responsibility of the Installer. The CQA Monitor will monitor or document the following with regard to the geotextile:

- Each geotextile roll is labeled with a roll number and a batch (lot) number;
- Rolls delivered to the site are free from defects and/or damage;
- The adequacy of on-site handling of equipment to minimize risk of damage to both the geotextile and underlying geosynthetic materials; and,
- The careful handling of the geotextile by the Installer's personnel.

The CQA Monitor will indicate/report to the Owner any rolls or portions thereof, which in the opinion of the CQA Monitor should be rejected and removed from the site because of visually obvious flaws; or rolls that include flaws, which may be repairable.

Selected samples of the geotextile material may be obtained by the CQA Manager for physical testing to document that the geotextile material tested satisfies the minimum material property requirements established in Appendix B.

3.2.2 Installation

Placement of the geotextile shall be conducted in accordance with the manufacturer's recommendations and with the direction provided herein. Any deviations from these procedures must be pre-approved by the CQA Manager.

The Geotextile Installer shall install the geotextile in such a manner that it is not damaged in any way.

The CQA Monitor shall observe and document that each of the above steps are performed by the Installer. Any noncompliance with the above requirements shall be reported by the CQA Monitor to the CQA Manager.

3.2.3 Geotextile Seaming

Seaming of the geotextile may be performed by one of three methods: sewing, thermal bonding or approved gluing.

3.2.4 Damage Repair

Any tears or other defects in the geotextile will be repaired by placing a patch extending a minimum of 12 inches beyond the edges of the hole or tear. The patch will be secured by heat tacking. If the tear or other defect width is more than 50 percent of the roll width, the damaged area will be cut out and replaced with new geotextile material. The CQA Monitor will examine and document that the repair of any geotextile is performed according to the above procedure.

3.3 Double-Sided Geocomposite

3.3.1 Transportation, Handling, and Storage

Every roll of geocomposite delivered to the site must be manufactured and inspected by the Geocomposite Manufacturer, according to the following requirements:

- The geocomposite must be properly labeled.
- The geocomposite must be free of holes and any other sign of contamination by foreign matter.

Each geocomposite roll, for use at the landfill facility, shall be marked by the Geocomposite Manufacturer with the following information and in the following manner:

- Name of Manufacturer (or supplier)
- Style and type number
- Roll length and width
- Batch (or lot) number
- Date of manufacture
- Roll number

The Geocomposite Manufacturer must provide a written certification accompanying all material shipments stating that their product meets manufacturing specifications and passes requirements and specifications listed in this CQA Plan. The Manufacturer shall also provide Quality Control documentation and results of testing that the material specified in this section meets or exceeds the requirements of the specifications and CQA Plan.

Transportation of the geocomposite is the responsibility of the Manufacturer, the Installer, or other party as decided by the Owner. All handling on-site after unloading is the responsibility of

the Installer. The CQA Monitor will monitor or document the following with regard to the geocomposite:

- Each geocomposite roll is labeled with a roll number and a batch (lot) number;
- Rolls delivered to the site are free from defects and/or damage;
- The adequacy of on-site handling of equipment to minimize risk of damage to both the geocomposite and underlying geosynthetic; and,
- The geocomposite is handled in a manner to minimize damage.

The CQA Monitor will indicate/report to the Owner any rolls or portions thereof, which in the opinion of the CQA Monitor should be rejected and removed from the site because of visually obvious flaws; or rolls that include flaws, which may be repairable.

Selected samples of the geocomposite material may be obtained by the CQA Manager for physical testing to document that the geocomposite material tested satisfies the minimum material property requirements established in Appendix C.

3.3.2 Installation

Placement of the geocomposite shall be conducted in accordance with the manufacturer's recommendations and with the direction provided herein. Any deviations from these procedures must be pre-approved by the CQA Manager.

- The Geocomposite Installer shall install the geocomposite in such a manner so that it is not damaged in any way.
- The panels will be orientated in the direction of the slope to minimize seams on the slope
- Panels will be overlapped in the direction of flow to facilitate drainage.
- If the cover material is a geomembrane or other geosynthetic, precautions shall be taken to prevent damage to the geocomposite by restricting heavy equipment traffic. Unrolling the geosynthetic can be accomplished through the use of lightweight, rubber-tired equipment such as a 4-wheel all-terrain vehicle (ATV). This vehicle can be driven directly on the geocomposite, provided the ATV makes no sudden stops, starts, or turns.

The CQA Monitor shall observe and document that each of the above steps are performed by the Installer. Any noncompliance with the above requirements shall be reported by the CQA Monitor to the CQA Manager.

3.3.3 Geocomposite Panel Seaming

The following requirements shall be met with regard to overlapping and joining of geocomposite rolls:

- Adjacent rolls shall be overlapped a minimum of 4 inches.
- The overlaps will be shingled to facilitate drainage.
- The overlaps shall be secured by tying to each other at a minimum of five foot spacing.
- The overlap at butt seams will be 12 inches and the geocomposite will be secured by tying at 6-inch spacing.
- Plastic fasteners shall be used to tie the geonet component. The plastic ties shall be white or brightly colored for easy identification. Metallic ties shall not be used in any circumstances.
- The geotextile portion of the geocomposite will be sewn together using a contrasting colored thread for easy inspection.

3.3.4 Damage Repair

Any tears or other defects in the geocomposite will be repaired by placing a patch extending a minimum of 2 feet beyond the edges of the hole or tear. The patch will be secured to the original geocomposite by tying every 6 inches. If the tear or other defect width is more than 50 percent of the roll width, the damaged area will be cut out and replaced with new geocomposite material. The CQA Manager will examine and document that the repair of any geocomposite is performed according to the above procedure.

3.4 Cap Integrity System

3.4.1 Below-Cap Stone Collectors

Stone collectors shall be a 2”-3” washed river gravel with the minimum dimensions indicated on the approved construction drawings. Location of the stone corridors is indicated on the approved construction drawings. Each proposed stone collector will be located by survey prior to construction. Record surveys will be completed on each stone corridor after installation is complete. GLOBAL CHANGE – just say approved construction drawings

3.4.2 Cap Integrity Piping

The piping material shall meet the specifications as described in the approved construction drawings to include material type, diameter, and wall thickness. Piping shall be installed in

accordance with industry standards and the approved construction drawings. Location of the piping is indicated on the approved construction drawings. Location of the piping shall be located by survey prior to installation, with record survey completed after installation.

3.4.3 Strip Drains

The strip drains shall be a 1" by 12" strip drain as indicated on the approved construction drawings. Strip drains shall be placed at approximate 75 foot spacing or as indicated on the approved construction drawings. Strip drains shall be installed in accordance with industry standards and the approved construction drawings. Location of the strip drains shall be located by survey prior to installation, with an as-built survey completed after installation.

3.4.4 Access Roads

The access roads will have a top deck width of approximately 10 feet with a minimum stone thickness of 24 inches and shall be constructed in accordance with the temporary cap and cover integrity system construction drawings. Access roads shall be installed on locations indicated on the temporary cap and cover integrity system construction drawings with corresponding stripping areas (approximately 20 feet wide) below the geosynthetics. Location of the access roads shall be located by survey prior to installation, with record survey completed after installation.

3.4.5 Perimeter Collection Trench

A Perimeter Collection Trench shall be excavated around the project limits as shown on the approved construction drawings. The trench will be excavated to a "typical" depth of 4 feet but may vary to support positive drainage. The trench will be backfilled with the 2"-3" washed river gravel. Location of the Perimeter Collection Trench will surveyed and recorded on the record drawings. Trench depths will be documented on an approximated 100' spacing.

3.4.6 Perimeter Collection Sumps

With the Perimeter Collection Trench, a series of Collection Sumps will be installed at locations shown on the approved construction drawings. Locations and depths will be documented and included on record drawings.

Collection Sumps will be installed using an excavator and backfilled with 2"-3" washed river gravel. The collection sumps shall also have an access pipe for installation of a pump for removal of liquids as shown on the approved construction drawings.

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3.5 Storm Water Management

The approved construction drawing has an approved storm water management plan prepared by Cornerstone Environmental Group.

The CQA firm shall document that the storm water management system is constructed in accordance with the approved plan. Components of documentation should include culvert location, sizes, storage ponds, ditches and other features required by the approved plan. Information shall be included in the record drawings.

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APPENDIX A
TEMPORARY COVER FLEXIBLE MEMBRANE LINER

RAVEN
INDUSTRIES

TO: Republic Services

SUBJECT: Raven X60FC1 QA testing methods and frequency (rev. 3)

DATE: April 12, 2013

IN REFERENCE TO: Bridgeton Landfill project, Bridgeton, MO

Raven X60FC1 geomembrane and its components undergo an extensive array of testing and measurement during the manufacturing process. The required tests, methods, and sampling frequency are based on the requirements set forth in GRI GM 13 ('Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes')

The minimum test values for X60FC1 using these test methods are listed the table provided with this letter.

Clint Boerhave

Clint Boerhave
Quality Manager
Raven Industries - Engineered Films Division

Test methods, minimum values, and test frequency for Raven X60FC1

Properties	Test Method	Test Value	Testing Frequency (minimum)
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	50 mils 45 mils 35 mils	per roll
Asperity Height mils (min. ave.)	GM 12	10 mils	per roll
Tensile Properties (3) (min. ave.) • break strength – lb/in. • MD break elongation - % (min. avg.) • TD break elongation - % (min. avg.)	6693 Type IV	 75 200 30	20,000 lb
Tear Resistance – lb (min. ave.)	D 1004	27	45,000 lb
Puncture Resistance – lb (min. ave.)	D 4833	55	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 400	200,000 lb

RAVEN INDUSTRIES

STATEMENT OF PERFORMANCE

SUBJECT: Raven X60FC1

IN REFERENCE TO: Seam testing minimum values and material separation in plane (SIP)
Republic Services Landfill cap project - Bridgeton, Missouri
SO# 195942-195948, 195950-195954

DATE: April 5, 2013

Absolute Barrier™ X60FC1 is a seven layer co-extruded textured geomembrane consisting of polyethylene with a core layer designed specifically as a barrier against radon, methane and VOCs on brownfield sites, residential and commercial buildings, and geomembrane containment and covering systems. A robust stabilization package provides long-term protection from thermal oxidation and ultraviolet degradation in exposed applications.

Due to the multilayer construction and the presence of a barrier core in this product, some separation in plane may occur during destructive seam testing. This is normal and should not be of concern as long as the tested peel and shear results meet the minimum values for this product:

Hot Wedge Seams	Minimum value
Shear Strength (lb/in)	80
Peel Strength (lb/in)	60
Extrusion Fillet Seams	
Shear Strength (lb/in)	80
Peel Strength (lb/in)	52

Clint Boerhave

Clint Boerhave
Quality Manager
Engineered Films Division

APPENDIX B
NON-WOVEN GEOTEXTILE

6 oz/sy Nonwoven Geotextile
Conformance Testing Summary

Properties	Test Method	Manufacturer QC Test Frequency(2)	Conformance QA Test Frequency	Required Test Values
Mass/Unit Area (min. ave.)	ASTM D5261	1 per 100,000 sf	N/A	6.0 oz/sy
Apparent Opening Size (max.)	ASTM D4751	1 per 540,000 sf	N/A	0.212 mm 70 (U.S. Sieve)
Grab Strength (min. ave.)	ASTM D4632	1 per 100,000 sf	N/A	160 lbs
Puncture Strength (min. ave.)	ASTM D4833/D6241	1 per 100,000 sf	N/A	95 lbs
UV Resistance	ASTM D4355	1 per resin formulation	N/A	70% (3)
Permittivity (min.)	ASTM D4491	1 per 540,000 sf	N/A	1.63 sec^{-1}

Notes:

(1) AOS and Permittivity shall only be tested for geotextiles used in filter applications.
(2) Manufacturer may elect to provide certification of values for geotextiles.
(3) After 500 hours of exposure.

APPENDIX C
DOUBLE-SIDED GEOCOMPOSITE

Geocomposite
Conformance Testing Summary

Properties	Test Method	Manufacturer QC Test Frequency	Conformance QA Test Frequency	Required Test Values
Geonet Component:				
Transmissivity, (min)	ASTM D4716	1 per 100,000 sf	N/A	$2x10^{-3}$ m^2/sec
Thickness (min)	ASTM D5199	1 per 100,000 sf	N/A	220 mils
Density (min)	ASTM D1505	1 per 100,000 sf	N/A	0.94 g/cm^2
Tensile Strength (min)	ASTM D5035	1 per 100,000 sf	N/A	45 lb
Carbon Black Content (min)	ASTM D1603	1 per 100,000 sf	N/A	2 to 3 %
Geotextile Component:				
Nominal 6 oz/sy non-woven – see Appendix B for specifications				
Geocomposite:				
Transmissivity, (min)[(1)]	ASTM D4716	1 per 100,000 sf	N/A	$1x10^{-4}$ m^2/sec
Ply Adhesion, (min)	ASTM D7005	1 per 100,000 sf	N/A	0.5 lb/in

Notes:

Transmissivity shall be measured using a seat time of 15 minutes, a load of 10,000psf, and a gradient of 0.1.

Comment 3: Section 3.1.8.3 Overlapping, please specify the minimum panel overlap for the flexible membrane liner (FML).

The FML panels shall have a minimum overlap of 4 to 6 inches for fusion welding. For extrusion welding, the FML shall overlap a minimum of 6 inches on each side. Section 3.1.8.3 of the CQA plan has been revised accordingly.

Comment 4: Section 3.1.8.7 Test Seams, states "Test seams will be made at the beginning of each seaming period and a minimum of once every five hours of continuous welding for each seaming apparatus used that day." Please specify if the test seams will be each seaming apparatus/operator combination.

Section 3.1.8.7 of the CQA plan has been revised to specify that tests seams are required for each seaming apparatus/operator combination.

Comment 5: Section 3.4.6 Perimeter Collection Sumps/Rock Chimneys, please remove rock chimneys from the section title.

Rock Chimneys have been removed from section title. Section 3.4.6 of the CQA Plan has been revised accordingly.

Comment 6: The literature provided in Appendix A states the testing requirements and specifications for the selected FML material is a 50 mil textured LLDPE. Previous submittals and correspondences have indicated that the outer layers of the FML will consist of 60 mil textured HDPE. Please explicitly state what the FML cap material will be made of and submit the accompanying testing information accordingly. This information must be consistent with each submittal.

During the preliminary material selection discussions for the geomembrane to be utilized on this project, an EVOH geomembrane with a "nominal" thickness of 60 mil was discussed. The final product chosen for this project consists of a geomembrane with an EVOH core layer for vapor control and outer layers of HDPE for UV protection in an exposed application. This geomembrane will have a minimum average thickness of 50 mil which includes the EVOH layer and the

other layers of HDPE. There was an incorrect identification in the Raven Industries correspondence for this material in the previous submission. Appendix A contains the revised letter along with the testing requirements for the EVOH with HDPE outer layers (X60FC1).

We trust that the information provided in this response is sufficient for your needs. For your convenience, an updated copy of the proposed CQA plan has been attached.

Sincerely,

Weaver Boos Consultants

Mark A. Moyer
Senior Project Manager

Ali Hashimi, P.E.
Certifying Engineer

Encl: Temporary Cap and Cap Integrity System CQA Plan, Revision No. 1