Geosyntec consultants

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7 April 2017

Mr. Theron Gay
County Administrator
Meriwether County
17234 Roosevelt Hwy Bldg. B
Greenville, Georgia 30222

Subject: **Notification of Submittal of a Coal Combustion Residuals (CCR) Management Plan to Georgia Department of Natural Resources Environmental Protection Division**
Greenbow, LLC - Turkey Run Landfill
Permit No. 099-019D(MSWL)
Meriwether County, Georgia

Dear Ms. Theron:

On the behalf of Greenbow, LLC (Greenbow), Geosyntec Consultants (Geosyntec) has prepared this letter to notify the Meriwether County of submittal of a Minor Modification Permit Application for inclusion of a Coal Combustion Residuals (CCR) Management Plan for the Turkey Run Landfill located in northwestern area of Meriwether County, Georgia.

The Turkey Run Landfill is a municipal solid waste landfill permitted [Permit No. 099-019D (MSWL)] by the Georgia Department of Natural Resources, Environmental Protection Division (EPD). A Minor Modification Permit Application was prepared, by Geosyntec on behalf of Greenbow, in response to the *Guidance Document for Coal Combustion Residuals (CCR) Management Plans* (Guidance Document) issued by Georgia EPD dated December 22, 2016. The Minor Modification Permit Application revises the Landfill's Design and Operation (D&O) Plan to incorporate a CCR Management Plan in accordance with EPD's Solid Waste Management Rule 391-3-4-.07(5) and the Guidance Document. The Guidance Document is included as Attachment 1.

Section 9 under the heading "CCR Management Plan Components" of the Guidance Document, requests notification to local governing authorities in which the landfill is located upon initial submittal of a CCR Management Plan to EPD. This letter is written to notify the Meriwether County that an initial submittal of a CCR Management Plan for the Turkey Run Landfill was made to the EPD on April 6, 2017.

In accordance with the Guidance Document, Meriwether County will be notified if any amendments are made to the CCR Management Plan for the Turkey Run Landfill in the future.

If you have any questions or need additional information, please feel free to contact the undersigned.

Sincerely,

Rutuparna Joshi, P.E.
Project Engineer
Geosyntec Consultants

Attachment 1 – Guidance Document for Coal Combustion Residuals (CCR) Management Plan, Georgia Department of Natural Resources Environmental Protection Division.

Copy to: Mr. Shawn Carroll, Waste Management
Mr. Gabriel Gribble, Waste Management

Geosyntec consultants

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5 April 2017

Mr. William Cook
Solid Waste Management Program
Georgia Environmental Protection Division
4244 International Parkway, Suite 104
Atlanta, Georgia 30354

Subject: **Minor Modification Application – Coal Combustion Residuals (CCR) Management Plan**
Greenbow, LLC – Turkey Run Landfill
Permit Number: 099-019D(MSWL)
Meriwether County, Georgia

Dear Mr. Cook:

On behalf of Greenbow, LLC, Geosyntec Consultants (Geosyntec) has prepared this minor permit modification application (Application) for the Turkey Run Landfill (Landfill) located in Meriwether County, Georgia. This Application is prepared in response to the *Guidance Document for Coal Combustion Residuals (CCR) Management Plans* (Guidance Document) issued by Georgia Department of Natural Resources, Environmental Protection Division (EPD) dated December 22, 2016. This Application revises the Landfill's Design and Operation (D&O) Plan to incorporate a CCR Management Plan in accordance with EPD's Solid Waste Management Rule 391-3-4-.07(5) and the Guidance Document. This Application consists of responses to requests within the Guidance Document, revised D&O Plan sheets (Attachment A) and updates to the design calculations. An executed minor modification form and three copies of the revised D&O Plan Sheets (Title Sheet, and Sheet Nos. 0, 1, 30A, 32, 32A, and 33) are included. Below is a summary of the revisions incorporated into the D&O Plan for compliance with the Guidance Document.

CCR GUIDANCE GENERAL REQUIREMENTS

1. *The CCR Management Plan shall be submitted as a request for modification to the facility's Design and Operational (D&O) Plan. Modifications which substantially alter the design of the facility, management practices, the types of wastes being handled, or the method of waste handling, and due to the nature of the changes would likely have an impact on the ability of the facility to adequately protect human health and the environment will require a major modification.*

Response: The Landfill facility is currently accepting CCR material. The facility comingles CCR and municipal solid waste (MSW). This CCR Management Plan proposes a maximum CCR to MSW ratio of 1:9, by weight. This request for modification will not substantially alter the design, management, types of waste or methods of waste handling. Therefore, it is being submitted as a minor modification to the facility's current permit.

2. *CCR Management Plans will be approved for a duration of one year. Facilities must submit a sealed professional engineer's Annual CCR Management and Dust Control Review describing activities, issues and any non-compliance from the prior year (for more on Fugitive Dust Control requirements, see below). Based on the annual review, Georgia EPD will either issue written approval to continue CCR management under the existing plan or will request the facility to amend their Plan. Amendments to the plan shall include any changes necessitated by the prior year's operations. The facility shall place the written EPD approval in the facility operating record. Facilities requested to amend their CCR Management Plan must obtain an approved amended Plan within 30 days of EPD's request or cease receipt of CCR until such approval is granted.*

   Response: Section 52 has been added to the Operations Plan narrative on Sheet 32A to define the annual reporting requirements related to CCR management and fugitive dust control.

   The current sources of CCR for this facility are defined in Section 3 of the Operations Plan narrative on Sheet 32. This section also requires that EPD approval be obtained prior to increases in the maximum CCR to MSW ratio.

3. *Plan sheets should be the same size (24"x30" to 24"x36") and have a standard title block.*

   Response: All plan sheets match the size of the current D&O Plan and include a standard title block.

4. *A professional engineer registered to practice in Georgia must stamp and sign all sheets.*

   Response: All modified D&O Plan sheets are stamped and signed by a Registered Professional Engineer in the State of Georgia.

CCR MANAGEMENT PLAN COMPONENTS

1. *Volume and Daily CCR Receipt*

   The estimated total amount of CCR to be accepted on annual basis and the daily maximum amount of CCR to be accepted must be listed in the Plan.

   For sites that will dispose of comingled CCR and MSW, the amount of MSW received and the maximum ratio of CCR to MSW for placement in the landfill must be listed in the Plan. The facility must be designed to address Section 4, Design Consistency, for comingling waste up to this maximum ratio. The facility may not dispose of comingled waste at a ratio that exceeds the maximum considered in the design calculations. Dedicated CCR cells that were previously approved for MSW disposal must also be redesigned to address the requirements of Section 4, Design Consistency.

   Response: Section 1 of the Operations Plan narrative on Sheet 32 has been modified to define the estimated daily and annual CCR and MSW tonnages to be accepted at the facility. Based on the annual tonnages for the year 2016, the Landfill accepted 2.4% CCR (i.e. CCR to MSW ratio of approximately 1:41). The maximum CCR to MSW ratio proposed for the purpose of this CCR Management Plan is 1:9. Section 1 of the Operations Plan narrative on Sheet 32 defines this maximum CCR to MSW ratio for comingled disposal.

   The design calculations that are affected by the CCR waste stream are included as attachments (Attachment B) to this submittal.

2. *Procedures for Waste Placement, Cover, and Recovery*

   The CCR Management Plan must include the following:

   a. *A description of how the working face will be managed at facilities where CCR and other wastes will be comingled, or identification of proposed CCR monofill cells.*

      Response: Section 2 of the Operations Plan on Sheet 32 has been modified to define the procedures governing the controlled unloading of CCR material at the working face and comingled with MSW. There are no CCR monofill cells designated for this facility.

b. *Description of waste placement procedures including (but not limited to):*

- *the initial layer placement of CCR above the liner and leachate collection system*

  Response: A narrative for initial placement of waste in a newly constructed cell has been added to Section 2 of the Operations Plan on Sheet 32. The first 10-ft thick lift of waste placed on top of the 24-inch thick protective cover soil will be select MSW and will not contain CCR.

- *placement and compaction requirements of CCR lifts to maintain stability*

  Response: The CCR will be comingled with MSW. Therefore, no amendments to the plan are required to define placement and compaction of CCR only lifts.

- *placement and compaction procedures for comingled wastes*

  Response: The procedures for spreading and compaction of comingled CCR and MSW will be the same as those currently in-place for the spreading and compaction of areas receiving MSW only. Narrative within Section 5 of the Operations Plan on Sheet 32 has been modified to reflect the same.

c. *Procedures and criteria for daily cover of comingled CCR and MSW.*

   Response: The procedures and criteria for daily cover on comingled CCR and MSW will be the same as those currently in-place for areas receiving MSW only. Narrative within Section 6 of the Operations Plan on Sheet 32 has been modified to reflect the same.

d. *The working face must be maintained at a size that is compatible with the facility's available equipment for spreading and compacting waste, and for suppressing dust. Describe the proposed maximum working face area and the equipment needed to manage a working face of this area.*

   Response: The size of maximum working face area will remain unchanged for comingled disposal of CCR and MSW. Section 2 of the Operations Plan on Sheet

32 has been revised to describe comingling of CCR and MSW at the working face. Additionally, Section 23 on Sheet 32 has been modified to define dust control procedures for a working face receiving comingled wastes.

e. *Operator inspection procedures for maintaining and documenting compliance with the CCR Management Plan must be given.*

Response: Landfill operators are trained to visually inspect each load that is placed at the working face. In addition, routine and documented Random Load Inspections are conducted. These standard procedures established by Waste Management will be utilized for incoming CCR waste loads.

Section 2 of the Operations Plan on Sheet 32 has been revised to require operator training related to CCR waste streams.

f. *If applicable, procedures for onsite liquid waste solidification operations using CCR.*

Response: The facility will not use CCR for liquid waste solidification.

g. *If applicable, procedures must be given for recovery of previously disposed CCR for beneficial reuse. EPD must be notified prior to disturbing and excavating previously disposed CCR for beneficial reuse.*

Response: The facility will not recover previously disposed CCR material for beneficial re-use.

3. *Fugitive Dust Control*

The CCR Management Plan must include measures that will minimize CCR from becoming airborne at the facility. Potential CCR fugitive dust emissions originating from CCR disposal units, roads, conditioning areas, and other CCR management and material handling activities must be minimized.

a. *Performance Standard: The percent opacity from CCR and any other fugitive dust source listed in Air Quality Rule 391-3-1-.02(2)(n)1 shall not exceed the limits set therein.*

Response: Section 23 of the Operations Plan on Sheet 32 has been modified to require compliance with Air Quality Rule 391-3-1-.02(2)(n)1.

b. *The Dust Control Plan must describe measures that the owner or operator will use to minimize CCR from becoming airborne, such as the following:*

- *locating CCR inside an enclosure/partial enclosure*
- *operating a water spray or fogging system*
- *reducing fall distances at material drop points*
- *using wind barriers, compaction, or vegetative covers*
- *establishing vehicle speed limits*
- *paving and sweeping roads*
- *covering trucks transporting CCR*
- *reducing or halting operations during high wind events*
- *applying daily cover or more frequent cover as needed*

Response: It is noted that the Landfill has an approved Title V Operating Permit (Permit Number: 4953-199-0025-V-03-0) from the Air Protection Branch of the Georgia EPD. In accordance with the permit conditions, the facility has already developed and emplaced a Dust Suppression Plan. Dust control measures described in the Dust Suppression Plan are currently being utilized and are expected to adequately address the CCR waste acceptance. The Dust Suppression Plan is included as Attachment E for reference.

Additionally, Section 23 of the Operations Plan on Sheet 32 has been modified to require moisture conditioning of CCR disposal areas with a water truck to control dust, if needed. Current operational procedures employ use of water trucks for other potentially fugitive dust waste streams.

c. *The Dust Control Plan must provide an explanation of how the selected measures are applicable and appropriate for the existing site conditions.*

Response: The use of a water truck to provide dust control (i.e., the equipment currently available at the facility) was selected and will provide for adequate dust suppression. See Section 19 of Sheet 32.

d. *The Dust Control Plan must provide procedures to emplace CCR with adequate moisture content or other suppressants added to minimize dust.*

Response: Section 23 of the Operations Plan on Sheet 32 has been modified to require moisture conditioning of CCR disposal areas with a water truck to control dust, if needed.

e. *Citizen Complaints: Procedures to log citizen complaints received by the owner or operator must be described in the Plan.*

Response: Section 23 of the Operations Plan on Sheet 32 has been modified to require the use of Waste Management's 1-800 Public Comment number for documenting citizen complaints.

f. *An "Annual Fugitive Dust Control Report" report will be due 12 months after the approval of the CCR Management Plan, and one year later for each subsequent report. The report shall include a description of the actions taken to control fugitive dust, a record of all citizen complaints, a summary of any corrective measures taken and, if applicable, recommendations to improve the dust control measures in the future.*

Response: Section 23 of the Operations Plan on Sheet 32 has been modified to require preparation and submission of an Annual Fugitive Dust Control Report. Additionally, narrative was added to Section 52 on Sheet 32A to allow for the Annual Fugitive Dust Control Report to be included with the annual CCR Management Plan renewal report.

4. *Design Consistency*

I. The CCR Management Plan must address the following landfill design considerations:

a. A demonstration that the design grades of the landfill are stable (i.e., for short operations and long-term static and seismic conditions).

Response: Revised stability analysis was performed to evaluate slope stability for the design grades of the landfill considering CCR acceptance. The results of the analysis indicate that the design grades of the landfill will remain stable considering CCR acceptance. The description and details of the performed slope stability analysis is included as Attachment B-1.

b. A demonstration that the liner system is designed to account for chemical exposure to CCR-generated leachate.

Response: A demonstration that the liner system materials are designed to account for chemical exposure to CCR-generated leachate is described in detail and included as Attachment C – Liner System Compatibility Analysis.

It is noted that the United States Environmental Protection Agency (US EPA) classifies CCR as a solid waste to be regulated under Subtitle D of the Resource Conservation and Recovery Act (RCRA). The permitted Subtitle D liner systems at the Turkey Run Landfill are designed to contain a mixed waste mass, including industrial wastes such as CCR. As noted in Attachment C, no adverse effects are anticipated on the liner system due to the leachate generated from comingling of CCR and MSW (with a maximum CCR to MSW ratio of 1:9 by weight).

c. The cell floor grading and construction plans shall account for settlement caused by the weight of the CCR or the comingled waste. Cell floor subsidence and leachate collection pipe crushing shall be evaluated, and a demonstration of adequate post-settlement cell floor grades, leachate pipe grades, and resistance to crushing shall be provided in the design calculations.

Response: Revised settlement analysis and leachate collection pipe structural stability analysis (including resistance to crushing) were performed in consideration of CCR comingled with MSW. The description and details of

settlement analysis is included as Attachment B-2. The description and details of leachate collection pipe structural stability analysis is included as Attachment B-4.

d. *The Leachate Collection and Removal System (LCRS) shall continue to maintain its functionality and limit the head of leachate on the liner system to a maximum of 30 centimeters. Drainage nets, filter fabrics, and other features of the LCRS must be demonstrated to be compatible with CCR. Pipes must be able to support the weight of the CCR without damage.*

   Response: Revised analysis were performed to evaluate the Leachate Collection and Removal System (LCRS) in consideration of CCR comingled with MSW. The results of the analysis indicate that the LCRS will continue to maintain its functionality and limit the head of leachate on the liner system within the thickness of the geonet drainage core. The description and details of LCRS maximum head and drainage evaluations is included as Attachment B-3. Attachment B-3 also presents Filter Geotextile Analysis.

e. *The landfill gas collection system design shall account for comingling of MSW and CCR waste.*

   Response: The currently permitted Gas Collection and Control System (GCCS) is not affected by the comingling of CCR and MSW. The GCCS has been designed by taking into consideration the acceptance of MSW which includes non-putrescible waste streams (such as inert debris). Furthermore, unlike putrescible waste that decomposes and generates landfill gas, CCR is considered as inert waste and further degradation is highly unlikely. Hence, landfill gas generation from CCR, if there is any, is anticipated to be very minimal. The design of the GCCS, therefore, would require no further changes and that the GCCS would be able to handle the acceptance of comingled CCR and MSW.

f. *Construction, operation, and maintenance of waste units to be used for CCR disposal shall remain consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR to be disposed.*

   Response: Comingling of CCR with MSW is not anticipated to affect the construction of waste units. Modification to the D&O Plan's specified operation or

maintenance of the waste units are reflected in this CCR Management Plan and revisions addressed herein.

g. *The plan must define any events or circumstances that represent a safety emergency, along with a description of the procedures that will be followed to detect a safety emergency in a timely manner*.

Response: The Landfill facility employs a safety emergency procedure. The facility provides an Emergency Stand Down Flyer (included as Attachment F) to its customers which describes in detail the procedures that need to be followed in the event of an emergency. Additionally, the facility requires its contractors and vendors to undergo a Contractor Safety Orientation training that includes definition of circumstances that represent safety emergency and protocol/procedures to be followed. In the event that emergency evacuation may be required, the facility employees are trained to notify customers, consultants, contractors, vendors, and fellow employees of the evacuation and to meet at the facility's front gate. It is noted that these procedures apply to standard waste handling activities; and acceptance of CCR will not affect these procedures.

h. *The plan must provide a detailed description of leachate and contact water management that demonstrates surface water contacting MSW or CCR will not be discharged into the stormwater management system. Describe or provide details for any required structures (such as chimney drains) and any management practices such as placement of diversion berms between the working face or exposed CCR and the stormwater collection ditches.*

Response: As CCR will be disposed of as comingled with MSW within a permitted lined cell with a LCRS, any contact water will be collected as leachate in the LCRS, and will not be discharged into the stormwater management system. Comingling of CCR will not require revisions to the D&O Plan specified leachate management requirements.

i. *Design calculations supporting the CCR Management Plan are to be performed by or be done under the direction of a Professional Engineer and shall be submitted as auxiliary materials to the Plan.*

Response: The performed design calculations are included with this CCR Management Plan, which is stamped and signed by a Registered Professional Engineer in the State of Georgia

II. *CCR shall not be placed in any previously constructed cell, either comingled or as a monofill, without a demonstration that the cell, as constructed, was designed or can be retrofitted (e.g., lowering of final grades) to accommodate CCR disposal.*

Response: The design calculations presented as Attachment B to this Application are updates to the facility's permitted design calculations and are, as such, applicable to the entire landfill including the previously constructed cells. Design calculations, included in Attachment B, address the Guidance Document requested landfill design consistency considerations and the demonstrations therein are applicable to the previously constructed cells. Based on demonstration of design consistency, no design changes/retrofitting are required in consideration of CCR disposal.

5. *Waste Compatibility Analysis*

The Plan must show that CCR waste is compatible (non-reactive) with MSW or industrial waste streams received at the facility, and that different CCR waste streams received are compatible with one another. In demonstrating compatibility, the plan shall contain at a minimum the following components:

- *List of source(s) of CCR waste streams*

Response: The current sources of CCR for this facility are defined in Section 3 of the Operations Plan narrative on Sheet 32. As with any other industrial or commercial Special Waste stream, generators wishing to dispose of CCR at the landfill are required to follow established procedures to obtain approval for disposal. These include characterizing the CCR by completing Waste Management's EZ Profile Worksheet and providing technical information such as Safety Data Sheets (SDS). Based on the generator provided information for profiling of CCR accepted at the landfill, the composition of CCR consists of ash, coal, soils, and plant life. The enlisted processes from which the CCR material was generated, as described in the profile, include "Maintenance and Cleaning of Boilers, Buildings, Coal and Ash Handling Equipment and Facilities, Coal Piles

and Grounds". Attachment G presents typical waste profiles for CCR material accepted at the landfill.

- *Chemical analyses of CCR waste streams*

  Response: Chemical composition of typical CCR material and compatibility of CCR material with MSW is evaluated and presented in detail in Attachment D.

- *Documentation of compatibility analyses for use in a solidification process, if applicable.*

  Response: The facility will not use CCR for liquid waste solidification.

The chemical analyses may be submitted as auxiliary materials to the Plan. If a new type of CCR is proposed for disposal a plan modification application must be submitted if, based on the above analyses, acceptance of the new CCR material necessitates changes to the facility's design or operations.

Response: If acceptance of a new type of CCR material necessitates changes to the facility's design or operations, a CCR Management Plan modification application will be submitted to the Georgia EPD.

Section 3 of the Operations Plan narrative on Sheet 32 requires EPD approval to be obtained prior to accepting any increases in the maximum CCR to MSW ratio.

6. *Closure and Post-Closure Care Impacts*

The CCR Management Plan shall evaluate impacts to the landfill's closure and post-closure care cost estimates. If CCR management changes either or both of these estimates, these plan sections must be revised to comply with 391-3-4-.11 or 391-3-4-.12. Groundwater monitoring costs should be updated to reflect the additional constituents monitored for landfills that have accepted CCR. If the largest open waste-accepting area increases due to CCR acceptance, closure cost estimates must be updated accordingly.

Response: The Closure/Post Closure Care Plan on Sheet 33 has been revised to address the additional groundwater monitoring costs during post closure care. The closure costs and largest waste accepting area open are unaffected by the CCR management plan.

7. *Groundwater Monitoring*

   Appendix III and IV constituents (including boron) must be incorporated into the facility's groundwater monitoring plan in accordance with 391-3-4-.14(21)(c) and 391-3-4-.14(25).

   Response: Sheet 30A has been added to the Water Monitoring Plan to address the additional groundwater monitoring requirements related to acceptance of CCR waste.

8. *Modification Procedures*

   The CCR Management Plan must be modified and submitted for EPD's approval if changes in either operating procedures or the facility design are necessary to comply with the requirements for CCR management.

   Response: Narrative has been added to Section 52 of the Operations Plan on Sheet 32A to require submittal of a revised CCR Management Plan if changes in either the operating procedures or facility design are necessary due to changes in the CCR waste stream.

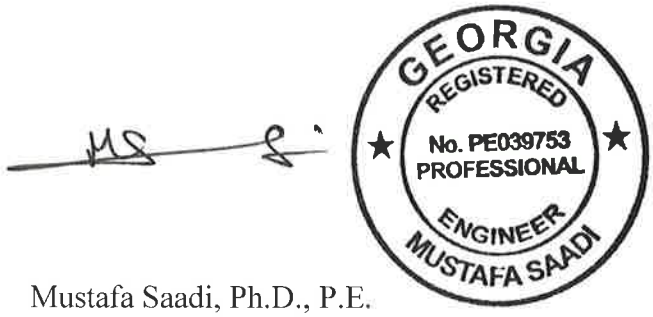
9. *Documentation of Notification to Local Governments*

   The owner or operator shall notify the local governing authorities of the county, and any city within the county, in which the landfill is located upon the initial submittal of a CCR Management Plan or upon submittal of an amended Plan to EPD. Copies of the correspondence to local governing authorities must be provided to EPD with the Plan submittal.

   Response: Narrative has been added to Section 52 of the Operations Plan on Sheet 32A to specify compliance with notification requirements. Documentation of notification to the local governing authority required as part of this initial submittal will be forwarded to EPD.

Geosyntec requests consideration of the above discussed minor modification application for the Turkey Run Landfill. The completed Request for Minor Modification to the Solid Waste Handling Permit form is provided as Attachment H. If you have any questions, please do not hesitate to contact either of the undersigned.

Sincerely,



Rutuparna Joshi, P.E.
Project Engineer

Mustafa Saadi, Ph.D., P.E.
Project Engineer

Enclosures:
- Attachment A – Revised D&O Plan
- Attachment B – Design Calculations Updates
  - Attachment B-1 – Slope Stability Analysis
  - Attachment B-2 – Settlement Analysis
  - Attachment B-3 – Leachate Collection and Removal System Design Calculations: Maximum Head on Liner & Drainage Evaluations
  - Attachment B-4 – Leachate Collection and Removal System Design Calculations: Pipe Structural Stability
- Attachment C – Liner System Compatibility Analysis
- Attachment D – Waste Compatibility Analysis
- Attachment E – Dust Suppression Plan
- Attachment F – Emergency Stand Down Flyer
- Attachment G – Typical CCR Waste Profiles
- Attachment H – Minor Modification Form

Copy to:
- Shawn Carroll, Waste Management
- John Workman, P.E., Waste Management
- Gabriel Gribble, Waste Management

ATTACHMENT A

Revised D&O Plan

DESIGN AND OPERATION PLAN
TURKEY RUN MSW LANDFILL

FOR

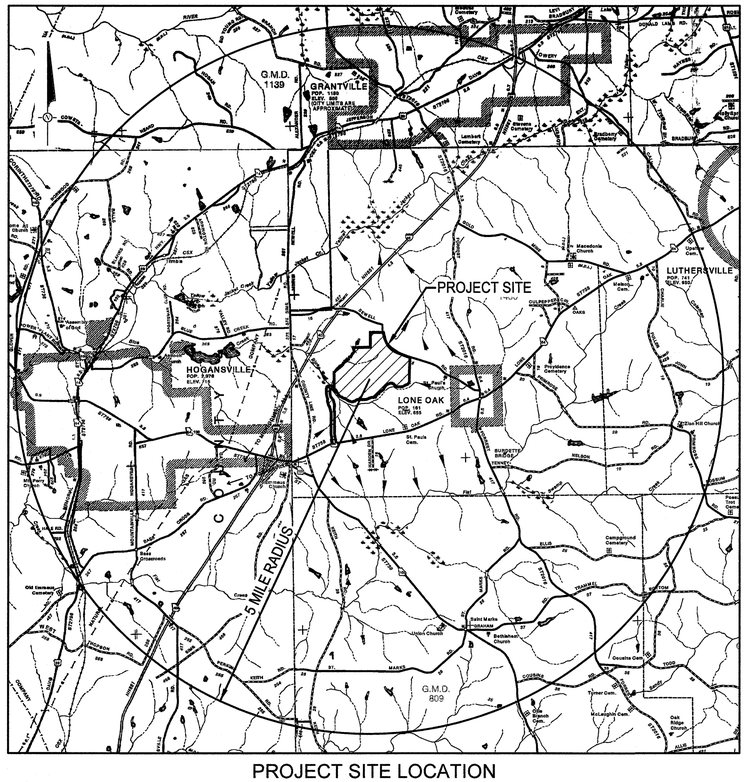
GREENBOW, LLC
MERIWETHER COUNTY, GEORGIA

APRIL, 2007

REVISED: APRIL, 2017

OWNER / OPERATOR / PERMITTEE

GREENBOW, LLC
3001 SOUTH PIONEER DRIVE
SMYRNA, GA 30082
(404) 898-9252



PROJECT SITE LOCATION

SCALE: 1" = 1 MILE

RESPONSIBLE OFFICIAL

GENE BARNES, DIRECTOR OF DISPOSAL
GREENBOW, LLC
1850 PARKWAY PLACE
SUITE 600
MARIETTA, GA 30067
(770) 590-3307

HODGES, HARBIN, NEWBERRY
& TRIBBLE, INC.

484 MULBERRY STREET, SUITE 265 - MACON, GEORGIA 31201
P.O. BOX 974 - MACON, GEORGIA 31202
(478) 743-7175

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

GEORGIA REGISTERED No. PE039753 PROFESSIONAL ENGINEER MUSTAFA SAADI

5 April 2017

TURKEY-TS-R6
9-17-10

MODIFICATION HISTORY

MOD. No.	REV. DESCRIPTION	MOD. TYPE	AFFECTED SHEETS	PREPARED BY (FIRM)	APPROVAL DATE
1	Alignment change to access road by pond #1	Minor	Shts. 5 thru 10, 15 thru 25 & 27	HHNT	10/21/2008
2	Transfer of ownership from Greenbow, LLC to Georgia Waste Systems, Inc.	Minor	NONE	Greenbow	1/22/2009
3	Addition of 125,000 gal temporary leachate tank	Minor	Title sheet, 7 & 32	HHNT	6/9/2009
4	Revision to mound leachate stone above protective cover	Minor	Title sheet & 41	HHNT	2/11/2010
5	Addition of 4-inch underdrain	Minor	Shts. 7 & 41	HHNT	3/11/2010
6	Addition of non-potable water well & supply system, rumble strip facility for sediment removal, revised groundwater well schedule, revised methane monitoring well design, amended marker post detail, revised groundwater monitoring sampling procedures (low flow w/pumps)	Minor	Title sheet, 1,6, 27 thru 31 & 42	HHNT	2/11/2010
7	Addition of a landfill gas collector along the perimeter cell sideslope	Minor	Title sheet, 7 & 41	HHNT	2/11/2010
8	Use of synthetic tarps as ADC, removal of intermediate cover between lifts, clarification that slope berms are constructed during final closure, allow facility operator to implement additional e&s measures, optional grass seeding, remove GA. PE rqmt for special waste protocol, addition of filter bays in pond #1.	Minor	Shts. 6,32,42	HHNT	11/2/2010
9	Allow second working face to help bring new cells online	Minor	NONE	WM	10/26/2011
10	Remove scale pits from MM monitoring, revised lab analysis to use SW-846 & other GW sampling & analysis changes, elimination of fence and removal of soil stockpile volume.	Minor	Shts. 28,30 thru 32 & 45	ACC	4/23/2012
11	Added process to apply leachate to working face	Minor	Shts. 0,32	ACC	2/8/2013
12	Revision to final cover system compacted soil thickness and permeability requirement, closure cost estimate, compacted clay liner and low permeability soil liner permeability test failure retesting requirements, interface friction test frequency and requirements, drainage burrito details, and soil berm and downdrain detail; correction of discrepancy in cap protective cover native soil permeability requirement ($k \geq 1x10^{-5}$ cm/s); revised distance between crest of liner and anchor trench to 3 ft and tie-in of final cover and liner membranes; removed requirement of duplicate leachate risers at sump; and added detail for leachate cleanout and riser pipe penetration through final cover for future cells 3A-10B.	Minor	Title sheet, Shts. 0, 1, 11-14, 32-36, 39, 40, 41, & 41A (added)	Geosyntec	6/16/2014
13	Add location of proposed blower/flare station and add language regarding soil for operational purposes	Minor	Title sheet, Shts. 0, 1, 6, 7, 8, 32	Geosyntec	8/4/2015
	Add detail sheet for proposed blower and flare system	Minor	41B (added)	Carlson Environmental Consultants	
14	Add location of proposed compressor building adjacent to the blower/flare station	Minor	Title sheet, Shts. 0, 1, 6, 7, 27	Geosyntec	3/18/2016
15	Add Coal Combustion Residuals (CCR) Management Plan narratives and revisions including revisions to landfill operations in the Operations Plan, revisions to the groundwater monitoring requirements in the Water Monitoring Plan and cost updates to the Closure/Post-Closure Care Plan.	Minor	Title sheet, Shts. 0, 1, 30A (added),32, 32A (added), 33	Geosyntec	

1

ATLANTIC COAST CONSULTING, INC.
630 Colonial Park Dr.
Suite 110
Roswell, GA 30075
o 770.594.5998
www.atlcc.net

PROJECT:

TURKEY RUN LEACHATE APPLICATION TO WORKING FACE

WASTE MANAGEMENT
1850 PARKWAY PLACE
SUITE 600
MARIETTA, GEORGIA 30067
(770) 590-3307

REVISIONS

Drawn by: SP

Checked by: DG

PROJECT NUMBER:

I002-302

November 2012

MODIFICATION HISTORY

Sheet 0 of 45

1 REVISED: APRIL 5, 2017 - ADDED MODIFICATION NO. 15
REVISED: OCTOBER 27, 2015 - ADDED MODIFICATION NO. 14
REVISED: JULY 27, 2015 - ADDED MODIFICATION NO. 13
REVISED: DECEMBER 23, 2013 - ADDED MODIFICATION NO. 12

Geosyntec consultants
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SIGNATURE

5 April 2017
DATE

GEORGIA REGISTERED No. PE039753 PROFESSIONAL ENGINEER MUSTAFA SAADI

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REVISED: OCTOBER 15, 2009 - RUMBLE STRIP, MAINTENANCE SHOP & WATER FACILITY
REVISED: NOVEMBER 5, 2007 - ADDRESS EPD COMMENTS

THIS DOCUMENT ORIGINALLY ISSUED AND SEALED BY WILLIAM F. HODGES, P.E. #15689 ON 10/22/09 AND R BRANT LANE, P.E. #27185 ON 10/22/09. THIS MEDIUM SHALL NOT BE CONSIDERED A CERTIFIED DOCUMENT.

1 REVISED: APRIL 5, 2017 - REVISED TITLE SHEET, SHEET NOS. 0, 1, 32, AND 33 AND ADDED SHEET NOS. 30A AND 32A
REVISED: JULY 27, 2015 - ADDED SHEET NO. 41B
REVISED: DECEMBER 23, 2013 - ADDED SHEET NO. 41A

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5 April 2017
DATE

GEORGIA REGISTERED No. PE039753 PROFESSIONAL ENGINEER MUSTAFA SAADI

ATLANTIC COAST CONSULTING, INC.
630 Colonial Park Dr.
Suite 110
Roswell, GA 30075
o 770.594.5998
www.atlcc.net

PROJECT:
TURKEY RUN LEACHATE APPLICATION TO WORKING FACE

WASTE MANAGEMENT
1850 PARKWAY PLACE
SUITE 600
MARIETTA, GEORGIA 30067
(770) 590-3307

REVISIONS

Drawn by: SP
Checked by: DG

PROJECT NUMBER:
I002-302
November 2012

INDEX TO DRAWINGS AND LEGEND

NOTE: THE FOLLOWING NARRATIVE IS ADDED TO THE "SAMPLING AND ANALYSIS PLAN" SECTION DESCRIBED ON SHEET 30.

COAL COMBUSTION RESIDUAL GROUNDWATER MONITORING ANALYTE REQUIREMENTS:

All groundwater wells at the facility will be sampled semi-annually for the list of parameters included in Appendix III of 40 CFR 257 (In addition to the parameters included in Appendix I/II of the Rules for Solid Waste Management - as documented on Sheet 30). Parameters included in Appendix III of 40 CFR 257 are shown in table below. Appendix III data will be evaluated in accordance with the statistical analysis plan. In the event of a verified SSI for an Appendix III specific compound in a groundwater monitoring well sample, the list of analytes will be expanded to include those listed in Appendix IV of 40 CFR 257.

40 CFR 257 APPENDIX III ANALYTICAL REQUIREMENTS				
PARAMETER SUITE	**CONTAINER TYPE**	**TEST METHODS***	**PRESERVATIVES**	**HOLD TIME**
BORON, CALCIUM	P	6010 OR 6020	HNO_3	180 DAYS
CHLORIDE, FLUORIDE, SULFATE	P	300/9056	4 °C	28 DAYS
pH	NONE	FIELD MEASUREMENT	NONE	NONE
TOTAL DISSOLVED SOLIDS	P	SM 2540C	4 °C	7 DAYS

Notes:
P = Polyethylene
°C = degrees Celsius

Assessment monitoring analytes are included in Appendix IV 40 CFR 257. The NELAP certified laboratory performing the analysis should be consulted regarding analytical requirements for the applicable parameter suites.

* Analysis methods from "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" SW-846 Third Ed. USEPA, Sept. 1986. It is noted that analytical methods used and referenced for meeting environmental testing requirements evolve over time due to changes in technology, updates and additions to published methodology, and when regulations change to require reference to different methods. In many instances there are equivalent methods for the same analyte published by different authorities on method development; e.g. the U.S. Environmental Protection Agency (EPA) Office of Water, U.S. EPA Office of Solid Waste, Standard Methods, and ASTM. Analytical methods listed in the plan may be substituted provided that the alternate methods are generally approved for use, provide technically defensible data, and are appropriate for the media being tested. The use of alternative approved methods is considered an acceptable deviation from the prescribed methods in the Water Monitoring Plan and will not be considered a violation of the requirements of the Water Monitoring Plan.

MARTHA K. CARR
NO. PG001139
GEORGIA REGISTERED PROFESSIONAL GEOLOGIST

I hereby certify that I am a qualified groundwater scientist, in accordance with the Rules of Solid Waste Management, and 40 CFR Part 258.50(g). A qualified ground-water scientist is a scientist or engineer who has received a baccalaureate or post-graduate degree in the natural sciences or engineering and has sufficient training and experience in groundwater hydrology and related fields as may be demonstrated by State registration, professional Certifications, or completion of accredited university programs that enable individuals to make sound professional judgements regarding ground-water monitoring, contaminant fate and transport, and corrective-action.

Signature: Martha K Carr

Date: 5 April 2017

REV	DATE	DESCRIPTION	DRN	APP

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TITLE: WATER MONITORING PLAN (CONTINUED)

PROJECT: DESIGN AND OPERATION PLAN - MINOR MODIFICATION

SITE: TURKEY RUN MSW LANDFILL

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

5 April 2017
DATE

GEORGIA REGISTERED No. PE039753 PROFESSIONAL ENGINEER MUSTAFA SAADI

DESIGN BY:	MC	DATE:	APRIL 2017
DRAWN BY:	RVJ	PROJECT NO.:	GR6304
CHECKED BY:	MC	FILE:	Turkey-CCR-GW
REVIEWED BY:	MC	DRAWING NO.:	30A OF 45
APPROVED BY:	MS		

L:\ACAD\TURKEY RUN LANDFILL\MINOR MODIFICATION\MINOR MODIFICATION GD\SHEETS\DRAWINGS\MINOR MODIFICATION APRIL 2017_GR6304M002-302-_24 OPERATIONS_PLAN - REV1_MOST CURRENT

OPERATIONS PLAN

1. VOLUME CALCULATIONS:

(A) Total volume of waste & cover	35,151,695	cubic yards
(B) Total Cover Material and Earth Fill Required	5,292,676	cubic yards
Daily Soil Cover (est)	1,406,108	cubic yards
Intermediate Soil Cover (est)	1,406,108	cubic yards
Final Soil Cover	1,149,632	cubic yards
Earth Fill Required	1,330,828	cubic yards
Available (on-site)	2,378,782	cubic yards
Imported	2,913,914	cubic yards
(C) Total Waste Volume	31,189,847	cubic yards

Maximum CCR to MSW Ratio By Weight:	1:9	
Estimated CCR Tonnages:	180	TN/day
	51,650	TN/year
Estimated MSW Tonnages:	1,620	TN/day
	464,850	TN/year
Estimated Total (MSW+CCR) Tonnages:	1,800	TN/day
	516,500	TN/year

(D) Area of Site - Total area of Permit ±417.54 acres
Usable Area for Landfilling ±192.59 acres
(E) Estimated Life of Landfill 30-40 years

2. CONTROLLED UNLOADING OF WASTES:
Municipal Solid Waste (MSW) and Coal Combustion Residuals (CCR) unloading shall be restricted to the working face (Maximum 200' x 200') of the cell in such a manner that waste may be easily incorporated into the solid waste landfill with available equipment. CCR and MSW shall be co-mingled at the working face. Scavenging shall be prohibited. With notification to EPD and approval to receive waste, the operator may choose to maintain two working faces for a period of 90 days after entering a newly constructed landfill cell. This will enable refuse that could potentially damage the FML liner to be placed in a lift other than the first lift.
For initial placement of waste, the first 10-ft thick lift placed on top of the 24-inch protective cover soil shall be select MSW and shall not contain CCR.

Operators will be trained to identify conditions that may impact CCR compaction and will observe the incoming CCR for excess moisture content.

In the event that CCR waste loads are brought to the facility containing excess moisture, the waste material will be spread in a staging area over intermediate cover and allowed to dry prior to incorporating it into the waste mass.

3. CCR WASTE CHARACTERIZATION AND COMPATIBILITY:
The facility's source of CCR is Southern Company. MSW to CCR ratios that exceed those defined in Section 1 of this plan shall be permitted through EPD prior to accepting increased ratios.

If operations indicate CCR reactivity with MSW, bulk samples of CCR from each source will be obtained for characterization and compatibility. Typically, samples will be tested for Toxicity Characteristic Leaching Procedure (TCLP) 8 RCRA metals by SW-846 Method 1311 and a Paint Filter Test by SW-845 Method 9095, or current equivalent method. Other analysis may be conducted as requested by Waste Management Technical Service Center (TSC).

4. CCR WASTE ACCEPTANCE PROTOCOL:
CCR is defined by the US Environmental Protection Agency as a solid waste to be regulated under Subtitle D (EO 12866 CCR 2050-AE81). CCR waste accepted for disposal at this facility will not require non-hazardous certification. Routine record keeping procedures as specified under Section 38 of this plan (i.e., Operations Plan) will be followed.

5. SPREADING AND COMPACTION:
MSW and CCR co-mingled with MSW shall be spread in uniform two foot layers and compacted to its smallest practical volume, by 3 to 5 passes with compaction equipment, before covering with earth. The working face shall have a maximum 4:1 slope when using a compactor and a maximum 3:1 slope when using a track type machine.

6. DAILY COVER:
A uniform compacted 6" thick layer of clean earth shall be spread over all MSW and CCR co-mingled with MSW at the end of the day's operations. Synthetic Tarps, which have been designed and manufactured for use as daily cover in landfills, may be used as an alternate daily cover. Tarps of sufficient size will be utilized to cover the working face, which will not exceed 200' x 200'. The tarps shall be Amoco 2044 and 2006 woven polypropylene tarp or equivalent.

In order to assit with compactive effort, site generated leachate will be applied to the landfill working face throughout the operational day. Leachate will be loaded into a fully enclosed tanker truck at the leachate tank storage area. The tanker will be dedicated to the process of leachate transport, and be of sufficient size to enable easy maneuvering around the working face. Leachate will be sprayed directly onto the active working face in such manner and rate that no runoff from the active disposal area will occur.

Procedures to be followed with the application process are as follows:
(1) Leachate will be applied to the working face at a rate of 25 gallons per ton to minimize the potential of excess liquid application;
(2) Leachate will not be applied on any day where precipitation is falling, or when the chance of precipitation is equal to or greater than 70%;
(3) Leachate will not be applied to waste that will make up an outside slope;
(4) A record shall be maintained on site to record the daily tons accepted and the volume of leachate applied to the working face.

All daily and alternate daily covers shall meet the following standards:
(1) The daily cover must be capable of preventing attraction of disease vectors, minimizing production of odors, and preventing blowing litter.
(2) Must be capable of completely covering the solid waste without change in the cover's properties by rain, heat, cold and other climatic conditions.
(3) Must be substantially free of rock fragments that are greater than 6" in diameter.
(4) Material for daily cover shall come from future cell excavation and borrow areas.

Cover material shall be excavated from on-site borrow areas. Any off-site cover material used shall come from a permitted source.

7. INTERMEDIATE COVER:
If more than one lift is required in a cell, a uniform compacted layer of clean earth cover not less than one foot in depth shall be placed over each intermediate lift. One foot of intermediate cover shall be placed on all MSW and CCR co-mingled with MSW disposal areas exposed more than one month. This cover material shall meet the same criteria for daily cover plus be capable of supporting the germination and propagation of vegetative cover.

Intermediate and daily cover may be removed from the top of each lift of waste prior to the placement of the next lift of waste in order to promote the downward migration of leachate. Cover soil shall only be removed from the landfill area that will be re-covered with the same day's receipt of incoming waste. This cover removal shall be performed at the Operator's discretion.

8. FINAL COVER:
The final cover system is designed to reduce infiltration and erosion. The erosion layer will be composed of 24" of soil capable of sustaining native plant growth. The infiltration layer will be composed of a geocomposite drainage layer, a 40 mil FML textured liner, and 12" of compacted soil material. The final cover system is installed on top of the existing intermediate cover. Side slope Drainage Berms as shown on the Final Drainage Plan (Sheet No. 9) shall be installed concurrently with final cover system installation.

Soil, for operational purposes (daily, intermediate and final cover), will be excavated from onsite borrow areas that are within the landfill's permitted waste footprint. The activity will be performed under the Georgia General Storm Water Permit GAR050000 entitled "Authorization to Discharge Under the National Pollutant Discharge Elimination System Storm Water Discharges Associated With Industrial Activity." Erosion and sediment control measures for maintaining compliance with respect to the Industrial Storm Water Permit are included in the Erosion Control Plan within this document and will be enacted prior to and maintained throughout the excavation activity.

9. GRADING AND DRAINAGE:
The disposal site shall be graded and drained to reduce runoff onto the landfill, to reduce erosion, and to drain water from the surface of the landfill. All construction grades will be a minimum of 3% to promote drainage. Final slopes shall be between 3% and 33%, shall be graded relatively smooth, and shall be vegetated.

10. FIRE PROTECTION:
The disposal site shall be designed, constructed, maintained, and operated to reduce the potential for fire or explosion. Suitable measures to control fires that may start shall be provided. A minimum supply of one day of cover material, minimum 750 cubic yards, must be maintained within 200 feet of the working face for fire fighting purposes.

11. SITE SUPERVISION:
Overall site supervision will be accomplished by the Landfill Supervisor. The Landfill Supervisor shall be a Certified Landfill Operator in accordance with O.C.G.A. 12-8-24.1. A copy of the approved Design and Operation Plan shall be kept at the site at all times. EPD shall approve any changes in the approved plans, prior to implementation. The on site supervisor shall be properly trained in the operation of municipal solid waste landfills, the implementation of design and operational plan, and must be present at all times during operation.

12. CONTINUITY OF OPERATION:
Access to fill location areas will be maintained to insure continued operation during wet weather. All areas of the site are considered adequate for wet weather operations. Provisions shall be made for prompt equipment repair or replacement when needed.

13. SILTATION AND EROSION CONTROL:
Erosion and sediment control measures and devices shall be installed in accordance with the plans and detail drawings. All erosion and sedimentation control measures or facilities, whether temporary or permanent, shall be continuously maintained by the operator so as to be effective. Runoff from the facility must be directed to permanent sediment control impoundments which are designed to assure discharges meeting the requirements of O.C.G.A. 12-7-6(18). Erosion and sedimentation control measures and facilities will be employed prior to and concurrent with clearing, grading, overburden removal, access or other land disturbing activities for preparation of the site for landfilling. Any construction that is required to be covered under the NPDES Construction Activity Permit, the facility will file a NOI and comply with the permit. Immediate measures must be implemented to establish vegetation on disturbed exposed soil which will not be a part of the waste disposal area or which will remain exposed for more than three (3) months.

Erosion, sedimentation control, and pollution prevention measures in addition to the measures shown in this plan may be installed as directed by the Operator to control erosion and pollution. These measures may include, but are not limited to, practices such as check dams, erosion control matting, polyacrylamide, mulching, diversion berms, downdrain pipes, sediment traps, rip-rap, ditch lining fabric or other ditch protection, and silt fence. Interim drainage berms and structures, if installed, shall be placed at locations determined by the owner, however they will generally be located in the vicinity of the berms and drainage structures shown on the final drainage plan. As may be required by Georgia EPD, construction activities on site will be covered under the NPDES General Permit for Construction Activities. This may also require additional erosion control plans and protection measures.

14. VEGETATIVE PLAN:
All disturbed areas shall be grassed and maintained in accordance with the following schedules. Vegetative cover of the final cover must take place within two weeks after final cover placement. Any disturbed areas which will remain exposed for longer than three (3) months and permanent covers which are slow to establish shall receive temporary seeding. The fertilizer requirements are suggested.

Planting dates, fertilizer rates, and seeding rates shall meet the requirements in the Manual for Erosion and Sediment Control in Georgia. Alternate grass types and/or sod may be used at the Landfill Operator's discretion.

SEEDS - PERMANENT	LBS/ACRE	DEPTH OF COVER	DATE OF PLANTING
BERMUDA, COMMON - HULLED	10	1/4" - 1/2"	3/1 - 6/30
FESCUE, TALL	50	1/4" - 1/2"	3/1 - 4/15 & 8/15 - 10/31
SEEDS - TEMPORARY	**LBS/ACRE**	**DEPTH OF COVER**	**DATE OF PLANTING**
RYEGRASS, ANNUAL	40	1/4" - 1/2"	8/1 - 4/15
MILLET, PEARL	50	1/4" - 1/2"	4/15 - 8/31

NOTE:
1. All seeding rates are pure live seed rates.
2. All seeding shall be mulched with clean dry hay at the rate of 2.5 tons per acre. Mulch shall be anchored by pressing the mulch into the soil immediately after the mulch is spread using a packer disk or disk harrow or equivalent piece of equipment.
3. Temporary seeding should also complement permanent seeding to produce a suitable cover while the permanent grasses germinate.
4. Disturbed slopes greater than 3%, including soil stockpiles, are to be mulched immediately.

FERTILIZER REQUIREMENTS				
TYPE OF SPECIES	YEAR	ANALYSIS OR EQUIVALENT N-P-K	RATE	N TOP DRESSING RATE
1. Cool season grasses	First	6-12-12	1500 lbs./ac.	50-100 lbs./ac.(1)(2)
	Second	6-12-12	1000 lbs./ac.	-
	Maintenance	10-10-10	400 lbs./ac.	30
2. Cool season grasses and legumes	First	6-12-12	1500 lbs./ac.	0-50 lbs./ac.(1)
	Second	0-10-10	1000 lbs./ac.	-
	Maintenance	0-10-10	400 lbs./ac.	-
3. Temporary cover crops seeded alone	First	10-10-10	500 lbs./ac.	30 lbs./ac.(3)
4. Warm season grasses	First	6-12-12	1500 lbs./ac.	50-100 lbs./ac.(2)(4)
	Second	6-12-12	800 lbs./ac.	50-100 lbs./ac.(2)
	Maintenance	10-10-10	400 lbs./ac.	30 lbs./ac.
5. Warm season grasses and legumes	First	6-12-12	1500 lbs./ac.	50 lbs./ac.(4)
	Second	0-10-10	1000 lbs./ac.	-
	Maintenance	0-10-10	400 lbs./ac.	-

NOTE:
1. Apply in spring following seeding.
2. Apply in split applications when high rates are used.
3. Apply to grass species only.
4. Apply when plants grow to a height of 2 to 4 inches.

15. SURVEY CONTROL:
Survey control will consist of both temporary and permanent control markers. Permanent markers will establish the "permanent", or lifelong horizontal and vertical control such as the edge of each cell, leachate cleanouts, and monitoring points. Horizontal control consists of northing and easting (X-Y) coordinates. The X-Y coordinate establishes a single horizontal point on the earth which can be reestablished at any time based on this single location. Vertical control is an elevation measured above a datum (z). The datum is Mean Sea Level (MSL).
Vertical control for this site is determined from a survey to a United States Geological Survey (USGS) control monument. Utilizing survey methods carried out be a Registered Land Surveyor (RLS), the permanent survey control has been established.

Temporary Survey control consists of monuments and stakes installed by an RLS. Examples of temporary control can include temporary monuments with X-Y-Z coordinates for operator guidance and construction accuracy. This will include survey control markers along the temporary edge of liner and posts within a cell which indicate the extent of fill in a particular lift. Additionally, temporary control can include construction stakeout. Construction stakeout will require the RLS to place stakes and off- set stakes at the location where specific construction elements will be installed. These stakes will be installed to designate the single specific X-Y-Z coordinate point on the earth where that constructed element will be built. The primary purpose of site survey control, as required by the rules is: "Site survey control shall be provided to ensure the operation will be on permitted lands." The rule further states:

"Survey control will be accomplished through use of permanent, accessible benchmarks, survey control stakes, and/or boundary markers which designate and/or delineate all permitted areas. Survey control shall be indicated on the design and operational plan. Where necessary for construction or operational purposes vertical as well as horizontal survey control will be established and maintained to delineate fill boundaries, buffers, and property boundaries. For this site, survey control will be utilized for construction, operations, delineating fill boundaries, buffers, and property boundaries. Also, survey control will be utilized for other items as required by the operator."

16. WATER MONITORING:
The surface water and groundwater monitoring wells shall be monitored according to the approved Environmental Monitoring Plan and the Water Monitoring Plan.

17. METHANE GAS CONTROL:
Methane gas control shall include quarterly sampling for methane gas at the locations shown on the plans and monitoring for possible stressed vegetation due to methane gas movement. Monitoring points are based upon site geology, topography, and location of on-site or adjacent structures. Results of monitoring and sampling shall be submitted to the Atlanta (International Parkway) Office of the EPD (Solid Waste Management Program) within 15 days of a test. The concentration of methane generated by the facility shall not exceed 25% of the lower explosive limit for the gases in facility structures and shall not exceed the lower explosive limit for methane at the facility property boundary.

The owner/operator shall apply for and obtain air quality permits under TITLE V and NSPS requirements of the Georgia and Federal rules for air quality. The design of the gas system will be submitted to the Air Protection Branch for approval. These permits applications, the permits, and any plans for landfill gas extraction and control shall be placed in the facility operating record, and a letter demonstrating these have been added shall be submitted to the EPD Solid Waste Program.

18. LEACHATE OUTBREAKS:
The cause of leachate outbreak(s) will be assessed followed by corrective measures which will include a minimum of 12" of compacted soil and grassed in accordance with the Vegetation plan.

19. SITE EQUIPMENT:
Minimum suggested equipment for this site includes:
CAT 826 Compactor Road Grader Various Pumps
Dozers Farm Tractor
Off-Road Trucks Water Wagon or Water Truck

Equipment shall be maintained on a regular basis and kept in good working order. From time to time, this equipment may be replaced with similar equipment or additional equipment rented for cleaning sediment from basins.

20. BACKUP EQUIPMENT:
Rental equipment shall be used for backup equipment and for cleaning sediment from basins.

21. DIRECTIONAL AND INFORMATION SIGNS:
Directional and informational signs will be located at the site which indicate the days and hours of operation. Temporary information and directional signs shall be used at the operator's discretion to direct vehicles to the active working face. Access to the site will be limited to those times when authorized personnel are on duty.

22. LITTER CONTROL:
Scattering of wastes by wind shall be controlled by fencing or other barriers and the entire site shall be inspected daily and all litter removed.

23. DUST CONTROL:
Dust control will be provided, if deemed necessary, through the use of a water wagon and shall be limited to site roadways.

Water wagon or water truck will be used to spray water in the CCR and MSW co-mingled disposal areas, if necessary. Fugitive dust from the CCR disposal areas will be minimized in accordance with Air Quality Rule 391-3-1-.02(2)(n)1 and will not exceed the limits defined therein.

Fugitive CCR dust complaints from citizens will be logged via Waste Management's 1-800 Public Comment Number and will be placed in the facility's records. The records will be made available to EPD for inspection.

The owner will prepare and submit to EPD an Annual Fugitive Dust Control Report. The report will be submitted every 12 months subsequent to approval of the original CCR Management Plan. The Annual Fugitive Dust Control Report will include the following:
A. Description of actions taken to control fugitive dust.
B. Record of all citizen complaints related to fugitive dust.
C. A summary of corrective actions taken and recommendations to improve fugitive dust control measures (if applicable).

24. ON-SITE FIRST AID:
A first aid kit will be available on the site.

25. SITE COMMUNICATIONS:
A telephone will be available on site.

26. EMPLOYEE FACILITIES:
Sanitary facilities including a potable water supply will be available on site.

27. THIS ITEM NOT USED.

28. ON-SITE SOLID WASTE PROCESSING PERFORMED:
(See item number 50 for processing).

29. WASTE REQUIRING SPECIAL HANDLING:
A. Asbestos waste may be disposed of at this site at the operator's discretion. Listed below are the procedures for its disposal.

1. Asbestos containing waste shall be sealed in leak-proof containers labeled with: "Caution-Contains Asbestos Fibers - Avoid Opening or Breaking Container - Breathing Asbestos is Hazardous to Your Health."

2. Asbestos containing waste shall be disposed of in such a manner as not to destroy the integrity of the asbestos containers prior to the placement of cover material. This waste shall be completely covered immediately after deposition with a minimum of six (6) inches of non-asbestos material.

3. Disposal of asbestos is to conform to applicable sections of 40 CFR Parts 61.140 to 61.156, specifically 61.151 and 61.1(g)(h)(i). Site should only accept asbestos that has been recovered and transported in accordance with the applicable NESHAP regulations (parts 61.140 - 61.156).

4. Asbestos, disposed of in the landfill, shall be located according to cell,site coordinates, and documented in the operating record as well as the amount of asbestos in cubic yards or pounds.

B. Recycle Material - see Item 50

30. SITE CLOSURE:
The site will not be closed until all wastes have been covered or disposed of by a adequate method of disposal so that the site will be in full compliance with section 391-3-4-.11 and .12 of the Rules and Regulations for Solid Waste Management, Chapter 391-3-4. The Closure and Post-Closure Care Plan for this site is described in the narrative plans attached.

31. SEPARATE DISPOSAL AREAS FOR WASTE REQUIRING MONTHLY COVER:
Not Applicable.

32. ZONING:
This site has been appropriately zoned for Meriwether County.

33. SITE ACCEPTABILITY CONDITIONS:
The following Site Limitations for the Meriwether County - Greenbow, LLC Turkey Run MSWL, Proposed Municipal Solid Waste Disposal Facility, were issued by the Environmental Protection Division in a letter dated March 6, 2007.

1. The area considered for suitability includes only that 608.24 acre area shown on Donaldson, Garrett & Associates, Inc.'s Boundary Survey dated June 28, 2006.

2. No waste shall be placed south of Blue Creek, as shown on Hodges, Harbin, Newberry & Tribble, Inc.'s Sheet 1 of 1: Topographic Survey, dated September 2006, and edited September 7, 2006. Blue Creek is unnamed on the Survey; however, it enters the site near the middle of the eastern property boundary and exits in the southwestern corner of the site.

3. A minimum 500-foot buffer shall be maintained between the waste disposal area and any adjacent residences and/or water supply wells.

4. A minimum 200-foot undisturbed buffer shall be maintained between the waste disposal area and the Property Line shown on the above-referenced Boundary Survey.

5. A minimum 150-foot undisturbed buffer shall be maintained between the waste disposal area and all streams shown on the above-referenced Topographic Survey.

6. A minimum 50-foot undisturbed buffer shall be maintained between the waste disposal area and the jurisdictional wetlands shown on the above-referenced Topographic Survey, unless otherwise permitted by the United States Army Corps of Engineers.

7. No construction activities shall be allowed in the floodplain areas of the site. Since no base flood elevations have been determined for Blue Creek, a minimum 10-foot undisturbed vertical buffer shall be maintained between the waste disposal area and Blue Creek, as shown on the above-referenced Topographic Survey.

8. If, during construction of the site, any springs or seeps are discovered, EPD shall be immediately notified and protective measures shall be incorporated into the facility's design and operations plans to prevent contamination of the spring or seep. Sampling of the spring or seep shall also be incorporated into the facility's surface water sampling plan.

9. A liner and leachate collection system shall be placed beneath all areas proposed for waste disposal. The liner system shall not be placed within 5 feet of seasonal high groundwater elevations. Therefore, a minimum 5-foot separation shall be maintained between the bottom of the liner system and the potentiometric surface depicted on Bunnell-Lammons Engineering, Inc's Figure No.11: Composite Seasonal High Water Table Elevation Contour Map, dated August 16, 2006.

The liner system shall not be placed within 5-foot of bedrock. Therefore, a minimum 5-foot separation shall also be maintained between the bottom of the liner system and the bedrock elevations shown on Bunnell-Lammons Engineering, Inc.'s Figure No.9: Estimated Top of Bedrock (Auger Refusal) Elevation Contour Map, dated August 16, 2006. If bedrock is encountered above groundwater during construction/grading activities at the site, at least 5 feet of clean, rubble-free soil shall be emplaced beneath the liner system in that area. No blasting shall be allowed at the site.

10. All borings and/or piezometers located within the proposed landfill footprint shall be abandoned by overdrilling and filling with a non-shrinking cement/bentonite mix via treme pipe. A report documenting the abandonment of all on-site borings and piezometers shall be submitted to EPD prior to the cell construction. This documentation shall be signed and stamped by the responsible professional geologist or professional engineer registered to practice in the State of Georgia.

11. Groundwater, surface water, and methane monitoring systems shall be installed at the site. At least 4 groundwater monitoring wells shall be installed to monitor fracture zones in bedrock at the site. The placement of the rock wells shall coincide with the fracture trace plots and lineament traces apparent at the site. Sampling paraments, sampling schedules, monitoring well construction and spacing shall adhere to the guidelines in EPD's Rules of Solid Waste Management, Chapter 391-3-4.

12. All erosion control measures and/or diversion ditches shall conform to the Erosion and Sediment Control Act and be protective of Blue Creek and its perennial and intermittent tributaries.

13. All recommendations suggested in Section 5.0 - Geotechnical Considerations of the Site Hydrogeologic Assessment Report, Proposed Turkey Run MSW Landfill, Meriwether County, Georgia dated August 16, 2006 and prepared by Bunnell-Lammons Engineering, Inc. shall be followed.

34. LIMITED ACCESS:
The Georgia Rules require limited access: a gate or other barrier shall be maintained at potential vehicular access points to block unauthorized access to the site when an operator is not on duty. A fence or other suitable barrier must be provided around the site, including impoundments, leachate collection and treatment systems and gas venting and processing facilities, sufficient to prevent unauthorized access." At the Turkey Run MSW Landfill, this vehicular access control is accomplished by use of natural and
manmade structures. The entire perimeter of the site is heavily wooded. Tree spacing and undergrowth are sufficient to prevent vehicular access. In addition, a 6' high chain link fence will be installed along the entire property boundary to limit access into the site. Where roads enter the facility boundary, a gate will be installed to control access. The perimeter of the site will be posted with signs notifying the public that this is a "Municipal Solid Waste Landfill Facility" and that access is prohibited except at the site entrance. The combination of a natural wooded barrier, access control gates, 6' high chain link fence, and adequate signage will provide a suitable barrier around the site.

35. ENVIRONMENTAL PROTECTION:
The landfill shall be operated in such a manner as to prevent air, land, or water pollution, and public health hazards.

36. HAZARDOUS WASTE:
The operator shall have a prohibited waste exclusion plan for excluding prohibited wastes. Excluded wastes include lead acid batteries, radioactive waste, regulated quantities of hazardous waste, polychlorinated biphenyl (PCB) waste as defined in 40 CFR, Part 761, and liquids as allowed in Paragraph 35. The prohibited waste exclusion plan is attached.

37. LIQUID WASTES:
(A) No liquid waste, either bulk or containerized, shall be placed in the landfill unless containerized in a container of one (1 gallon capacity or less. No generator may discard in excess of four (4) gallons of liquids in containers.

(B) "Liquid Waste" means any waste material that is determined to contain "free liquids" as defined by Method 9095 (Paints Filter Liquids Test), as described in "Test Methods for the Evaluation of Solid Wastes, Physical/Chemical Methods" (EPA Pub. No. SW-846).

NOTE: THE NARRATIVE FOR OPERATIONS PLAN IS CONTINUED ON SHEET 32A.

PROHIBITED WASTE EXCLUSION PLAN

1. GENERAL:
Pursuant to the Rules for Solid Waste Management, Chapter 391-3-4-.07-(3)-(c)&(m), the Operator has developed this plan to exclude prohibited waste from being disposed at this facility. These prohibited materials include liquids, lead acid batteries,biomedical waste, sewage sludge, radioactive wastes, polychlorinated biphenyl (PCB) waste as defined in 40 CFR, Part 761, and regulated quantities of hazardous waste. It shall also be the policy of the Operator to identify quantities of hazardous waste below the regulatory threshold and to exclude these wastes also.

2. NON-CONFORMING WASTE REVIEW.
In order to ensure that incoming loads do not contain prohibited wastes, personnel who are trained to recognize prohibited wastes will make random inspections, keep records of such inspections and notify the Director of the Georgia Environmental Protection Division if prohibited wastes are discovered at the facility. These procedures will be made a part of the operating record. The random inspections will be conducted at a minimum every 4,000 tons of waste received or every ten (10) days.

Also, tipping area personnel trained to recognize prohibited wastes will be designated for the detection of non-conforming hazardous waste. They will observe each load as it is deposited on the tipping area. Records at each inspection will be made and kept as a part of the operating record. Liquid containers larger than 5 gallons in size which are not perforated and drained will be rejected. Likewise, pesticides, herbicides, lead acid batteries, biomedical waste, corrosives, and flammables will be rejected. If the non-conforming hazardous materials are delivered by a private hauler, the inspector will make a record of the materials and the hauler and report him to the Operator. Private haulers will be required to remove these materials from the facility.

The Operator will report the private hauler to the Georgia Department of Natural Resources Solid Waste Management Division. If the same hauler is caught fora second time, he will be banned from bringing any waste to the facility. If the culprit is not caught and identified, the cost of disposition of the waste will be borne by the Owner. The Operator must use a qualified hazardous waste handling company to properly dispose of any non-conforming materials that are brought to the facility. This waste will be immediately transported to an appropriate disposal facility.

In all cases, notification of the Director of the Georgia Environmental Protection Division will be made if a prohibited waste is discovered at the facility.

3. WASTE ACCEPTANCE OR REJECTION:
The acceptance or rejection of particular waste is based on the following factors:
*Federal, State and Local regulations, laws, or permit conditions.
*Waste characteristics.
*Operations and equipment limitations.
Of these three items, the regulations, laws and permit conditions affect most of the waste excluded from this site. Wastes specifically excluded by the regulations, laws, and permit conditions include liquids, lead acid batteries, biomedical wastes, radioactive wastes, and regulated quantities of hazardous wastes.

a. Liquid Waste Restrictions at Facility
(1.) Bulk or noncontainerized liquid waste will not be accepted.
(2.) Containers holding liquid waste may not be accepted, unless:
a. The container is a small container similar in size to that normally found in household waste;
b. The container is designed to hold liquids for use other than storage; or
c. The waste is household waste.
(3.) For purposes of this section:
a. "Liquid waste" means any waste material that is determined to contain "free liquids" as defined by Method 9095 (Paint Filter Liquids Test), as described in "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods" (EPA Pub. No. SW-846).

b. Lead Acid Batteries
Lead Acid batteries are automobile type batteries. These items, whether from an automobile, a truck, a tractor, or other equipment are categorically excluded from this facility.

c. Biomedical Waste
Biomedical Wastes are any type of pathological waste, biological waste, cultures, infectious wastes, contaminated animal wastes, body parts, chemotherapy waste, discarded medical equipment and parts, and any other contaminated medical device. Disposal of this type of waste is categorically prohibited from disposal at this facility.

d. Radioactive Waste
Radioactive waste is any material which exhibits radioactive characteristics. This waste is categorically prohibited from this facility.

e. Sewage Sludge Waste
Per the amended and restated host agreement between Meriwether County and Greenbow,LLC, the solid waste handling permit shall prohibit the disposal of any amount of sewage sludge. Sewage Sludge is defined as solid, semi-solid, or liquid residue generated during the treatment of domestic sewage or a combination of domestic sewage and industrial wastewater in a treatment works, as defined in Section 391-3-6-.17 of the Rules of the EPD.

f. Hazardous Waste
Hazardous wastes are those materials with characteristics, either physical or chemical, that could cause harm to health or the environment
A waste is hazardous if it is:
*Ignitable
*Corrosive
*Reactive
*Toxic (As defined by the TCLP test procedure)
*Is a listed hazardous waste

A waste material is ignitable if it has a flash point of 140 degrees F or less, causes fire by friction under normal conditions, or is an oxidizer. Examples of ignitable waste include solvents, bottom material from solvent recovery, and peroxide. This waste is typically generated by automobile repair shops, machine shops, dry cleaners, and industry.

A waste is corrosive if the pH is 2 or less, or 12.5 or greater. An example of corrosive waste is spent pickle liquor from a metal plating operation or battery acid.

A waste is reactive if it is unstable under normal conditions, reacts violently with water, forms an explosive mixture with water, contain any quantity of cyanide, contains sulfur which could be released to the atmosphere, or can be easily detonated or exploded. Waste from certain chemical operations, munitions works, or fertilizer plants can be reactive.

A waste is toxic if it so tests by the TCLP procedure. The TCLP test stands for the Toxic Characteristics Leaching Procedure. For this test, a leachate is removed from the waste and this leachate is analyzed for specific constituents as listed in the Code of Federal Regulations, Chapter 40. If a waste checks toxic, then the waste is hazardous based on the TCLP test.

Toxic materials can cause cancer, birth defects, or illness if released to the environment. Examples of toxic waste includes solvents industrial process sludges, emission control wastes.

A waste is characterized as a listed waste if it is listed in the Code of Federal Regulations, Chapter 40 or any amendments of this document.

A typical listed waste is one in which the known characteristics of that material will likely endanger the health or environment. The exhaustive list of hazardous waste is in the Part 261, of Chapter 40 of the Code of Federal Regulations.

4. SITE OPERATIONS:
Recognition of these wastes by the operators is imperative. The operators of the facility have been trained to detect this material and call it to the attention of management. When material of this type is detected in the daily operation, the material is immediately segregated from the remainder of the waste stream and cordoned off. The hauler who delivered that waste to the facility is then notified to return to the facility and remove the material. All hazardous material inadvertently delivered to the facility is to be removed by the hauler within 24 hours.

5. WASTE ACCEPTANCE PROTOCOL
For those generators or haulers with waste which they are unsure of, the facility will use a protocol for testing those wastes. This particular protocol is to be used for all industrial waste and contaminated soil. The protocol includes:

1. Perform the hazardous characteristics tests for ignitability, reactivity, corrosivity, and toxicity.
2. Test the material for PCB, TPH, and pH.
3. Report all testing to the Operator in original form signed by the Laboratory Principal.
4. Provide a certification that the test results represent the waste mass.
5. Identify the waste generator and provide a complete description of the waste.
6. Provide a certification from the generator stating the waste is Non-Hazardous.
7. Provide estimates of waste volumes. The Operator will review this data and either approve or disapprove prior to waste being transported to the landfill.

6. OUT OF STATE WASTE
No waste shall be received for disposal at the facility from sources outside the State of Georgia. Sources include but are not limited to generators, haulers, and permitted transfer stations.

REVISED: OCTOBER 25, 2010 - OPERATIONAL CHANGES
REVISED: SEPTEMBER 17, 2010 - OPERATIONAL CHANGES
REVISED: MAY 7, 2009 - REVISE LEACHATE TANKS
REVISED: DECEMBER 17, 2007 - ADDRESS EPD COMMENTS
REVISED: NOVEMBER 5, 2007 - ADDRESS EPD COMMENTS
REVISED: APRIL 30, 2007 - ADD RECYCLING FACILITY

REVISED: DECEMBER 23, 2013 - REVISE FINAL COVER COMPACTED SOIL LAYER THICKNESS (SECTION 6, NOW SECTION 8) AND ADD TEMPORARY GEOMEMBRANE COVER OPTION OVER CELL LINER (SECTION 49, NOW SECTION 51)
REVISED: APRIL 8, 2015 - ADD LANGUAGE REGARDING SOIL FOR OPERATIONAL PURPOSES

1 REVISED: APRIL 5, 2017 - CCR MANAGEMENT PLAN REVISIONS

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
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SIGNATURE
5 April 2017
DATE

GEORGIA REGISTERED No. PE039753 PROFESSIONAL ENGINEER MUSTAFA SAADA

OPERATIONS PLAN AND PROHIBITED WASTE EXCLUSION PLAN

DESIGN AND OPERATION PLAN
TURKEY RUN MSW LANDFILL
FOR
GREENBOW, LLC
MERIWETHER COUNTY, GEORGIA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
(478) 743-7175
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

DATE	DESCRIPTION
12/06/2012	REV 0 – INITIAL ISSUE
12/20/2012	REV 1 – DELETED TEXT

ATLANTIC COAST CONSULTING, INC.

PROJ. NO.	8080-016-01	DWG.	TURKEY-OP-R5 | EDIT 10-25-10
SCALE	NOT TO SCALE		
DATE	APRIL, 2007	SHEET	32 OF 45

THIS DOCUMENT ORIGINALLY ISSUED AND SEALED BY R. BRANT LANE, P.E. #27185 ON 10/25/10 AND WILLIAM F. HODGES, P.E. #15689 ON 10/25/10. THIS MEDIUM SHALL NOT BE CONSIDERED A CERTIFIED DOCUMENT.

1 NOTE: THE NARRATIVE FOR OPERATIONS PLAN IS CONTINUED FROM SHEET 32

38. OPERATIONAL RECORDS / DAILY LOGS:
Accurate written, daily records by actual weight shall be kept of all waste received at the landfill. Copies of such records shall be maintained for a period of at least three (3) years and shall be made available to the Division upon request. This facility will meet the record keeping requirements as found in the Georgia Rules for Solid Waste Management, 391-3-4-.07(3)u.

1 Documentation of Routine Load Inspections conducted for incoming loads of waste shall be maintained at the facility for compliance with the CCR Management Plan.

39. SITE USE AFTER CLOSURE:
Upon closure of the site, all areas will receive vegetative cover. Any post-closure use of the landfill property must be approved by EPD.

40. LEACHATE COLLECTION, TREATMENT AND ANALYSIS:
Leachate will be collected and stored in the on-site leachate storage tank.

Leachate shall be disposed by pump and haul or direct discharge to a permitted wastewater treatment facility. The Operator shall record on a weekly basis the volume stored in the leachate tanks, and the volume transported to a wastewater treatment facility.

The chemical composition of leachate flowing to the leachate tanks should be analyzed in accordance with the receiving POTW permit requirements. For purposes of this analysis the leachate sample should be collected from the leachate tanks and should be representative of the average mixed influent leachate quality.

41. LEACHATE SYSTEM MAINTENANCE AND INSPECTION:
A. Leachate Collection and Header Pipes - The continuing operation of the leachate collection system is important to the operations of the overall landfill facility. Therefore, as necessary, leachate collection lines should be cleaned on a periodic basis. Lines shall be cleaned with high pressure water jets passed through the lines from the cleanout entrance to the leachate sump. The high pressure cleaning equipment shall be similar to sanitary sewer cleaning equipment. This equipment shall not utilize cutters capable of damaging the collection lines. Only high pressure water jets on sewer cleaning equipment shall be utilized.

B. Leachate Storage Tank - The facility will utilize one (1) - 125,000 gallon leachate storage tank inside secondary containment until leachate generation exceeds 4,200 gallons per day on a monthly average. The leachate storage tanks shall be inspected daily for visible leaks. The leak detection system should also be inspected on a daily basis.

42. REMEDIAL ACTION FOR LINER AND LEACHATE COLLECTION SYSTEM:
The operator shall immediately notify the Division and describe remedial steps to be taken if:
1) Operation of the treatment facilities under the approved plan cannot prevent any of the following:
(i) Violating the terms of its permits, the Georgia Water Quality Control Act and regulations, thereunder.
(ii) Surface water or groundwater pollution.
2) The facility is generating a quality or quantity of leachate that exceeds the design capacity of any future on-site pretreatment system.
3) Failure of the liner or leachate collection is suspected or documented.

43. CONSTRUCTION CERTIFICATION:
1 Upon receipt of a final and effective solid waste handling permit, construction may commence in accordance with the approved design and operational plan and permit conditions. Prior to receipt of solid waste or CCR the Division must be provided with written certification by a professional engineer licensed to practice in Georgia, that the facility has been constructed in accordance with the approved permit. Unless notified otherwise by the Division, within 15 days of receipt by the Division of the written certification, the facility owner or operator may commence disposal of solid waste. This process shall be repeated for each subsequent major construction phase, including but not limited to, new cells or trenches, additional monitoring wells, sediment ponds, leachate treatment systems, modifications adding a new solid waste handling process, and application of final cover. The approved CQA Manual and Technical Specifications shall be used for each cell construction and shall not be amended unless approved by the Georgia EPD. No construction changes shall be made unless approved by the Georgia EPD. Borrow soils must come from sites with appropriate land disturbing permits.

44. RESPONSIBLE INDIVIDUAL:
The site operator will be certified as required by the Comprehensive Solid Waste Management Act and shall be available 24 hours per day.

45. SEQUENCE OF FILL:
The sequence of fill shall progress as described in the Design and Operation Plan, unless modified.

46. AIR CRITERIA:
The owner/operator shall apply for and obtain air quality permits under TITLE V and NSPS requirements of the Georgia and Federal rules for air quality. The design of the gas system will be submitted to the Air Protection Branch for approval. These permits applications, the permits, and any plans for landfill gas extraction and control shall be placed in the facility operating record, and a letter demonstrating these have been added shall be submitted to the EPD Solid Waste Program.

47. OPEN BURNING:
There shall be no opening burning of solid waste at this MSWLF unit. A plan must be submitted to and approved by the Georgia EPD prior to the infrequent burning of agricultural wastes, silvicultural wastes, land clearing debris, diseased trees, debris from emergency cleanup operations, or debris during construction.

48. DISEASE VECTOR CONTROL:
The owner and/or operator of this MSWLF unit will prevent or control on-site populations of disease vectors using techniques appropriate for the protection of human health and the environment.

49. PROHIBITED ACTS:
The landfill will be operated and maintained to prevent open burning, scavenging, and the open dumping of waste.

50. RECYCLE MATERIAL:
The site may construct a 8" thick gravel pad for collection, storage and processing of recycle material (see sheets No. 43 and 44). Initially, the operator will recycle the following:

A. Wood Wastes: Untreated lumber, stumps and timbering slash will be recycled for use as renewable fuel.

B. Concrete Wastes: Concrete wastes will be crushed, the reinforcing steel removed, then the concrete will be re-used as an economy road base material.

C. Asphalt Paving Wastes: Broken, cured asphalt paving material will be crushed, then re-used as an economy road base material.

D. Plastic bottles of various types to be recycled to offset petrochemical processing of raw material.

51. TEMPORARY GEOMEMBRANE COVER OVER CELL LINER
In order to reduce the infiltration of rain water into the leachate collection system, portions of the constructed cell liner system with no waste in place may be covered with temporary geomembrane cover material. The stormwater runoff from the top of the temporary geomembrane cover shall be directed to and handled by the existing surface water management features at the site. The temporary geomembrane cover shall be progressively removed prior to commencing waste placement activities in the cell.

52 CCR MANAGEMENT PLAN RENEWAL, MODIFICATIONS AND LOCAL GOVERNMENT NOTIFICATIONS:
1 Upon approval of the CCR Management Plan by EPD, the CCR Management Plan shall be valid for a duration of one year. The facility will submit an Annual CCR Management and Dust Control Re-iew sealed by a professional engineer registered in the State of Georgia. The Annual CCR Management Report may be combined with the Annual Fugitive Dust Control Report described in Section 23 of this Operations Plan.

This CCR Management Plan will be revised and submitted to EPD for approval if changes to the operational procedures or facility design are required due to changes in the CCR waste stream.

The Owner or Operator will provide written notification to Meriwether County informing that the Turkey Run Landfill is accepting CCR waste. Additionally, Meriwether County will be provided with a written notification from the Owner or Operator if the CCR Management Plan is amended.

1 REVISED: APRIL 5, 2017 - CCR MANAGEMENT PLAN REVISIONS

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
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WM
1850 PARKWAY PLACE
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TITLE:
OPERATIONS PLAN AND PROHIBITED WASTE EXCLUSION PLAN (CONTINUED)

PROJECT:
DESIGN AND OPERATION PLAN - MINOR MODIFICATION

SITE:
TURKEY RUN MSW LANDFILL

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION. UNLESS SEALED.

SIGNATURE
5 April 2017
DATE

GEORGIA REGISTERED No. PE039753 PROFESSIONAL ENGINEER MUSTAFA SAADI

DESIGN BY:	RVJ	DATE:	APRIL 2017
DRAWN BY:	JJA	PROJECT NO.:	GR6304
CHECKED BY:	RVJ	FILE:	Turkey-CCR-OP
REVIEWED BY:	RVJ	DRAWING NO.:	32A OF 45
APPROVED BY:	MS		

L:\CAD\TURKEY RUN LANDFILL\MODIFICATION\MINOR MODIFICATION GD0457\DRAWINGS\MINOR MODIFICATION APRIL 2017_GR6304#002.32S_32-OPERATIONS_PLAN_REV1_MOST CURRENT

CLOSURE PROCEDURES

1. GENERAL
The owner of this disposal site shall close this site in a manner that minimizes the need for further maintenance and minimizes the potential of post-closure release of contaminants to the ground or surface waters. The closure plan considers partial or contingent closure of the landfill. Facility phasing drawings provide guidance on closure at the end of any cell. Should intermediate closure be required, all components of this plan should be followed.

2. CERTIFICATION
A Professional Engineer must certify that the site was closed in accordance with the approved Design and Operational Plan and the Rules for Solid Waste Management. Shoulu the facility close prior to reaching permitted elevations the Engineers certification shall include an as-built plan.

3. NOTIFICATION
The owner shall notify the Environmental Protection Division of final closure within 30 days of receiving the final load of waste, providing E.P.D. with the date of final waste receipt and an accurate legal description of the boundaries of the landfill.
The Owner will complete all closure activities of each MSWLF unit in accordance with this Closure Plan within 180 days following the beginning of closure. See Closure Schedule below.
Signs shall be posted at the entrance gate notifying users of the closure. Upon closure, the property deed and legal description shall be filed at the county courthouse in accordance with O.C.G.A. 8-6-3. All deeds must be recorded and reported as outlined in the Georgia Rules of Solid Waste Management 391-3-4-.11(5).

4. SURVEY CONTROL
The complete legal description of the property is shown on the plans. All areas within which solid waste has been disposed shall be located to the best of the owner's ability and surveyed by a Registered Surveyor who shall provide a legal description of the waste management boundaries within 30 days of closure. Should partial closure occur, a topographic as-built survey of the site shall be developed.

5. CLOSURE SUPERVISION
Closure of the site shall be under supervision of the current landfill supervisor.

6. DIRECTIONAL AND INFORMATIONAL SIGNS
Signs shall be posted at the entrance gate notifying users of the landfill of the closure and providing the location of the nearest municipal solid waste landfill in the area. A telephone number for emergencies shall be printed on the sign.

7. REMOVAL OF WASTES
If the owner/operator of this facility wishes to remove wastes, waste residues or any contaminated soils, the owner/operator shall request and receive written approval from EPD prior to conducting any such activity.

8. FINAL COVER
Upon closure, all waste received at the site shall be spread, compacted and capped with the final cover system as described on the plans. Should the site be closed prior to attaining final grades, all uncovered and intermittently covered areas shall be capped with the system specified above. The final cap shall be placed within one month of the placement of solid waste in the lift. The minimum slope of the final cap shall be 3% and the maximum slope shall be 33%. One methane gas vent per acre shall be installed as shown on the detail sheet.
Final cover shall be secured from on-site excavation of cell areas, stockpiles or other EPD approved borrow source areas as necessary.
The final cap system shall meet the following standards:
a) The cover must be capable of preventing attraction of disease vectors, minimizing production of odors, and preventing blowing litter, and;
b) Must be capable of completely covering the solid waste without change in the cover's properties by rain, heat, cold and other climatic conditions; and
c) Must be substantially free of rock fragments that are greater than six inches in diameter.
d) Must be capable of supporting the germination and propagation of vegetative cover.
e) Must compact well and preclude the excessive infiltration of surface water.

The locations, and any design and operational information on landfill gas vents or extraction wells shall be submitted to EPD for review at the time of installation or closure. Installation documentation shall also be provided to EPD at the completion of gas vent construction.

9. VEGETATIVE PLAN
All disturbed areas shall be grassed and maintained in accordance with the following schedules. A vegetative cover shall be established within two weeks after final cover placement. Permanent covers which are slow to establish shall receive temporary seeding. The fertilizer requirements are suggested. The operator will submit soil samples to the County Extension Agent for analysis and determination of proper soil conditioners including lime. This analysis will become part of the operational records. Planting dates, fertilizer rates, and seeding rates shall meet the requirements in the Manual for Erosion and Sediment Control in Georgia.

SEEDS - PERMANENT	LBS/ACRE	DEPTH OF COVER	DATE OF PLANTING
BERMUDA, COMMON - HULLED	10	1/4" - 1/2"	3/1 - 6/30
FESCUE, TALL	50	1/4" - 1/2"	3/1 - 4/15 & 8/15 - 10/31
SEEDS - TEMPORARY	LBS/ACRE	DEPTH OF COVER	DATE OF PLANTING
RYEGRASS, ANNUAL	40	1/4" - 1/2"	8/1 - 4/15
MILLET, PEARL	50	1/4" - 1/2"	4/15 - 8/31

NOTE:
1. All seeding rates are pure live seed rates.
2. All seeding shall be mulched with clean dry hay at the rate of 2.5 tons per acre. Mulch shall be anchored by pressing the mulch into the soil immediately after the mulch is spread using a packer disk or disk harrow or equivalent piece of equipment.
3. Temporary seeding should also complement permanent seeding to produce a suitable cover while the permanent grasses germinate.
4. Disturbed slopes greater than 3%, including soil stockpiles, are to be mulched immediately.

FERTILIZER REQUIREMENTS

TYPE OF SPECIES	YEAR	ANALYSIS OR EQUIVALENT N-P-K	RATE	N TOP DRESSING RATE
1. Cool season grasses	First	6-12-12	1500 lbs./ac.	50-100 lbs./ac.(1)(2)
	Second	6-12-12	1000 lbs./ac.	-
	Maintenance	10-10-10	400 lbs./ac.	30
2. Cool season grasses and legumes	First	6-12-12	1500 lbs./ac.	0-50 lbs./ac.(1)
	Second	0-10-10	1000 lbs./ac.	-
	Maintenance	0-10-10	400 lbs./ac.	-
3. Temporary cover crops seeded alone	First	10-10-10	500 lbs./ac.	30 lbs./ac.(3)
4. Warm season grasses	First	6-12-12	1500 lbs./ac.	50-100 lbs./ac.(2)(4)
	Second	6-12-12	800 lbs./ac.	50-100 lbs./ac.(2)
	Maintenance	10-10-10	400 lbs./ac.	30 lbs./ac.
5. Warm season grasses and legumes	First	6-12-12	1500 lbs./ac.	50 lbs./ac.(4)
	Second	0-10-10	1000 lbs./ac.	-
	Maintenance	0-10-10	400 lbs./ac.	-

NOTE:
1. Apply in spring following seeding.
2. Apply in split applications when high rates are used.
3. Apply to grass species only.
4. Apply when plants grow to a height of 2 to 4 inches.

10. SITE EQUIPMENT NEEDED
The owner shall make adequate equipment available at the municipal solid waste landfill to ensure that closure requirements are executed correctly and efficiently. Should said equipment not be available, back up equipment may be obtained from the rental companies. Below is a minimum list of equipment which shall be required.
A. Dozer/Compactor
B. Scraper/Pan

11. SEDIMENT REMOVAL
Accumulated sediment shall be removed from drop inlets, drainage pipes, diversion ditches, and other drainage structures.

12. EROSION AND SEDIMENTATION CONTROL
Upon closure, all ditches, diversion berms, culverts, rip-rap, silt fence and other drainage structures serving disturbed areas, but not already built, shall be constructed and placed according to the Plan of Operation.

13. COST OF CLOSURE
The estimated third party closure costs of the maximum area of active landfill unclosed at any time is $5,653,083.63. This figure is based on 2007 year costs and shall be updated on an annual basis and submitted to EPD.

13. COST OF CLOSURE
The estimated third party closure costs of the maximum area of active landfill unclosed at any time is $3,949,595.55. This figure is based on 2007 year costs and shall be updated on an annual basis and submitted to EPD.

14. COST LEGEND
The following items were considered in the cost of closure for the site. The unit price of each item includes labor, materials, equipment, overhead, and profit. This estimate is based on worst case closure (see Note C below and Closure sequence on Sheet 45 of 45).

CLOSURE COST ESTIMATE

ITEM NO.	ITEM	QTY.	UNIT	UNIT PRICE ($)	COST ($)
1.	6" Topsoil	50,308	C.Y.	9.00	452,772.00
2.	18" Cover Soil	150,924	C.Y.	7.50	1,131,930.00
3.	12" Compacted Cover Soil	100,616	C.Y.	7.50	754,620.00
4.	Drainage Layer (Geotextile Geocomposite)				
	Material	2,716,627	S.F.	0.28	760,655.56
	Labor	2,716,627	S.F.	0.06	162,997.62
5.	40 mil LLDPE Material & Installation	2,716,627	S.F	0.35	950,818.45
6.	Seed	2,960	Lbs.	3.50	10,360.00
7.	Fertilizer	59.2	Tons	200.00	11,840.00
8.	Lime	59.2	Tons	35.00	2,072.00
9.	Mulch	59.2	Acre	75.00	4,440.00
10.	Labor for Seeding, Fertilizing, Lime & Mulching	59.2	Acre	200.00	11,840.00
11.	Silt Fence	8,700	L.F.	4.00	34,800.00
12.	Drainage Structure Construction	1	L.S.	5,000.00	5,000.00
13.	Final Disposal of Waste & Cleanup	2,000	Tons	30.00	60,000.00
14.	Side slope Berm Construction	41,328	L.F.	8.50	351,288.00
15.	Downdrain Construction	3,850	L.F.	25.00	96,250.00
16.	Sediment Pond Cleanout	13,500	C.Y.	4.00	54,000.00
17.	Engineering & Closure Certification	1	L.S.	300,000.00	300,000.00
18.	Refuse Limits Survey	1	L.S.	7,500.00	7,500.00
19.	Construction Manager	12	MO	6,000.00	72,000.00
20.	Mobilization, Bonds, Surveying, Bidding	1	L.S.	100,000.00	100,000.00
21.	Soil Subgrade Preparation	59.2	Acre	2000.00	118,400.00
22.	Outlet Protection	1800	S.Y.	40.00	72,000.00
23.	Removal of Unprocessed/ processed materials in Recycling Facility	3,000	Tons	40.00	120,000.00
24.	Removal of steel scrap in Recycling Facility	10	Tons	50.00	500.00
25.	Removal of processing equipment in Recycling Facility	1	L.S.	5,000.00	5,000.00
26.	Closure Certification in Recycling Facility by a Professional Engineer	1	L.S.	2,000.00	2,000.00
				TOTAL	$5,653,083.63

NOTES:
a) All costs shown are for in-place quantities and include labor, materials, and equipment.
b) The cost estimate equals the cost of closing the largest area of all MSWLF unit ever requiring a final cover at any time during the active life when the extent and manner of its operation would make closure the most expensive, as indicated by its closure plan.
c) The site will be filled in order of the cell number sequence. Based on this sequencing, the worst case situation (maximum area unclosed at any time) will be 62.37 acres (see sequence chart on Sheet 45 of 45).
d) During the active life of the MSWLF unit, the owner and/or operator must annually adjust the closure cost estimate for inflation.
e) Construction and Operation of the Landfill Gas Collection and Control Systems shall be in accordance with 40 CFR Subpart WWW.
f) This closure cost is based on 2007 costs and shall be adjusted annually for inflation.
g) See sheet 45 for closure sequence chart.

15. LEGAL DESCRIPTION
CURRENTLY BEING REVISED BY SURVEYOR

LEGAL DESCRIPTION: TRACT "A" BOUNDARY

ALL THAT CERTAIN PIECE, PARCEL OR LOT LAND, LYING AND BEING IN LAND LOTS 71, 72, 89, 90, 103 AND 104 OF THE 11TH DISTRICT, MERIWETHER COUNTY, GEORGIA, BEING MORE FULLY SHOWN AND DESIGNATED ON A BOUNDARY SURVEY FOR TURKEY RUN MSW LANDFILL BY TOOLE SURVEYING COMPANY, INC. DATED APRIL 2007, LAST REVISED SEPTEMBER 19, 2007, AND HAVING THE FOLLOWING METES AND BOUNDS, TO WIT:

BEGINNING AT THE INTERSECTION OF LAND LOT 71, LAND LOT 72, LAND LOT 90 AND LAND LOT 89 AT A #4 REBAR FOUND ALSO KNOWN AS THE POINT OF BEGINNING;

N00-23-23E FOR A DISTANCE OF 1103.62; S89-40-07E FOR A DISTANCE OF 963.99; S14-22-24E FOR A DISTANCE OF 494.64; THENCE ALONG A CURVE WITH AN ARC LENGTH OF 1415.70 AND A RADIUS OF 1490.00 WITH A CHORD LENGTH OF: 1363.04 AND A CHORD BEARING OF S 41-35-34 E; S68-48-09E FOR A DISTANCE OF 1031.49; S02-08-09W FOR A DISTANCE OF 836.62; S02-08-09W FOR A DISTANCE OF 274.25; S00-27-18W FOR A DISTANCE OF 389.81; S00-41-13W FOR A DISTANCE OF 267.93; S00-37-03E FOR A DISTANCE OF 99.65; S53-01-33W FOR A DISTANCE OF 74.96; S38-45-36W FOR A DISTANCE OF 101.52; S71-09-33W FOR A DISTANCE OF 111.06; S63-54-15W FOR A DISTANCE OF 178.58; S57-30-07W FOR A DISTANCE OF 131.53; S86-31-48W FOR A DISTANCE OF 120.82; S73-53-21W FOR A DISTANCE OF 39.18; N79-43-47W FOR A DISTANCE OF 88.56; THENCE ALONG A CURVE WITH AN ARC LENGTH OF21.84 AND A RADIUS OF 100.00 WITH A CHORD LENGTH OF 21.79 AND A CHORD BEARING OF N85-59-09W; S87-45-30W FOR A DISTANCE OF 113.09; S80-36-09W FOR A DISTANCE OF 55.32; S78-22-01W FOR A DISTANCE OF 9.26; N30-34-35W FOR A DISTANCE OF 31.09; N49-51-26W FOR A DISTANCE OF 80.71; N64-30-06W FOR A DISTANCE OF 103.75; N25-02-54W FOR A DISTANCE OF 60.85; THENCE ALONG A CURVE WITH AN ARC LENGTH OF36.48 AND A RADIUS OF 100.00 WITH A CHORD LENGTH OF 36.27 AND A CHORD BEARING OF N 35-29-52 W; N45-56-50W FOR A DISTANCE OF 23.34 THENCE ALONG A CURVE WITH AN ARC LENGTH OF38.63 AND A RADIUS OF 100.00 WITH A CHORD LENGTH OF 38.39 AND A CHORD BEARING OF N57-00-55W; N68-04-59W FOR A DISTANCE OF 89.62; N83-12-17W FOR A DISTANCE OF 73.50; S81-22-24W FOR A DISTANCE OF 72.67; S69-38-46W FOR A DISTANCE OF 192.17; S61-23-23W FOR A DISTANCE OF 73.76; S52-25-09W FOR A DISTANCE OF 91.09; S34-01-01W FOR A DISTANCE OF 181.40; S29-08-25W FOR A DISTANCE OF 84.50; S23-10-48W FOR A DISTANCE OF 5.21; THENCE ALONG A CURVE WITH AN ARC LENGTH OF62.99 AND A RADIUS OF 100.00 WITH A CHORD LENGTH OF: 61.96 AND A CHORD BEARING OF S05-08-01W; S12-54-47E FOR A DISTANCE OF 19.55; S53-37-52W FOR A DISTANCE OF 45.34; S39-59-57W FOR A DISTANCE OF 26.74; S39-59-57W FOR A DISTANCE OF 10.17; S71-01-44W FOR A DISTANCE OF 91.47; THENCE ALONG A CURVE WITH AN ARC LENGTH OF31.83 AND A RADIUS OF 100.00 WITH A CHORD LENGTH OF 31.69 AND A CHORD BEARING OF S61-54-40W; S52-47-36W FOR A DISTANCE OF 46.01; S62-34-17W FOR A DISTANCE OF 100.52; S57-44-40W FOR A DISTANCE OF 49.47; S48-46-55W FOR A DISTANCE OF 96.15; THENCE ALONG A CURVE WITH AN ARC LENGTH OF53.47 AND A RADIUS OF 100.00 WITH A CHORD LENGTH OF 52.84 AND A CHORD BEARING OF S33-27-48W; S18-08-41W FOR A DISTANCE OF 11.90; S53-20-40W FOR A DISTANCE OF 72.61; S47-46-00W FOR A DISTANCE OF 62.15; S54-56-14W FOR A DISTANCE OF 342.42; N71-24-55W FOR A DISTANCE OF 32.86; S86-05-21W FOR A DISTANCE OF 66.65; S70-12-42W FOR A DISTANCE OF 178.42; S64-23-33W FOR A DISTANCE OF 115.53; S68-49-53W FOR A DISTANCE OF 116.11; S89-50-28W FOR A DISTANCE OF 413.25; S88-09-30W FOR A DISTANCE OF 258.38; THENCE ALONG A CURVE WITH AN ARC LENGTH OF65.35 AND A RADIUS OF 100.00 WITH A CHORD LENGTH OF 64.19 AND A CHORD BEARING OF S69-26-16W; S50-43-03W FOR A DISTANCE OF 55.73; S64-57-24W FOR A DISTANCE OF 188.98; S71-54-19W FOR A DISTANCE OF 46.90; S84-17-00W FOR A DISTANCE OF 88.14; N74-11-27W FOR A DISTANCE OF 104.72; N69-59-28W FOR A DISTANCE OF 185.61; N56-57-47W FOR A DISTANCE OF 15.63; N55-05-45W FOR A DISTANCE OF 213.90; THENCE ALONG A CURVE WITH AN ARC LENGTH OF32.60 AND A RADIUS OF 100.00 WITH A CHORD LENGTH OF 32.45 AND A CHORD BEARING OF N64-26-01W; N73-46-18W FOR A DISTANCE OF 38.82; N66-15-40W FOR A DISTANCE OF 274.08; N76-39-25W FOR A DISTANCE OF 112.29; N33-19-28W FOR A DISTANCE OF 91.83; N48-03-34W FOR A DISTANCE OF 83.60; N25-16-47W FOR A DISTANCE OF 71.98; N31-46-10W FOR A DISTANCE OF 65.27; N27-11-07W FOR A DISTANCE OF 203.55; N39-47-25W FOR A DISTANCE OF 162.51; N63-22-30W FOR A DISTANCE OF 72.89; N00-00-00E FOR A DISTANCE OF 1175.73; N36-17-45E FOR A DISTANCE OF 337.46; N44-31-11E FOR A DISTANCE OF 307.16; N57-54-45E FOR A DISTANCE OF 148.42; N85-47-36E FOR A

N71-24-55W FOR A DISTANCE OF 32.86; S86-05-21W FOR A DISTANCE OF 66.65; S70-12-42W FOR A DISTANCE OF 178.42; S64-23-33W FOR A DISTANCE OF 115.53; S68-49-53W FOR A DISTANCE OF 116.11; S89-50-28W FOR A DISTANCE OF 413.25; S88-09-30W FOR A DISTANCE OF 258.38; THENCE ALONG A CURVE WITH AN ARC LENGTH OF65.35 AND A RADIUS OF 100.00 WITH A CHORD LENGTH OF 64.19 AND A CHORD BEARING OF S69-26-16W; S50-43-03W FOR A DISTANCE OF 55.73; S64-57-24W FOR A DISTANCE OF 188.98; S71-54-19W FOR A DISTANCE OF 46.90; S84-17-00W FOR A DISTANCE OF 88.14; N74-11-27W FOR A DISTANCE OF 104.72; N69-59-28W FOR A DISTANCE OF 185.61; N56-57-47W FOR A DISTANCE OF 15.63; N55-05-45W FOR A DISTANCE OF 213.90; THENCE ALONG A CURVE WITH AN ARC LENGTH OF32.60 AND A RADIUS OF 100.00 WITH A CHORD LENGTH OF 32.45 AND A CHORD BEARING OF N64-26-01W; N73-46-18W FOR A DISTANCE OF 38.82; N66-15-40W FOR A DISTANCE OF 274.08; N76-39-25W FOR A DISTANCE OF 112.29; N33-19-28W FOR A DISTANCE OF 91.83; N48-03-34W FOR A DISTANCE OF 83.60; N25-16-47W FOR A DISTANCE OF 71.98; N31-46-10W FOR A DISTANCE OF 65.27; N27-11-07W FOR A DISTANCE OF 203.55; N39-47-25W FOR A DISTANCE OF 162.51; N63-22-30W FOR A DISTANCE OF 72.89; N00-00-00E FOR A DISTANCE OF 1175.73; N36-17-45E FOR A DISTANCE OF 337.46; N44-31-11E FOR A DISTANCE OF 307.16; N57-54-45E FOR A DISTANCE OF 148.42; N85-47-36E FOR A
DISTANCE OF 28.40; THENCE ALONG A CURVE WITH AN ARC LENGTH OF151.11 AND A RADIUS OF 100.00 WITH A CHORD LENGTH OF 137.14 AND A CHORD BEARING OF N42-30-12E; N00-47-13W FOR A DISTANCE OF 12.26; N21-21-21E FOR A DISTANCE OF 137.98; N18-14-12W FOR A DISTANCE OF 45.36; N77-19-18E FOR A DISTANCE OF 20.29 N70-03-04E FOR A DISTANCE OF 100.68; N58-47-20E FOR A DISTANCE OF 115.24; N26-15-34E FOR A DISTANCE OF 37.45; N87-52-10E FOR A DISTANCE OF 31.86; N75-52-18E FOR A DISTANCE OF 67.82; N47-13-46E FOR A DISTANCE OF 83.82; N14-02-08E FOR A DISTANCE OF 80.23; N10-11-23W FOR A DISTANCE OF 10.77; N42-47-53E FOR A DISTANCE OF 43.72; N55-40-43E FOR A DISTANCE OF 14.12; N78-50-59E FOR A DISTANCE OF 43.35; N57-26-14E FOR A DISTANCE OF 91.57; N28-52-09E FOR A DISTANCE OF 119.00; N29-45-00E FOR A DISTANCE OF 96.11; N40-30-04E FOR A DISTANCE OF 14.57; N49-27-53E FOR A DISTANCE OF 57.33; N25-51-01E FOR A DISTANCE OF 47.13; N31-47-23E FOR A DISTANCE OF 63.21; N12-09-44E FOR A DISTANCE OF 53.26; N07-25-30W FOR A DISTANCE OF 93.78; N16-49-14W FOR A DISTANCE OF 4.96; N17-36-59E FOR A DISTANCE OF 102.53; N02-31-36W FOR A DISTANCE OF 47.68; N19-16-37W FOR A DISTANCE OF 31.48; N89-28-21E FOR A DISTANCE OF 433.89; N89-04-54E FOR A DISTANCE OF 779.94 TO THE POINT OF BEGINNING AND CONTAINING 417.54 ACRES

LEGAL DESCRIPTION:
"ACCESS ROAD"

ALL THAT CERTAIN PIECE, PARCEL OR LOT LAND, LYING AND BEING IN LAND LOTS 90,91,102,103 AND 122 OF THE 11TH DISTRICT, MERIWETHER COUNTY, GEORGIA, HAVING THE FOLLOWING METES AND BOUNDS, TO WIT:

BEGINNING AT THE NORTHEASTERN INTERSECTION OF LONE OAK ROAD (GA HWY #54) AND COUNTY LINE ROAD AT A POINT KNOWN AS THE POINT OF COMMENCEMENT; THENCE NORTH 67 DEGREES 07 MINUTES 44 SECONDS EAST (N67°07'44"E) FOR A DISTANCE OF 2,207.22 FEET TO A POINT ALSO KNOWN AS THE POINT OF BEGINNING; THENCE NORTH 09 DEGREES 36 MINUTES 35 SECONDS WEST (N09°36'25"W) FOR A DISTANCE OF 513.50 FEET TO A POINT; THENCE ALONG A CURVE WITH A RADIUS OF 430.00' AND AN ARC LENGTH OF 74.88 WITH A CHORD BEARING OF NORTH 04 DEGREES 37 MINUTES 16 SECONDS WEST (N04° 37'16"W) FOR A DISTANCE OF 74.78 FEET TO A POINT; THENCE NORTH 00 DEGREES 22 MINUTES 13 SECONDS EAST (N00°22'13"E) FOR A DISTANCE OF 1506.10 FEET TO A POINT; THENCE ALONG A CURVE WITH A RADIUS OF 170.00' AND AN ARC LENGTH OF 43.48 WITH A CHORD BEARING OF NORTH 06 DEGREES 57 MINUTES 23 SECONDS WEST (N06° 57'23"W) FOR A DISTANCE OF 43.36 FEET TO A POINT; THENCE NORTH 41 DEGREES 16 MINUTES 58 SECONDS WEST (N41°16'58"W) FOR A DISTANCE OF 436.72 FEET TO A POINT; THENCE NORTH 33 DEGREES 53 MINUTES 44 SECONDS WEST (N33°53'44"W) FOR A DISTANCE OF 151.94 FEET TO A POINT; THENCE NORTH 14 DEGREES 17 MINUTES 00 SECONDS WEST (N14°17'00"W) FOR A DISTANCE OF 298.58 FEET TO A POINT; THENCE NORTH 05 DEGREES 19 MINUTES 51 SECONDS EAST (N05°19'51"E) FOR A DISTANCE OF 151.94 FEET TO A POINT; THENCE NORTH 14 DEGREES 16 MINUTES 58 SECONDS WEST (N14°16'58"W) FOR A DISTANCE OF 323.72 FEET TO A POINT; THENCE ALONG A CURVE WITH A RADIUS OF 430.00 FEET AND AN ARC LENGTH OF 107.19 WITH A CHORD BEARING OF NORTH 07 DEGREES 08 MINUTES 29 SECONDS WEST (N07°08'29"W) FOR A DISTANCE OF 106.91 FEET TO A POINT; THENCE NORTH 00 DEGREES 00 MINUTES 00 SECONDS WEST (N00°00'00"W) FOR A DISTANCE OF 398.34 FEET TO A POINT; THENCE ALONG A CURVE WITH A RADIUS OF 200.00 FEET AND AN ARC LENGTH OF 363.67 WITH A CHORD BEARING OF NORTH 52 DEGREES 05 MINUTES 32 SECONDS EAST (N52°05'32"E) FOR A DISTANCE OF 315.60 FEET TO A POINT; THENCE SOUTH 75 DEGREES 48 MINUTES 56 SECONDS EAST (S75°48'56"E) FOR A DISTANCE OF 23.80 FEET TO A POINT; THENCE ALONG A CURVE WITH A RADIUS OF 200.00 FEET AND AN ARC LENGTH OF 7.04 WITH A CHORD BEARING OF SOUTH 85 DEGREES 53 MINUTES 40 SECONDS EAST (S85°53'40"E) FOR A DISTANCE OF 7.00 FEET TO A POINT; THENCE NORTH 84 DEGREES 01 MINUTES 36 SECONDS EAST (N84°01'36"E) FOR A DISTANCE OF 103.59 FEET TO A POINT; THENCE ALONG A CURVE WITH A RADIUS OF 330.00 FEET AND AN ARC LENGTH OF 191.88 WITH A CHORD BEARING OF SOUTH 79 DEGREES 18 MINUTES 59 SECONDS EAST (S79°18'59"E) FOR A DISTANCE OF 189.18 FEET TO A POINT; THENCE SOUTH 00 DEGREES 00 MINUTES 00 SECONDS WEST (S00°00'00"W) FOR A DISTANCE OF 191.31 FEET TO A POINT; THENCE SOUTH 63 DEGREES 22 MINUTES 30 SECONDS EAST (S63°22'30"E) FOR A DISTANCE OF 72.89 FEET TO A POINT; THENCE SOUTH 39 DEGREES 47 MINUTES 25 SECONDS EAST (S39°47'25"E) FOR A DISTANCE OF 162.51 FEET TO A POINT; THENCE SOUTH 27 DEGREES 11 MINUTES 07 SECONDS EAST (S27°11'07"E) FOR A DISTANCE OF 116.56 FEET TO A POINT; THENCE ALONG A CURVE WITH A RADIUS OF 280.00 FEET AND AN ARC LENGTH OF 241.78 WITH A CHORD BEARING OF NORTH 67 DEGREES 14 MINUTES 04 SECONDS WEST (N67°14'04"W) FOR A DISTANCE OF 234.34 FEET TO A POINT; THENCE NORTH 42 DEGREES 29 MINUTES 47 SECONDS WEST (N42°29'27"W) FOR A DISTANCE OF 157.33 FEET TO A POINT; THENCE ALONG A CURVE WITH A RADIUS OF 70.00 FEET AND AN ARC LENGTH OF 65.33 WITH A CHORD BEARING OF NORTH 69 DEGREES 14 MINUTES 06 SECONDS WEST (N69°14'06"W) FOR A DISTANCE OF 62.99 FEET TO A POINT; THENCE SOUTH 84 DEGREES 01 MINUTES 36 SECONDS WEST (S84°01'36"W) FOR A DISTANCE OF 103.59 FEET TO A POINT; THENCE ALONG A CURVE WITH A RADIUS OF 280.00 FEET AND AN ARC LENGTH OF 23.15 WITH A CHORD BEARING OF SOUTH 88 DEGREES 45 MINUTES 09 SECONDS WEST (S88°45'09"W) FOR A DISTANCE OF 46.14 FEET TO A POINT; THENCE SOUTH 00 DEGREES 00 MINUTES 00 SECONDS EAST (S00°00'00"E) FOR A DISTANCE OF 326.32 FEET TO A POINT; THENCE ALONG A CURVE WITH A RADIUS OF 170.00 FEET AND AN ARC LENGTH OF 42.38 WITH A CHORD BEARING OF SOUTH 07 DEGREES 08 MINUTES 29 SECONDS EAST (S07°08'29"E) FOR A DISTANCE OF 42.27 FEET TO A POINT; THENCE SOUTH 14 DEGREES 16 MINUTES 58 SECONDS EAST (S14°16'58"E) FOR A DISTANCE OF 191.13 FEET TO A POINT; THENCE SOUTH 37 DEGREES 18 MINUTES 32 SECONDS EAST (S37°18'32"E) FOR A DISTANCE OF 324.41 FEET TO A POINT; THENCE SOUTH 14 DEGREES 37 MINUTES 58 SECONDS EAST (S14°37'58"E) FOR A DISTANCE OF 377.63 FEET TO A POINT; THENCE SOUTH 05 DEGREES 37 MINUTES 11 SECONDS WEST (S05°37'11"W) FOR A DISTANCE OF 379.53 FEET TO A POINT; ; THENCE SOUTH 14 DEGREES 16 MINUTES 58 SECONDS EAST (S14°16'58"E) FOR A DISTANCE OF 121.10 FEET TO A POINT; THENCE ALONG A CURVE WITH A RADIUS OF 429.96 FEET AND AN ARC LENGTH OF 109.97 WITH A CHORD BEARING OF SOUTH 06 DEGREES 57 MINUTES 22 SECONDS EAST (S06°57'22"E) FOR A DISTANCE OF 109.67 FEET TO A POINT; THENCE SOUTH 00 DEGREES 22 MINUTES 13 SECONDS WEST (S00°22'13"W) FOR A DISTANCE OF 1506.10 FEET TO A POINT; THENCE ALONG A CURVE WITH A RADIUS OF 170.00 FEET AND AN ARC LENGTH OF 29.60 WITH A CHORD BEARING OF SOUTH 04 DEGREES 37 MINUTES 06 SECONDS EAST (S04°37'06"E) FOR A DISTANCE OF 29.57 FEET TO A POINT; THENCE SOUTH 09 DEGREES 36 MINUTES 25 SECONDS EAST (S09°36'25"E) FOR A DISTANCE OF 206.61 FEET TO A POINT; THENCE SOUTH 80 DEGREES 23 MINUTES 35 SECONDS WEST (S80°23'35"W) FOR A DISTANCE OF 35.74 FEET TO A POINT; THENCE SOUTH 09 DEGREES 36 MINUTES 25 SECONDS EAST (S09°36'25"E) FOR A DISTANCE OF 101.46 FEET TO A POINT; THENCE NORTH 80 DEGREES 23 MINUTES 35 SECONDS EAST (N80°23'35"E) FOR A DISTANCE OF 35.74 FEET TO A POINT; THENCE SOUTH 09 DEGREES 36 MINUTES 25 SECONDS EAST (S09°36'25"E) FOR A DISTANCE OF 207.31 FEET TO A POINT; THENCE SOUTH 80 DEGREES 40 MINUTES 41 SECONDS WEST (S80°40'41"W) FOR A DISTANCE OF 260.00 FEET TO A POINT BEING THE POINT OF BEGINNING AND CONTAINING 30.00 +/- ACRES.

16. CLOSURE SCHEDULE
Once the decision has been made by the Owner to close the landfill, the following schedule shall be followed over a 180 day period:
1. Notify EPD of final closure within 30 days of receiving final load of waste.
2. Provide EPD with date of final waste receipt.
3. Prepare accurate legal description of final waste management boundary.
4. Prepare accurate legal description of entire property
5. Prepare final topographic as-built survey if partial closure occurs.
6. Post signs at entrance gate notifying users of closure and location of nearest MSWLF.
7. Obtain written permission from EPD to remove waste, if required.
8. Install final cover system.
9. Initiate vegetative plan.
10. Remove all accumulated sediments from ponds, ditches and other drainage structures.
11. Construct all erosion and sediment control systems serving disturbed areas, but not previously built.
12. Obtain certification from a registered professional engineer, licensed in the State of Georgia verifying that closure of each MSWLF unit has been completed in accordance with the Closure Plan.
13. Notify EPD that this certification has been placed in the operating records.
14. On all deeds of real property which has been used for landfilling, include notice of landfill operations, the date the landfill operation commenced and terminated, an accurate legal description of the actual location of the landfill, and a description of the type of solid wastes which have been deposited in the landfill.
15. Submit to the Director of EPD confirmation that the information required in closure schedule item no. 14 above has been noticed on the property deed.

17. WASTE INVENTORY
The maximum inventory of wastes ever on-site over the active life of the landfill facility will be calculated at the time of closure.

18. METHANE GAS VENT TESTING
Gas vents shall be tested as required by 40 CFR part 60 subpart WWW and applicable NSPS standards.

POST-CLOSURE CARE PROCEDURES

The owner of this disposal site shall conduct extended Post-Closure Care for at least 30 years after the completion of closure to adequately protect human health and the environment. Post-Closure shall consist of at least the following:

1. POST-CLOSURE USE OF THE PROPERTY
The owner shall ensure that post-closure use of property shall never be allowed to disturb the integrity of the final cover, liners, or any other components of the containment system or the function of the monitoring systems, unless the Environmental Protection Division determines that the activities are necessary to meet the requirements of chapter 391-3-4-.12. There is no planned use of this property during the Post-Closure Care Period at this time. Prior to any future use, EPD approval is required.

2. WATER MONITORING
Water monitoring, which includes groundwater and surface water, shall continue throughout the Post-Closure Care Period as described in the Plan of Operation. Following each semi-annual sampling event, results will be provided to EPD for its review. The groundwater monitoring wells shall be maintained throughout this period. An analysis of the groundwater monitoring data shall be submitted to the Solid Waste Compliance Program at the Atlanta Office of EPD every five years after the site is closed. A recommendation of the next five years of post-closure care procedures shall be submitted with this report.

3. METHANE GAS MONITORING
Methane gas monitoring shall continue on a quarterly basis at points shown on the plans for as long as EPD deems necessary. Results shall be submitted to the Solid Waste Compliance Program at the Atlanta Office of EPD within 15 days. If methane gas concentrations are noted to exceed 25 percent of the lower explosive limit on the site in structures or 5% methane by volume (100% LEL) at the property boundary, EPD shall be notified immediately and appropriate safety precautions and venting procedures shall be taken. On-site methane vents will be inspected to insure they are operational. Testing of methane vents will continue as detailed on the plans.

4. LEACHATE COLLECTION AND TREATMENT
The leachate collection shall be maintained and shall collect leachate for a minimum of 30 years or until leachate does not provide a contamination threat. During the post closure care period sampling of the leachate shall continue as described in the approved design and operational plan. The storage and pumping systems shall be monitored with a high level alarm in the tank and an alarm in the secondary containment area which indicates a 6" liquid accumulation from precipitation or a leachate tank leak. These systems shall be maintained in good working order throughout the post closure care period. Leachate, collected during the post-closure care period, shall be disposed of in a POTW approved for this purpose.

5. ROUTINE INSPECTION OF VEGETATIVE/FINAL COVER/DRAINAGE SYSTEM
Throughout the Post-Closure Care Period, the site shall be inspected on a quarterly basis to ensure that all waste disposed of in the facility remains covered with a minimum of a 42" final cover system as shown on the design and operation plan. The repair work on the soil cover or synthetic cap liner shall meet or exceed the original construction requirements. Any areas noted to have less than the required cover from the effects of erosion, vehicular traffic, etc., shall have sufficient cover placed over them within ten working days. All areas lacking proper vegetation shall be grassed and maintained according to the vegetation and fertilization plans in this plan. Downdrain systems shall be maintained in proper working condition in accordance with the Plan of Operation.

6. SEDIMENT BASIN MAINTENANCE/CLEAN-OUT
Throughout the Post-Closure Period, all ditches, diversion berms, culverts, rip-rap, silt fence and other drainage structures shall be maintained according to the Operational Procedures. Sediment ponds shall be cleaned upon the accumulation of the designed depth of silt within the pond. Erosion control structures shall be maintained so as to prevent damage to the final cover.

7. LIMITED ACCESS
Access to the site shall be controlled by fencing, gates, buffers, etc. Access shall be limited to those time periods when the site is undergoing maintenance activities.

8. POST-CLOSURE SUPERVISION
Post-Closure Care of the site shall be under the supervision of the current landfill supervisor. The person to contact about the facility during the Post-Closure Period is:

Landfill Operator
229 South Highway
Hogansville, Georgia 30230
(706) 637-8431

9. SITE EQUIPMENT
The owner shall make adequate equipment available to the municipal solid waste landfill to ensure that Post-Closure Care requirements are executed correctly and efficiently. Rental equipment shall be utilized in the event that equipment dedicated to the municipal solid waste landfill should break down during Post-Closure Care procedures.

10. DIRECTIONAL AND INFORMATIONAL SIGNS
Signs shall be posted at the entrance gate notifying users of the landfill that the facility is closed and providing the location of the nearest municipal solid waste landfill in the area.

11. REMOVAL OF WASTES
If the owner/operator of this facility wishes to remove wastes, waste residue, or any contaminated soils, the owner/operator shall request and receive written approval from EPD prior to conducting any such activity.

12. LEACHATE OUTBREAKS
The cause of leachate outbreak(s) will be assessed followed by corrective measures which will include a minimum of 12" of compacted soil and grassed in accordance with the Vegetation plan.

13. POST-CLOSURE CARE COST
The third party estimated annual cost for Post-Closure Care of this site is $135,310.00. This figure is based on 2007 year costs and shall be updated on an annual basis and submitted to EPD.

POST-CLOSURE COST ESTIMATE

ITEM NO.	ITEM	QTY.	UNIT	UNIT PRICE ($)	COSTS ($)
1.	Water Monitoring Schedule				
	Groundwater	49	Ea./Yr.	1,100.00	53,900.00
	Surface Water	8	Ea./Yr.	900.00	7,200.00
2.	Methane Gas Monitoring	Total Site	Quarterly	800.00	3,200.00
3.	Erosion & Sedimentation Controls including repair of final cap and slope failures	1	L.S.	15,000.00	15,000.00
4.	Sediment Pond Maintenance/ Cleanout	13,500	C.Y.	2.50	33,750.00
5.	Engineering Inspections	4	Quarterly	1,800.00	7,200.00
6.	Leachate Collection, Treatment & Analysis	1	L.S.	9,060.00	9,060.00
7.	Independent Construction Manager	1	Ea./Yr.	6,000.00	6,000.00
				Total Yearly Post-Closure Cost	$135,310.00

1

NOTES:
a) This post-closure cost is based on 2007 cost.
b) All costs shown include labor, materials, and equipment.
c) Cost of water & gas monitoring is based on current costs for these services.
d) The above cost estimate is based on the most expensive costs of the post-closure care during the post-closure care period.
e) Item no. 3 above is based on a contract cost to repair one(1) slope failure per year ($2,000), and replace soil and regrass one (1) acre per year ($2,000). This area is based on ±1% replacement per year. Also, a cost for engineering on these corrections ($1,000) is included.
f) During post-closure, less than 1000 gallons per year of leachate will be produced. This can be disposed at a commercial treatment facility for $0.06 per gallon or $60.00 per year. Operation and maintenance of the leachate collection system, including pumps will cost $9,000.00 per year, plus laboratory analyses.
g) During the active life of the MSWLF unit and during the post-closure care period, the owner and/or operator will annually adjust the post-closure cost estimate for inflation.
h) When a gas management system compliant with NSPS and TITLE V is approved for the site, amend the post closure cost to include the cost of operating that system. This amendment will be a minor modification to the site.

14. NOTIFICATION OF MONITORING STANDARDS EXCEEDED
The owner and/or operator shall be responsible for conducting all monitoring activities. If at any time the monitoring results indicate exceeding of established standards or indicate a threat to human health or the environment, the Owner and/or operator shall notify the Environmental Protection Division within 5 days of such determination and shall provide a plan for remediation within 30 days of such notice. The plan shall be submitted to the Director of the Environmental Protection Division for approval. Unless notified otherwise by the Division within 30 days of receipt of a complete plan, the plan shall stand approved. Upon approval, the owner and/or operator shall implement the approved plans.

15. CERTIFICATION
Following the closure of all MSWLF units, a professional engineer registered in the State of Georgia, will certify that the post-closure care was completed in accordance with the post-closure care plan and that the certification was placed in the operating record.

THIS DOCUMENT ORIGINALLY ISSUED AND SEALED BY H. LOWRY TRIBBLE, P.E. #11762 ON 11/06/07 AND WILLIAM F. HODGES, P.E. #15689 ON 11/06/07. THIS MEDIUM SHALL NOT BE CONSIDERED A CERTIFIED DOCUMENT.

REVISED: DECEMBER 23, 2013 - REVISE FINAL COVER COMPACTED SOIL VOLUME AND COST AND TOTAL CLOSURE COST IN CLOSURE COST ESTIMATE TABLE.

1 REVISED: APRIL 5, 2017 - CCR MANAGEMENT PLAN REVISIONS

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

SIGNATURE
5 April 2017
DATE

GEORGIA REGISTERED No. PE039753 PROFESSIONAL ENGINEER MUSTAFA SAADI

REVISED: NOVEMBER 5, 2007 - ADDRESS EPD COMMENTS

CLOSURE/POST CLOSURE CARE PLAN

DESIGN AND OPERATION PLAN
TURKEY RUN MSW LANDFILL
FOR
GREENBOW, LLC
MERIWETHER COUNTY, GEORGIA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
(478) 743-7175
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	3004-011-01	DWG. TURKEY-CPC-R	EDIT 11-5-07
SCALE	NOT TO SCALE	SHEET 33 OF 45	
DATE	APRIL, 2007		

ATTACHMENT B

Design Calculation Updates

ATTACHMENT B-1

Slope Stability Analysis

ATTACHMENT B1
SLOPE STABILITY ANALYSIS

PURPOSE

The Guidance Document for Coal Combustion Residuals (CCR) Management Plans issued by Georgia Environmental Protection Division (EPD) dated 22 December 2016 states that the CCR Management Plan must address landfill design considerations to account for acceptance of CCR. The purpose of this calculation package is to evaluate the static and seismic slope stability of the Turkey Run Landfill (Landfill) located in Meriwether County, GA, taking into consideration the comingling of CCR with Municipal Solid Waste (MSW) at the landfill. The location of the selected cross section and material properties are based on the original stability analysis performed by Bunnell-Lammons Engineering, Inc. (BLE) as part of the permitted landfill design calculations (BLE, 2007). The CCR Management Plan calls for the disposal of comingled CCR and MSW into the landfill with a maximum CCR to MSW ratio of 1:9 (by weight).

The remainder of this calculation package is organized as follows: (i) analysis methodology; (ii) material properties; (iii) analyzed cross section; (iv) analysis results; and (v) conclusions.

ANALYSIS METHODOLOGY

Slope stability analyses were performed using the Spencer's method (Spencer, 1973), as implemented in the computer program SLIDE, version 6.038 (Rocscience, 2016). Spencer's method, which satisfies vertical and horizontal force and moment equilibrium, is considered to be more rigorous than other methods. The SLIDE program is used to generate potential circular, non-circular, and block-type slip surfaces, calculate the factor of safety (FS) for each of these surfaces, and identify the slip surface with the lowest FS (termed as critical slip surface).

Seismic slope stability was performed using a pseudostatic approach in SLIDE. The site specific pseudostatic coefficient was selected based on a design earthquake having a two percent probability of exceedance in 50 years as discussed in BLE (2007).

Information required for the static and pseudostatic slope stability analyses include:

- the material properties (i.e., unit weight and shear strength) of the various materials and geosynthetic components;
- the geometry of the slopes and subsurface soil stratigraphy at the cross section location;
- water surface elevations; and

- pseudostatic coefficient for seismic slope stability analysis.

MATERIAL PROPERTIES

The required material properties for slope stability analysis include the unit weight and shear strength of all the materials.

Figure B1-1 presents the unit weight of MSW as reported by Zekkos et al. (2006). Furthermore, Figure B1-1 shows the well-accepted correlation between MSW unit weight and depth as established by Kazavanjian et al. (1995). The Landfill is expected to be accepting CCR and comingling CCR with MSW with a maximum CCR to MSW ratio of 1:9, by weight. Based on EPA (1988) and EPRI (2009), the unit weight of CCR is in the range of 65 – 110 pounds per cubic foot (pcf). This range of CCR unit weight (also shown on Figure B1-1) is within the variation of MSW unit weights reported by Zekkos et al. (2006). In short, both MSW and CCR encompass a similar and wide range of unit weights as shown on Figure B1-1. Given that the maximum CCR to MSW ratio is 1:9 by weight (i.e., primarily MSW and relatively small amount of CCR), the original selected unit weight of 70 pcf for the MSW by BLE (2007) appears to be reasonable and comparable to the unit weight of CCR. Nevertheless, to evaluate the effect of the unit weight on slope stability, a sensitivity study was conducted assuming a unit weight for CCR of 85 pcf, which translates into a unit weight for the comingled waste of 71.5 pcf.

The shear strength in terms of cohesion, c, and internal friction angle, ϕ, of MSW based on the original slope stability analysis report by BLE (2007) is shown in Figure B1-2. The cohesion and internal friction angle used in their analysis are 50 psf and 30^o, respectively. Kazavanjian et al. (1995) established a shear strength envelope for stability analyses of MSW landfills. This shear strength envelope shown in Figure B1-2, is well known and accepted in the industry. The strength envelope consists of $\phi = 0^o$ with c = 500 psf at normal stresses below 770 psf and $\phi = 33^o$ with c = 0 psf at higher normal stresses. Based on CCR literature reviewed (Lacour, 2012; Ramme and Tharaniyil, 2013), a typical range of shear strength of CCR was identified and is also shown in Figure B1-2. CCR is typically considered cohesionless (c = 0) and the friction angle ranges approximately between 25^o and 45^o. Based on this information, the shear strength of the comingled waste was conservatively selected as the original value reported by BLE (2007), c = 50 psf and $\phi = 30^o$. Material properties used in the current slope stability analysis are summarized in Table B1-1.

ANALYZED CROSS SECTION AND GROUNDWATER TABLE

The analyzed cross section and groundwater table were selected based on the original stability analysis performed by BLE (BLE, 2007) as part of the permitted landfill design calculations.

Consistent with the factor of safety considered acceptable by BLE as part of the permitted landfill design calculations, the target FS for long term static conditions was selected to be 1.5. Target FS for seismic conditions was selected to be 1.0.

ANALYSIS RESULTS

For the analyzed slope, the calculated critical non-circular slip surface for static conditions is shown in Figure B1-3 and the corresponding calculated FS is 1.83. For a block failure mode under static conditions, a lower calculated FS of 1.67 is found and is also shown in Figure B1-3. Under seismic conditions, the calculated FS for the critical non-circular and block failure modes are 1.44 and 1.30, respectively, as shown in Figure B1-4. The results from the slope stability analysis of the analyzed cross section are summarized in Table B1-2. The results indicate that the calculated FS exceeds the target FS for the static and seismic conditions considered in this package.

CONCLUSIONS

Static and seismic slope stability analyses were performed to evaluate slope stability for the design grades of the landfill considering that the landfill will allow for the disposal of comingled CCR and MSW (with maximum CCR to MSW ratio of 1:9, by weight). The analyzed cross section, material properties, and groundwater table were selected based on the original stability analysis performed by BLE (BLE, 2007) as part of the permitted landfill design calculations. A sensitivity study was conducted on slope stability taking into account the unit weight of the comingled waste. The results of the slope stability analysis indicate that the calculated FS exceeds the target FS for static and seismic conditions considered in this calculation package and no changes to design grades are required due to the acceptance of comingled waste with maximum CCR to MSW ratio of 1:9, by weight.

REFERENCES

BLE (2007) Supplemental Report of Slope Stability Analyses. BLE Project Number J07-3958-08, Bunnell-Lammons Engineering, Inc. (Oct 2007).

EPA (1988) Report to Congress: wastes from the combustion of coal by electric utility power plants. Report no EPA/530-SW88-002, Washington, DC, USA, Environmental Protection Agency, Office of Solid Waste, 231 pp (Feb 1988).

EPRI (2009) Coal ash: characteristics, management and environmental issues. EPRI report 1019022, Palo Alto, CA, USA, Electric Power Research Institute, 11 pp (Sep 2009).

Kavazanjian, E. Jr., Matasovic, N., Bonaparte, R., and Schmertmann, G.R. (1995). "Evaluation of MSW Properties for Seismic Analysis." *Geoenvironment 2000*, Vol. 2, 1126-1141.

Lacour, N.A. (2012). "Engineering Characteristics of Coal Combustion Residuals and a Reconstitution Technique for Triaxial Samples." Master Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Ramme, B.W. and Tharaniyil, M.P. (2013) Coal Combustion Products Utilization Handbook, 3rd Edition, A We Energies Publication, 438pp (2013), USA.

Rocscience (2016), "SLIDE – 2-D Limit Equilibrium Slope Stability for Soil and Rock Slopes," User's Guide, Rocscience Software, Inc., Toronto, Ontario, Canada.

Spencer, E. (1973), "The Thrust Line Criterion in Embankment Stability Analysis," *Géotechnique*, Vol. 23, No. 1, pp. 85-100.

Zekkos, D., Bray, D.B., Kavazanjian, E. Jr., Matasovic, N., Rathje, E.M., Riemer, M.F., and Stokoe, K.H. (2006). "Unit Weight of Municipal Solid Waste," *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 132, No. 10, pp. 1250-1261.

TABLES

Table B1-1. Summary of Selected Geotechnical Parameters

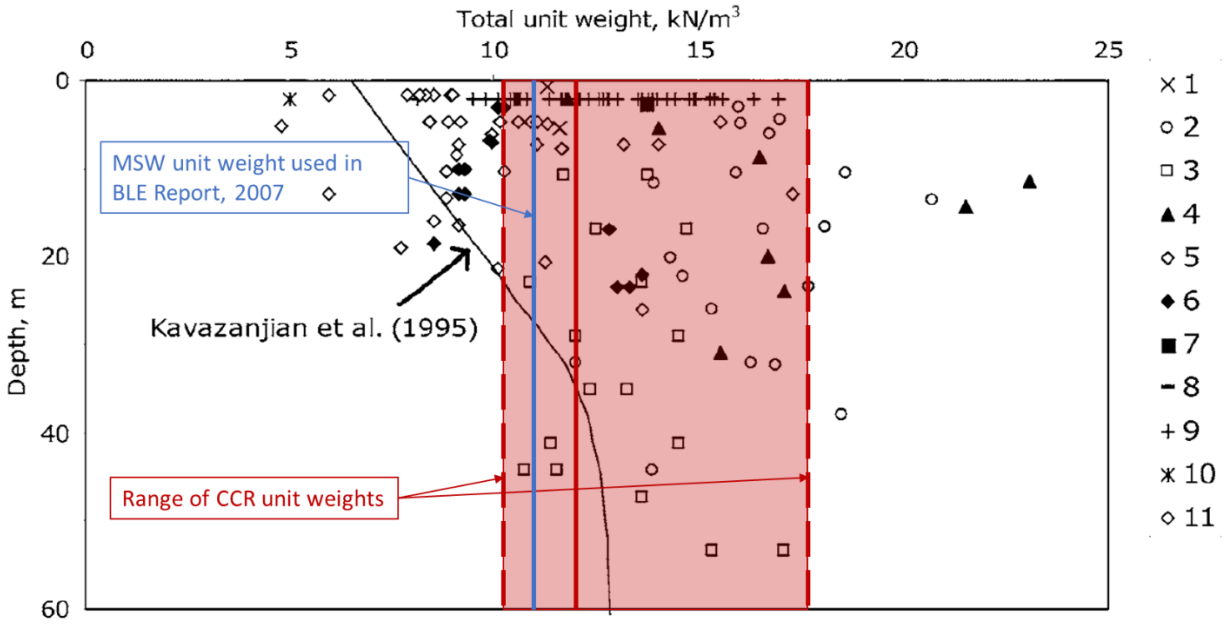
Material	Unit Weight (pcf)	Shear Strength Parameters	
		c (psf)	ϕ (deg)
Waste [1]	71.5	50	30
Residual: Loose Silty Sand[2]	110	0	30
Fill[2]	110	20	30
Interface[2]	110	0	20.5

Notes:
[1] The unit weight of the comingled waste was calculated based on the maximum CCR to MSW ratio of 1:9, by weight, where the MSW unit weight is assumed to be 70 pcf the CCR unit weight is assumed to be 85 pcf. The shear strength parameters of waste were obtained from the Slope Stability Report by BLE (2007).
[2] Unit weight and shear strength parameters were obtained from the Slope Stability Report by BLE (2007).

Table B1-2. Calculated Factor of Safety

Condition	Failure Mode	Calculated FS	Target FS	Figure Number
Static	Non-Circular	1.83	1.5	B1-3
	Block	1.67	1.5	
Seismic	Non-Circular	1.44	1.0	B1-4
	Block	1.30	1.0	

FIGURES



(1) Santo Tirso, Portugal (Gomes et al. 2002); (2) OII, California, USA (Matasovic and Kavazanjian, 1998); (3) Azusa, California, USA (Kavazanjian et al, 1996); (4) Tri-Cities, California, USA (this study); (5) no name older landfill (Oweis and Khera, 1998); (6) no name younger landfill (Oweis and Khera, 1998); (7) Hong Kong, China (Cowland et al. 1993); (8) Central Maine landfill, USA (Richardson and Reynolds, 1991); (9) 11 Canadian landfills (Landva & Clark, 1986); (10) Valdemingomez, Spain (Pereira et al. 2002); (11) Cherry Island landfill, Delaware, USA (Geosyntec, 2003);

Figure B1-1. Unit Weight Values from In-Situ Large Scale Tests (after Zekkos et al. 2006)

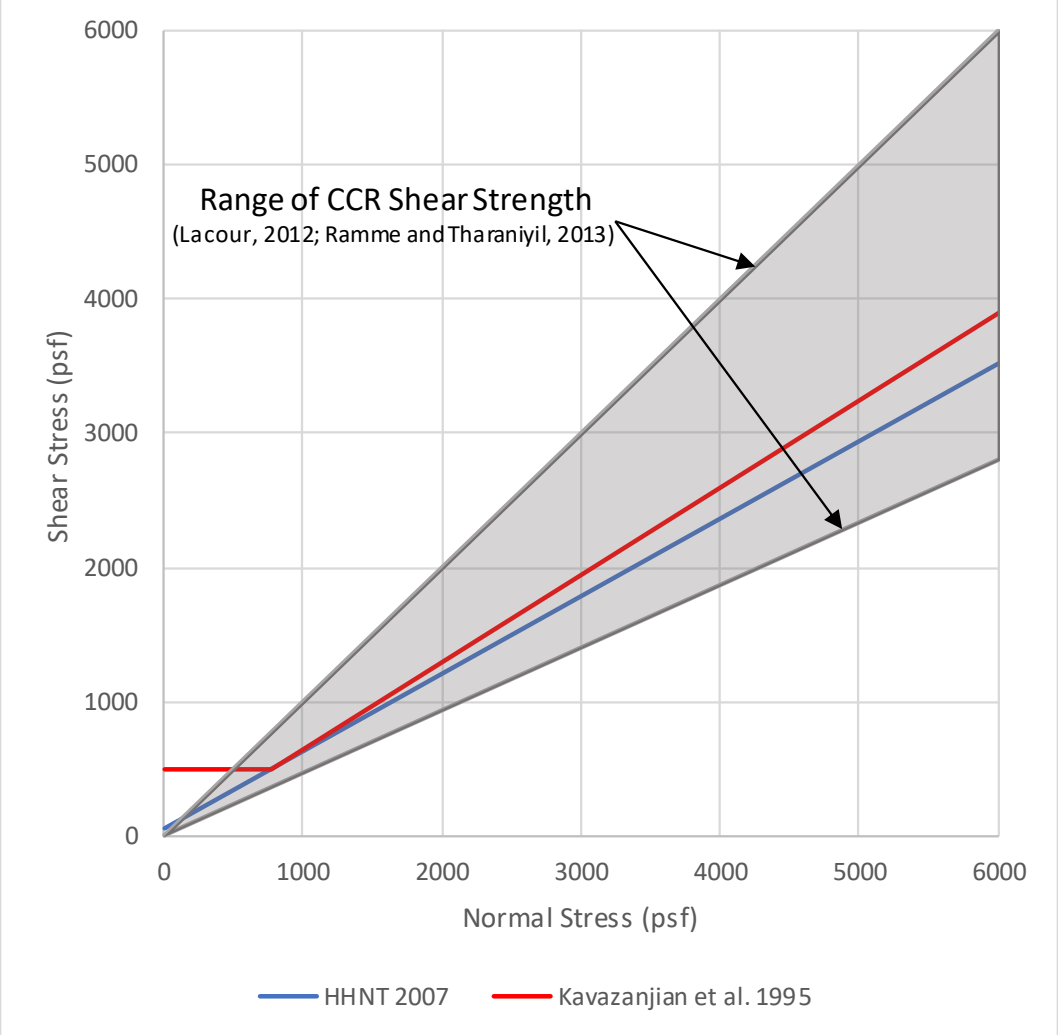


Figure B1-2. Shear Strength Envelopes of MSW and CCR

Prepared by: **W. Tabet** Date: **3/30/2017** Reviewed by: **S. Nadukuru** Date: **4/4/2017**

Client: **Waste Management** Project: **Turkey Run Landfill CCR Management Plan** Project No.: **GR6304** Phase No.: **02/01**

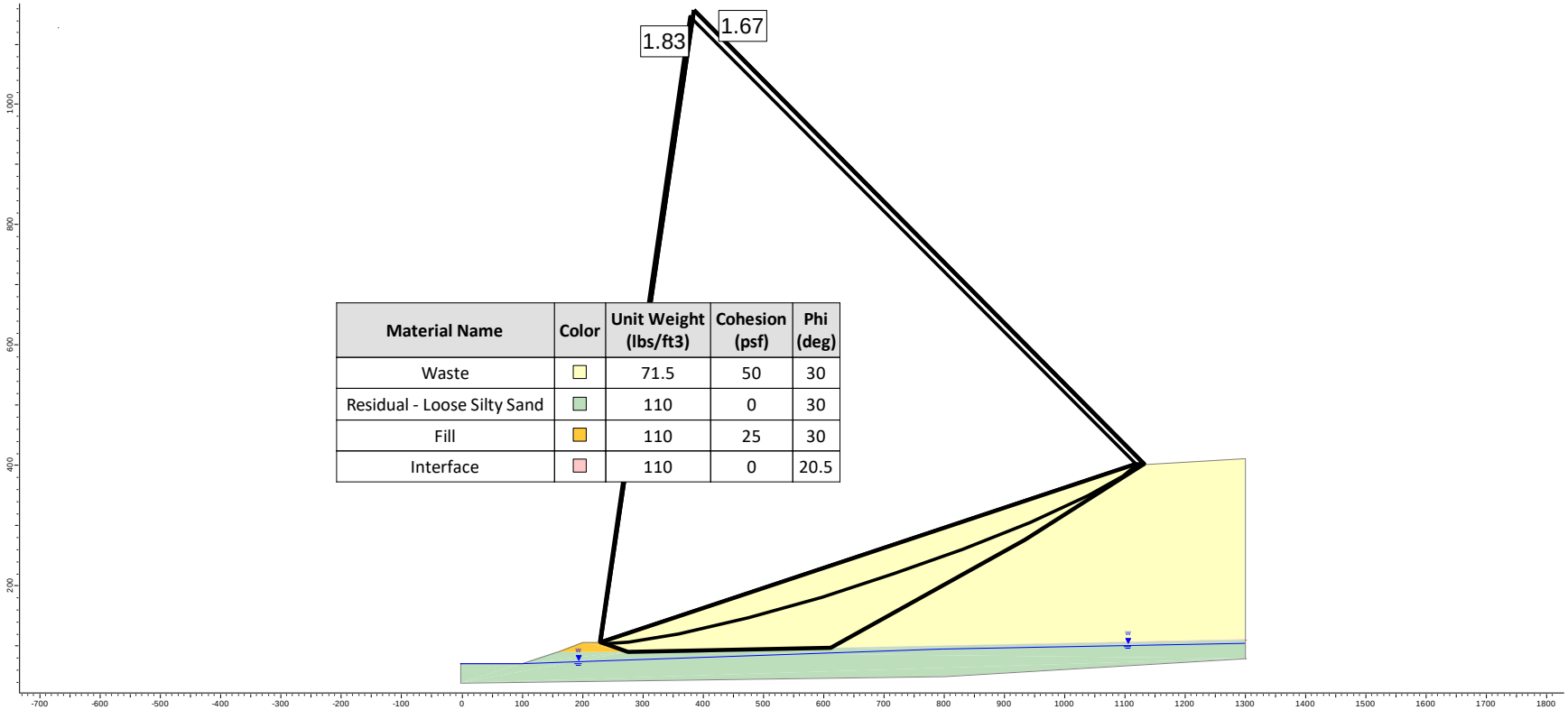
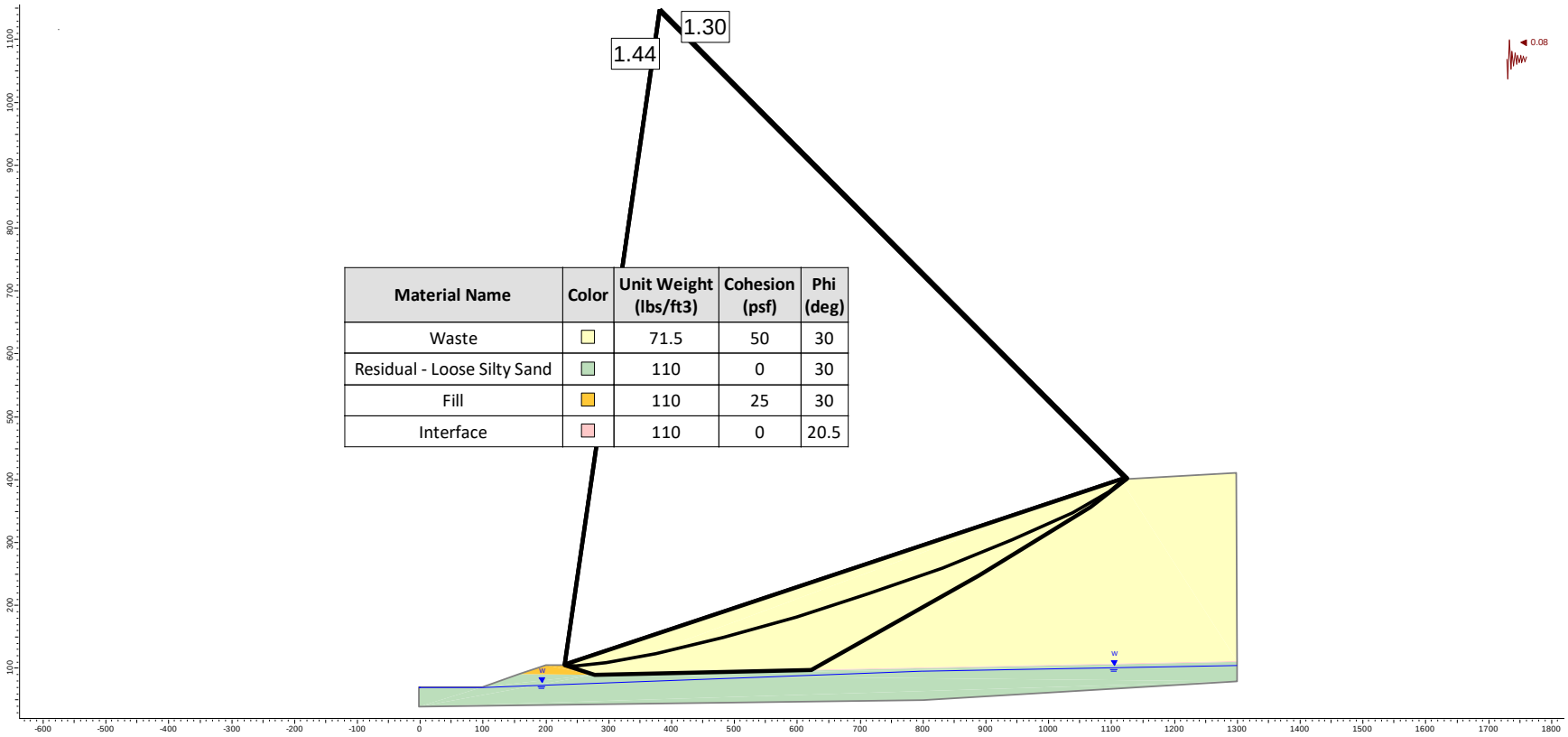


Figure B1-3. Slope Stability Analysis Results Under Static Conditions

Prepared by: **W. Tabet** Date: **3/30/2017** Reviewed by: **S. Nadukuru** Date: **4/4/2017**

Client: **Waste Management** Project: **Turkey Run Landfill CCR Management Plan** Project No.: **GR6304** Phase No.: **02/01**



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Waste		71.5	50	30
Residual - Loose Silty Sand		110	0	30
Fill		110	25	30
Interface		110	0	20.5

Figure B1-4. Slope Stability Analysis Results Under Seismic Conditions

ATTACHMENT B-2

Settlement Analysis

Prepared by:	W. Tabet	Date:	3/24/2017	Reviewed by:	S. Nadukuru	Date:	3/31/2017
Client:	Waste Management	Project:	Turkey Run Landfill CCR Management Plan	Project No.:	GR6304	Phase No.:	02/02

ATTACHMENT B2
SETTLEMENT ANALYSIS

PURPOSE

The Guidance Document for Coal Combustion Residuals (CCR) Management Plans by Georgia Environmental Protection Division (EPD) dated 22 December 2016 states that the CCR Management Plan must address landfill design considerations to account for acceptance of CCR. The purpose of this calculation package is to calculate the estimated subgrade settlement due to overburden stress from the CCR comingled with Municipal Solid Waste (MSW) at Turkey Run Landfill (Landfill), Meriwether County, Georgia. Based on the information provided by Waste Management, the landfill is expected to accept the disposal of comingled CCR and MSW with maximum CCR to MSW ratio of 1:9, by weight. The calculated settlements and separation of the liner from the groundwater table post settlement are based on the subsurface properties discussed by Bunnell-Lammons Engineering, Inc. (BLE) in the permitted landfill design calculations, BLE (2007) (Permit No. 099-019 D(MSWL)).

The remainder of this calculation package is organized as follows: (i) methodology; (ii) material properties; (iii) analysis results; and (iv) conclusions.

METHODOLOGY

For the purpose of this calculation package, the settlements were evaluated at two soil borings, PZ-2 and PZ-19, that are located within the landfill footprint and had: (i) the minimum separation to groundwater table; and (ii) the maximum calculated settlement, based on the calculations provided in BLE (2007). From these two borings, it was observed that all the subsurface soils consist of sandy soils. Consistent with the calculations presented in BLE (2007), only elastic settlements were estimated at these locations. The immediate or elastic settlement, s, is estimated using the theory of elasticity and can be calculated using equations (1) and (2) below:

$$s = \varepsilon \cdot H \quad (1)$$

$$\varepsilon = \sigma / E \quad (2)$$

where ε = strain,
H = layer thickness,
σ = stress,
E = Young's modulus.

MATERIAL PROPERTIES

The material properties of CCR comingled with MSW are discussed in Attachment B1: Slope Stability Analysis. Consistent with the discussion presented in Attachment B1, a sensitivity analysis was performed as part of this settlement analysis assuming a comingled CCR with MSW unit weight of 71.5 pounds per cubic feet (pcf). The Young's modulus of the subsurface soils at the two borings PZ-2 and PZ-19 was selected to be consistent with BLE (2007) (presented in Table B2-1).

ANALYSIS RESULTS

The maximum total subgrade settlement and separation of the liner from the groundwater table were estimated at soil borings PZ-2 and PZ-19. At PZ-2, the maximum subgrade settlement and separation of the liner from the groundwater table were estimated to be 0.3 feet and 5 feet, respectively, while at PZ-19 they were estimated to be 0.8 feet and 6 feet, respectively. The results are summarized in Table B2-1. The calculated settlement indicates that the minimum required separation distance of 5 feet between the liner and the groundwater table, per Solid Waste Management Rule 391-3-4-.07. Landfill Design and Operations, is met.

CONCLUSIONS

The maximum total subgrade settlement and separation of the liner from the groundwater table were evaluated taking into consideration that the landfill will allow for the disposal of comingled CCR and MSW (with maximum CCR to MSW ratio of 1:9, by weight). Settlements were evaluated at two soil borings, PZ-2 and PZ-19, located within the landfill footprint, that had the minimum separation to groundwater table and maximum calculated settlement, respectively, based on the calculations provided in BLE (2007). The calculated maximum settlement at the analyzed soil borings indicates that the minimum required separation distance of 5 feet between the liner and the groundwater table, per Solid Waste Management Rule 391-3-4-.07. Landfill Design and Operations, is met. Therefore, no modifications to the landfill design is required due to the acceptance of comingled CCR and MSW with maximum CCR to MSW ratio of 1:9, by weight.

REFERENCES

BLE (2007) Revised Report of Estimated Settlement. BLE Project Number J07-3958-08, Bunnell-Lammons Engineering, Inc. (Oct 2007).

TABLE

Table B2-1. Summary of Settlement Calculations

Boring Number	Soil Type	Layer Thickness (feet)	Surcharge Pressure[1] (psf)	Soil Modulus[2] (ksf)	Layer Settlement (feet)	Groundwater Separation (feet)
PZ-2	Loose-Firm Silty Sand	30	4,658	470	0.3	5
	Very Dense Silty Sand	5	4658	1250		
PZ-19	Very Stiff Sandy Silt	16	10,597	720	0.8	6
	Loose Silty Sand	24	10,597	470		

Notes:
[1] Surcharge pressure assumes unit weight of comingled waste (maximum CCR to MSW ratio of 1:9, by weight) of 71.5 pcf.
[2] Soil modulus obtained from BLE (2007).
[3] Soil description and layer thickness obtained from BLE (2007).

ATTACHMENT B-3

Leachate Collection and Removal System Design Calculations: Maximum Head on Liner & Drainage Evaluations

Prepared by:	R. Mijares	Date:	3/28/2017	Reviewed by:	R. Joshi	Date:	4/4/2017
Client:	Waste Management	Project:	Turkey Run Landfill CCR Management Plan	Project No.:	GR6304	Phase No.:	02/03

ATTACHMENT B3
LEACHATE COLLECTION AND REMOVAL SYSTEM
DESIGN CALCULATIONS: MAXIMUM HEAD ON LINER SYSTEM & DRAINAGE EVALUATION

INTRODUCTION

The Guidance Document for Coal Combustion Residuals (CCR) Management Plans by Georgia Environmental Protection Division (EPD) dated 22 December 2016 requires that the CCR Management Plan must address landfill design considerations due to acceptance of CCR. This includes design consistency on the leachate collection and removal system (LCRS) which requires maintaining its functionality and limiting the hydraulic head on the liner system geomembrane to a maximum of 30 cm under normal operating conditions.

The permitted liner system for the Turkey Run Landfill includes an LCRS consisting of a drainage geocomposite (geonet drainage core with geotextile on both sides). Hence, the maximum hydraulic head is required to be maintained within the thickness of the geonet drainage core (i.e., significantly less than 30 cm) to ensure that the drainage capacity of the geocomposite is not exceeded.

HELP MODEL COMPUTATIONS

The design calculations performed by Richardson Smith Gardner & Associates, Inc. (RSG), dated 6 November 2007, as part of the permitted landfill design package (Permit No. 099-019 D(MSWL)) [RSG, 2007], recommended a drainage geocomposite with a 0.25-inch thick geonet drainage core. The Hydrologic Evaluation of Landfill Performance (HELP) model, Version 3.07 [Schroeder, et al., 1994a; Schroeder, et al., 1994b] was used to estimate the maximum hydraulic head on the geomembrane component of the liner system to verify that the peak daily head that will be developed under a 25-year, 24-hour storm event for the site (i.e., 6.8 inches) would not exceed the thickness of the geonet drainage core. Three conditions were considered in its evaluation: (i) Case 1 (Active Conditions) – a scenario consisting of 30 ft of waste in-place with 12 inches of cover; (ii) Case 2 (Intermediate Conditions) – a scenario consisting of 100 ft of waste in-place with 12 inches of intermediate cover; and (iii) Case 3 (Final Conditions) – a scenario consisting of 250 ft of waste in-place with final cover.

The design calculations performed by RSG assumed a saturated hydraulic conductivity of MSW equal to 1×10^{-3} cm/s. The CCR Management Plan calls for the disposal of comingled CCR and MSW into the landfill with maximum CCR to MSW ratio of 1:9 (by weight). The hydraulic

conductivity of CCR is very variable and depends on a number of factors (e.g., CCR type, nature of deposition, moisture content, etc.). Fly ash, which typically consists of silt-size particles, is reported to have a saturated hydraulic conductivity ranging from 1×10^{-6} cm/s to 1×10^{-4} cm/s [EPRI, 2009; Ramme and Tharaniyil, 2013; Zhang, 2014]. Bottom ash, which typically consists of fine to coarse grained sand-size particles [EPRI, 2009], is more permeable and is reported to have a saturated hydraulic conductivity ranging from 1×10^{-3} cm/s to 1×10^{-1} cm/s [EPRI, 2009; Ramme and Tharaniyil, 2013; Zhang, 2014]. The CCR expected to be accepted at the Turkey Run Landfill may consist of fly ash or bottom ash or other ash contaminated soils and is therefore anticipated to be heterogenous. MSW is also a heterogeneous material. The comingling of CCR with MSW may result in the CCR particles filling voids within MSW and thereby rendering a less permeable waste mass. However, given the relatively small quantity of CCR being comingled with MSW, the effect on reduction of the saturated hydraulic conductivity of the waste mass is anticipated to be minimal, if any. To verify the effect of the anticipated reduction, if there is any, in the saturated hydraulic conductivity due to comingling of CCR and MSW, the HELP model runs performed by RSG for the three conditions were re-analyzed using a value for the saturated hydraulic conductivity of the waste layer (i.e., comingled CCR and MSW) equal to 1×10^{-4} cm/s (i.e., an order of magnitude lower than the originally assumed value of 1×10^{-3} cm/s); all other parameters were kept the same. Appendix B3-A presents the results of the revised HELP model runs. As shown, for the three conditions, the calculated peak daily heads did not exceed the thickness of the geonet drainage core. Hence, the LCRS would still be able to continue to maintain its functionality even when the landfill allows the disposal of comingled CCR and MSW (with maximum CCR to MSW ratio of 1:9, by weight) and limit the hydraulic head on the liner system geomembrane within the thickness of the geonet drainage core.

Filter Geotextile Analysis

The design calculations performed by RSG also demonstrated that the upper geotextile component of the proposed drainage geocomposite would be able to provide proper retention to protect the drainage media from piping and clogging from adjacent soil and also provide proper drainage from the adjacent soil. Accordingly, the geotextile filtration properties were selected based on the up-gradient soil gradation and plasticity. In the design calculations, RSG assumed that the 24-inch thick protective soil cover above the drainage geocomposite will be silty sands and non-dispersive.

This CCR Management Plan does not intend to modify the original specifications for the 24-inch thick protective soil cover. Hence, no changes to the filter geotextile analysis performed by RSG are necessary. Furthermore, this CCR Management Plan recommends that, prior to placement of comingled CCR and MSW (with maximum CCR to MSW ratio of 1:9, by weight) into the landfill,

a minimum 10-ft thick lift of select MSW without any CCR shall be placed on top of the 24-inch protective soil cover. Gradation curves for typical fly ash are shown in Figure B3-1 [EPRI, 2012]. As shown, the fly ash is typically in the silt-size range. Therefore, with CCR gradation comparable to the gradation of a silty soil and the placement of select MSW layer above the protective soil cover as an added buffer, the geotextile component of the drainage geocomposite would still be able to provide proper retention and drainage even when the landfill allows the disposal of comingled CCR and MSW (with maximum CCR to MSW ratio of 1:9, by weight).

Leachate Collection Pipe Capacity

The design calculations performed by RSG also demonstrated that the proposed leachate collection pipes would be able to adequately accommodate the anticipated flow in the system and support the weight of the overlying waste. RSG estimated the flow capacity of the proposed 8-inch diameter leachate collection pipe to be approximately 1.23 cfs, or 552 gpm.

Based on the results of the HELP model runs presented in Appendix B3-A, for comingled CCR and MSW (with maximum CCR to MSW ratio of 1:9, by weight), the estimated maximum drainage collected from the drainage geocomposite is approximately 160.57 cubic feet per day per acre, or 1,202 gallons per day per acre (Case 1). For the 32.71 acres of base liner where the greatest flow would be anticipated (as discussed by RSG), the maximum total flow is approximately 39,318 gallons per day, or 27.3 gpm. Hence, the proposed leachate collection pipes would be able to adequately accommodate the maximum flow in the system that is anticipated for comingled CCR and MSW (with maximum CCR to MSW ratio of 1:9, by weight) with a factor of safety of 20.2 (i.e., 552gpm / 27.3 gpm = 20.2).

SUMMARY AND CONCLUSIONS

The LCRS would still be able to continue to maintain its functionality even when the landfill allows the disposal of comingled CCR and MSW (with maximum CCR to MSW ratio of 1:9, by weight) and limit the hydraulic head on the liner system geomembrane within the thickness of the geonet drainage core. The design of the LCRS, therefore, would require no further changes and the LCRS would be able to handle the acceptance of comingled CCR and MSW. Furthermore, the proposed leachate collection pipes would also be able to adequately accommodate the maximum flow in the system that is anticipated for comingled CCR and MSW.

REFERENCES

EPRI, 2009. Characterization of coal combustion residues from electric utilities – Leaching and characterization data, Report No. EPA-600/R-09/151.

EPRI, 2012. Geotechnical properties of fly ash and potential for static liquefaction, Volume 1 – Summary and Conclusions, Technical Report, Electric Power Research Institute.

Ramme, B.W., and Tharaniyil, M.P., 2013. Coal combustion products utilization handbook, 3rd Edition, We Energies Publication, 438 p.

RSG, 2007. Leachate Collection/Protective Cover System Evaluation, Turkey Run MSW Landfill, Richardson Smith Gardner & Associates, Inc. (6 November 2007).

Schroeder, P.R., Lloyd, C.M., and Zappi, P.A., 1994a. The hydrologic evaluation of landfill performance (HELP) model, User's guide for version 3, U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C., Report No. EPA/600/R-94/168a.

Schroeder, P.R., Dozier, T.S., Zappi, P.A., McEnroe, B.M., Sjostrom, J.W., and Peyton, R.L., 1994b. The hydrologic evaluation of landfill performance (HELP) model – Engineering documentation for version 3, U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C., Report No. EPA/600/R-94/168b, 116 p.

Zhang, X., 2014. Management of coal combustion wastes, IEA Clean Coal Centre.

FIGURE

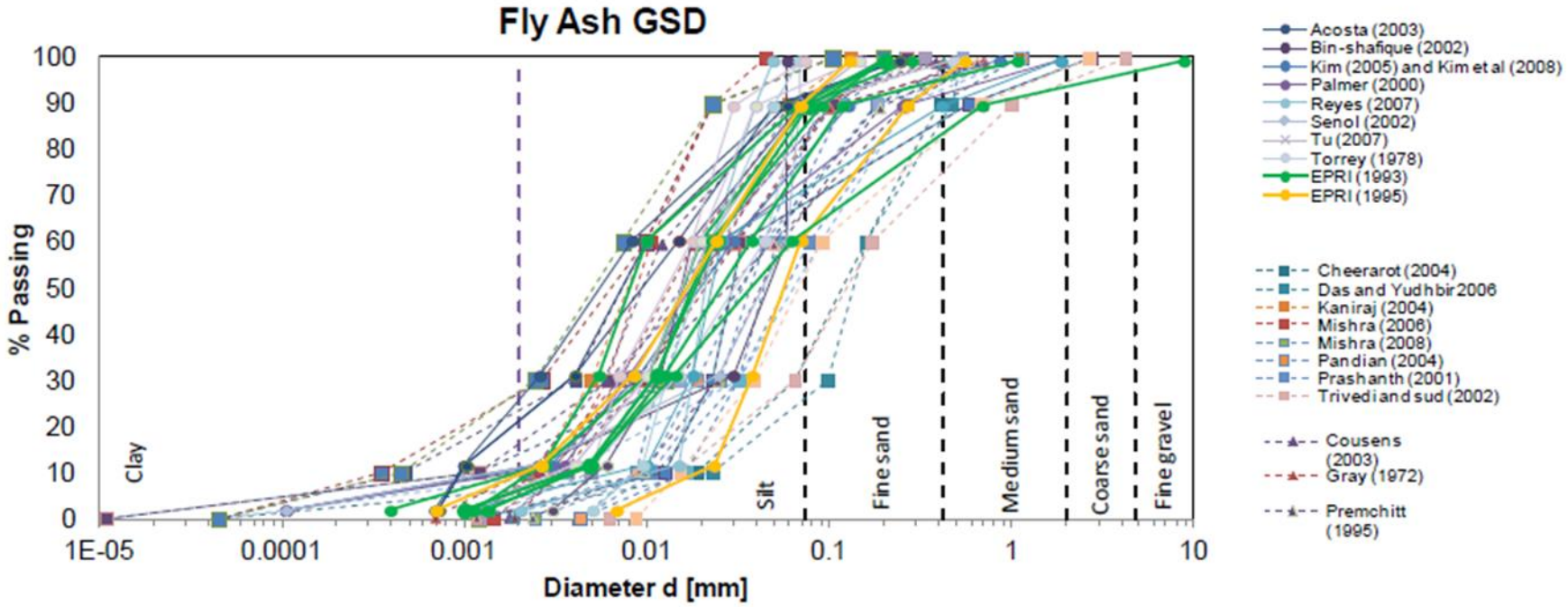


Figure B3-1. Fly Ash Particle Size Distribution [EPRI, 2012]

APPENDIX B3-A
HELP MODEL OUTPUT

```
**********************************************************************
**********************************************************************
**                                                                  **
**                                                                  **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE        **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)        **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY          **
**                     USAE WATERWAYS EXPERIMENT STATION            **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY      **
**                                                                  **
**                                                                  **
**********************************************************************
**********************************************************************


PRECIPITATION DATA FILE:    C:\HELP\TRLRUN1.D4
TEMPERATURE DATA FILE:      C:\HELP\TRLRUN1.D7
SOLAR RADIATION DATA FILE:  C:\HELP\TRLRUN1.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\TRLRUN1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\TRLRUN1R.D10
OUTPUT DATA FILE:           C:\HELP\TRLRUN1R.OUT


TIME:  15:59     DATE:   3/28/2017


**********************************************************************

     TITLE:  TURKEY RUN LANDFILL - 30' Waste w/ 12" Cover (Case 1)

**********************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
               COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  10
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.3980 VOL/VOL
          FIELD CAPACITY               =      0.2440 VOL/VOL
          WILTING POINT                =      0.1360 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2688 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.119999997000E-03 CM/SEC
       NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                LAYER  2
                                --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =    360.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3021 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-04 CM/SEC


                                LAYER  3
                                --------
```



```
                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   1
          THICKNESS                    =     24.00   INCHES
          POROSITY                     =      0.4170 VOL/VOL
          FIELD CAPACITY               =      0.0450 VOL/VOL
          WILTING POINT                =      0.0180 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1047 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.999999978000E-02 CM/SEC


                                LAYER  4
                                --------

                    TYPE 2 - LATERAL DRAINAGE LAYER
                        MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =      0.25   INCHES
          POROSITY                     =      0.8500 VOL/VOL
          FIELD CAPACITY               =      0.0100 VOL/VOL
          WILTING POINT                =      0.0050 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0214 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =   7.86999989000     CM/SEC
          SLOPE                        =      2.00   PERCENT
          DRAINAGE LENGTH              =    300.0    FEET


                                LAYER  5
                                --------

                    TYPE 4 - FLEXIBLE MEMBRANE LINER
                        MATERIAL TEXTURE NUMBER  35
          THICKNESS                    =      0.06   INCHES
          POROSITY                     =      0.0000 VOL/VOL
          FIELD CAPACITY               =      0.0000 VOL/VOL
          WILTING POINT                =      0.0000 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
          FML PINHOLE DENSITY          =      0.00   HOLES/ACRE
          FML INSTALLATION DEFECTS     =      4.00   HOLES/ACRE
          FML PLACEMENT QUALITY        =  3 - GOOD


                                LAYER  6
                                --------

                    TYPE 3 - BARRIER SOIL LINER
                        MATERIAL TEXTURE NUMBER  16
          THICKNESS                    =     24.00   INCHES
          POROSITY                     =      0.4270 VOL/VOL
          FIELD CAPACITY               =      0.4180 VOL/VOL
          WILTING POINT                =      0.3670 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.4270 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000001000E-06 CM/SEC


               GENERAL DESIGN AND EVAPORATIVE ZONE DATA
               ---------------------------------------

        NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                 SOIL DATA BASE USING SOIL TEXTURE #10 WITH BARE
                 GROUND CONDITIONS, A SURFACE SLOPE OF  5.% AND
                 A SLOPE LENGTH OF  300. FEET.

      SCS RUNOFF CURVE NUMBER             =     94.00
      FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
      AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
      EVAPORATIVE ZONE DEPTH              =     22.0    INCHES
      INITIAL WATER IN EVAPORATIVE ZONE   =      7.393  INCHES
```

```
       UPPER LIMIT OF EVAPORATIVE STORAGE  =     11.486  INCHES
       LOWER LIMIT OF EVAPORATIVE STORAGE  =      2.402  INCHES
       INITIAL SNOW WATER                  =      0.000  INCHES
       INITIAL WATER IN LAYER MATERIALS    =    124.765  INCHES
       TOTAL INITIAL WATER                 =    124.765  INCHES
       TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


                EVAPOTRANSPIRATION AND WEATHER DATA
                -----------------------------------

        NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                 MACON                 GEORGIA

            STATION LATITUDE                        =  32.42 DEGREES
            MAXIMUM LEAF AREA INDEX                 =   2.00
            START OF GROWING SEASON (JULIAN DATE)   =     61
            END OF GROWING SEASON (JULIAN DATE)     =    330
            EVAPORATIVE ZONE DEPTH                  =  22.0  INCHES
            AVERAGE ANNUAL WIND SPEED               =   7.70 MPH
            AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  69.00 %
            AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  69.00 %
            AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  77.00 %
            AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  72.00 %


        NOTE:  PRECIPITATION DATA FOR     ATLANTA             GEORGIA
                 WAS ENTERED FROM THE DEFAULT DATA FILE.


        NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    MACON               GEORGIA

            NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

    JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
    -------     -------     -------     -------     -------     -------
     46.60       49.20       56.50       65.30       72.70       78.90
     81.40       81.00       76.00       65.20       55.30       48.70


        NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    MACON               GEORGIA
                   AND STATION LATITUDE  =  32.42 DEGREES


********************************************************************************

        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1974 THROUGH 1978
--------------------------------------------------------------------------------

                          JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                          -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                  6.16     3.94     6.21     2.94     4.96     3.39
                            4.79     4.05     2.08     3.34     4.50     3.76

    STD. DEVIATIONS         1.82     3.60     3.57     1.25     2.19     1.23
                            2.28     2.33     1.81     1.90     1.47     0.98

  RUNOFF
  ------
    TOTALS                  2.326    1.045    1.896    0.678    1.109    0.465
                            1.030    0.840    0.275    0.994    1.305    0.804

    STD. DEVIATIONS         1.902    1.337    1.887    0.560    1.195    0.288
                            0.616    0.626    0.417    0.923    1.033    0.454
```



```
  EVAPOTRANSPIRATION
  ------------------
    TOTALS                  1.715    2.028    2.959    3.285    4.961    3.648
                            3.315    3.355    1.895    1.465    1.130    1.234

    STD. DEVIATIONS         0.159    0.376    0.274    0.546    0.917    1.073
                            1.554    1.501    1.125    0.659    0.156    0.133

  LATERAL DRAINAGE COLLECTED FROM LAYER  4
  ----------------------------------------
    TOTALS                  0.5642   0.4079   0.2729   0.1196   0.1905   0.2618
                            0.4038   0.7519   0.6982   0.6885   0.6343   0.6280

    STD. DEVIATIONS         0.1346   0.0863   0.0226   0.0250   0.1237   0.2778
                            0.2156   0.1435   0.1192   0.1128   0.0998   0.0966

  PERCOLATION/LEAKAGE THROUGH LAYER  6
  -------------------------------------
    TOTALS                  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


--------------------------------------------------------------------------------
              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
--------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  5
  -------------------------------------
    AVERAGES                0.0061   0.0049   0.0030   0.0013   0.0021   0.0029
                            0.0044   0.0082   0.0078   0.0075   0.0071   0.0068

    STD. DEVIATIONS         0.0015   0.0010   0.0002   0.0003   0.0013   0.0031
                            0.0023   0.0016   0.0013   0.0012   0.0011   0.0010

********************************************************************************


********************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1974 THROUGH 1978
--------------------------------------------------------------------------------
                                        INCHES            CU. FEET       PERCENT
                                   -------------------   -------------   ---------
  PRECIPITATION                    50.13    (   9.333)     181971.9     100.00

  RUNOFF                           12.766   (  3.9269)      46339.75     25.465

  EVAPOTRANSPIRATION               30.989   (  3.8803)     112488.62     61.816

  LATERAL DRAINAGE COLLECTED        5.62166 (  0.92974)     20406.625    11.21416
    FROM LAYER  4

  PERCOLATION/LEAKAGE THROUGH       0.00001 (  0.00000)         0.035     0.00002
    LAYER  6

  AVERAGE HEAD ON TOP               0.005 (    0.001)
    OF LAYER  5

  CHANGE IN WATER STORAGE           0.754   (  3.6815)       2736.87      1.504

********************************************************************************
```

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PEAK DAILY VALUES FOR YEARS 1974 THROUGH 1978

	(INCHES)	(CU. FT.)
PRECIPITATION	6.80	24684.000
RUNOFF	5.353	19430.3262
DRAINAGE COLLECTED FROM LAYER 4	0.04424	160.57309
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00021
AVERAGE HEAD ON TOP OF LAYER 5	0.015	
MAXIMUM HEAD ON TOP OF LAYER 5	0.030	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	1.24	4514.7563

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3809
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1092

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

****

****

FINAL WATER STORAGE AT END OF YEAR 1978

LAYER	(INCHES)	(VOL/VOL)
1	3.1860	0.2655
2	112.4356	0.3123
3	2.6575	0.1107
4	0.0078	0.0311
5	0.0000	0.0000
6	10.2480	0.4270
SNOW WATER	0.000	

****
****

```
*******************************************************************************
*******************************************************************************
**                                                                           **
**                                                                           **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                     USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                           **
**                                                                           **
*******************************************************************************
*******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP\TRLRUN2.D4
TEMPERATURE DATA FILE:      C:\HELP\TRLRUN2.D7
SOLAR RADIATION DATA FILE:  C:\HELP\TRLRUN2.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\TRLRUN2.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\TRLRUN2R.D10
OUTPUT DATA FILE:           C:\HELP\TRLRUN2R.OUT


TIME:  16: 5     DATE:   3/28/2017


*******************************************************************************

     TITLE:  TURKEY RUN LANDFILL - 100' Waste w/ 12" Cover (Case 2)

*******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
               COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  10
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.3980 VOL/VOL
          FIELD CAPACITY               =      0.2440 VOL/VOL
          WILTING POINT                =      0.1360 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2688 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.119999997000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =   1200.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2954 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-04 CM/SEC


                                  LAYER  3
                                  --------
```



```
                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   1
          THICKNESS                    =     24.00   INCHES
          POROSITY                     =      0.4170 VOL/VOL
          FIELD CAPACITY               =      0.0450 VOL/VOL
          WILTING POINT                =      0.0180 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1031 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.999999978000E-02 CM/SEC


                                  LAYER  4
                                  --------

                     TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =      0.25   INCHES
          POROSITY                     =      0.8500 VOL/VOL
          FIELD CAPACITY               =      0.0100 VOL/VOL
          WILTING POINT                =      0.0050 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0344 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =   3.17000008000     CM/SEC
          SLOPE                        =      2.00   PERCENT
          DRAINAGE LENGTH              =    300.0    FEET


                                  LAYER  5
                                  --------

                     TYPE 4 - FLEXIBLE MEMBRANE LINER
                         MATERIAL TEXTURE NUMBER  35
          THICKNESS                    =      0.06   INCHES
          POROSITY                     =      0.0000 VOL/VOL
          FIELD CAPACITY               =      0.0000 VOL/VOL
          WILTING POINT                =      0.0000 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
          FML PINHOLE DENSITY          =      0.00   HOLES/ACRE
          FML INSTALLATION DEFECTS     =      4.00   HOLES/ACRE
          FML PLACEMENT QUALITY        =  3 - GOOD


                                  LAYER  6
                                  --------

                     TYPE 3 - BARRIER SOIL LINER
                     MATERIAL TEXTURE NUMBER  16
          THICKNESS                    =     24.00   INCHES
          POROSITY                     =      0.4270 VOL/VOL
          FIELD CAPACITY               =      0.4180 VOL/VOL
          WILTING POINT                =      0.3670 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.4270 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000001000E-06 CM/SEC


               GENERAL DESIGN AND EVAPORATIVE ZONE DATA
               ---------------------------------------

      NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
               SOIL DATA BASE USING SOIL TEXTURE #10 WITH BARE
               GROUND CONDITIONS, A SURFACE SLOPE OF  5.% AND
               A SLOPE LENGTH OF  300. FEET.

     SCS RUNOFF CURVE NUMBER             =     94.00
     FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
     AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
     EVAPORATIVE ZONE DEPTH              =     22.0    INCHES
     INITIAL WATER IN EVAPORATIVE ZONE   =      7.393  INCHES
```

```
       UPPER LIMIT OF EVAPORATIVE STORAGE  =     11.486  INCHES
       LOWER LIMIT OF EVAPORATIVE STORAGE  =      2.402  INCHES
       INITIAL SNOW WATER                  =      0.000  INCHES
       INITIAL WATER IN LAYER MATERIALS    =    370.494  INCHES
       TOTAL INITIAL WATER                 =    370.494  INCHES
       TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


                 EVAPOTRANSPIRATION AND WEATHER DATA
                 -----------------------------------

        NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                 MACON                 GEORGIA

            STATION LATITUDE                        =  32.42 DEGREES
            MAXIMUM LEAF AREA INDEX                 =   2.00
            START OF GROWING SEASON (JULIAN DATE)   =     61
            END OF GROWING SEASON (JULIAN DATE)     =    330
            EVAPORATIVE ZONE DEPTH                  =  22.0  INCHES
            AVERAGE ANNUAL WIND SPEED               =   7.70 MPH
            AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  69.00 %
            AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  69.00 %
            AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  77.00 %
            AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  72.00 %


        NOTE:  PRECIPITATION DATA FOR     ATLANTA             GEORGIA
                 WAS ENTERED FROM THE DEFAULT DATA FILE.


        NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    MACON               GEORGIA

            NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

    JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
    -------     -------     -------     -------     -------     -------
     46.60       49.20       56.50       65.30       72.70       78.90
     81.40       81.00       76.00       65.20       55.30       48.70


        NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                 COEFFICIENTS FOR    MACON               GEORGIA
                   AND STATION LATITUDE  =  32.42 DEGREES


********************************************************************************

        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1974 THROUGH 1978
--------------------------------------------------------------------------------

                          JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                          -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                  6.16     3.94     6.21     2.94     4.96     3.39
                            4.79     4.05     2.08     3.34     4.50     3.76

    STD. DEVIATIONS         1.82     3.60     3.57     1.25     2.19     1.23
                            2.28     2.33     1.81     1.90     1.47     0.98

  RUNOFF
  ------
    TOTALS                  2.326    1.045    1.896    0.678    1.109    0.465
                            1.030    0.840    0.275    0.994    1.305    0.804

    STD. DEVIATIONS         1.902    1.337    1.887    0.560    1.195    0.288
                            0.616    0.626    0.417    0.923    1.033    0.454
```



```
  EVAPOTRANSPIRATION
  ------------------
    TOTALS                  1.715    2.028    2.959    3.285    4.961    3.648
                            3.315    3.355    1.895    1.465    1.130    1.234

    STD. DEVIATIONS         0.159    0.376    0.274    0.546    0.917    1.073
                            1.554    1.501    1.125    0.659    0.156    0.133

  LATERAL DRAINAGE COLLECTED FROM LAYER  4
  ----------------------------------------
    TOTALS                  0.4235   0.3580   0.2213   0.1042   0.0960   0.0992
                            0.1331   0.1951   0.4080   0.4420   0.4270   0.4396

    STD. DEVIATIONS         0.0674   0.0721   0.0094   0.0210   0.0333   0.0393
                            0.1946   0.1750   0.0583   0.0513   0.0482   0.0542

  PERCOLATION/LEAKAGE THROUGH LAYER  6
  -------------------------------------
    TOTALS                  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


--------------------------------------------------------------------------------
              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
--------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  5
  -------------------------------------
    AVERAGES                0.0114   0.0106   0.0060   0.0029   0.0026   0.0028
                            0.0036   0.0053   0.0114   0.0119   0.0119   0.0118

    STD. DEVIATIONS         0.0018   0.0021   0.0003   0.0006   0.0009   0.0011
                            0.0052   0.0047   0.0016   0.0014   0.0013   0.0015

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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1974 THROUGH 1978
--------------------------------------------------------------------------------

                                        INCHES              CU. FEET       PERCENT
                                    -------------------   -------------   ---------
  PRECIPITATION                     50.13    (   9.333)      181971.9      100.00

  RUNOFF                            12.766   (  3.9269)       46339.75      25.465

  EVAPOTRANSPIRATION                30.989   (  3.8803)      112488.62      61.816

  LATERAL DRAINAGE COLLECTED         3.34692 (  0.52627)      12149.336     6.67649
    FROM LAYER  4

  PERCOLATION/LEAKAGE THROUGH        0.00001 (  0.00000)          0.045     0.00002
    LAYER  6

  AVERAGE HEAD ON TOP                0.008 (    0.001)
    OF LAYER  5

  CHANGE IN WATER STORAGE            3.029   (  3.7763)       10994.11      6.042

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PEAK DAILY VALUES FOR YEARS 1974 THROUGH 1978

	(INCHES)	(CU. FT.)
PRECIPITATION	6.80	24684.000
RUNOFF	5.353	19430.3262
DRAINAGE COLLECTED FROM LAYER 4	0.02984	108.32829
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00032
AVERAGE HEAD ON TOP OF LAYER 5	0.025	
MAXIMUM HEAD ON TOP OF LAYER 5	0.050	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	1.24	4514.7563

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3809
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1092

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1978

LAYER	(INCHES)	(VOL/VOL)
1	3.1860	0.2655
2	369.5950	0.3080
3	2.5954	0.1081
4	0.0132	0.0530
5	0.0000	0.0000
6	10.2480	0.4270
SNOW WATER	0.000	

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**********************************************************************
**********************************************************************
**                                                                  **
**                                                                  **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE        **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)        **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY          **
**                     USAE WATERWAYS EXPERIMENT STATION            **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY      **
**                                                                  **
**                                                                  **
**********************************************************************
**********************************************************************


PRECIPITATION DATA FILE:    C:\HELP\TRLRUN3.D4
TEMPERATURE DATA FILE:      C:\HELP\TRLRUN3.D7
SOLAR RADIATION DATA FILE:  C:\HELP\TRLRUN3.D13
EVAPOTRANSPIRATION DATA:    C:\HELP\TRLRUN3.D11
SOIL AND DESIGN DATA FILE:  C:\HELP\TRLRUN3R.D10
OUTPUT DATA FILE:           C:\HELP\TRLRUN3R.OUT


TIME:  16: 9     DATE:   3/28/2017


**********************************************************************

     TITLE:  TURKEY RUN LANDFILL - 250' Waste w/ Final Cover (Case 3)

**********************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  10
          THICKNESS                    =     24.00   INCHES
          POROSITY                     =      0.3980 VOL/VOL
          FIELD CAPACITY               =      0.2440 VOL/VOL
          WILTING POINT                =      0.1360 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2929 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.119999997000E-03 CM/SEC
       NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                LAYER  2
                                --------

                     TYPE 2 - LATERAL DRAINAGE LAYER
                       MATERIAL TEXTURE NUMBER  20
          THICKNESS                    =      0.25   INCHES
          POROSITY                     =      0.8500 VOL/VOL
          FIELD CAPACITY               =      0.0100 VOL/VOL
          WILTING POINT                =      0.0050 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0176 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =   10.0000000000     CM/SEC
          SLOPE                        =     33.00   PERCENT
          DRAINAGE LENGTH              =    150.0    FEET
```



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                                LAYER  3
                                --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  36
     THICKNESS                    =      0.04   INCHES
     POROSITY                     =      0.0000 VOL/VOL
     FIELD CAPACITY               =      0.0000 VOL/VOL
     WILTING POINT                =      0.0000 VOL/VOL
     INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.399999993000E-12 CM/SEC
     FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
     FML INSTALLATION DEFECTS     =      8.00   HOLES/ACRE
     FML PLACEMENT QUALITY        =  3 - GOOD


                                LAYER  4
                                --------

                TYPE 3 - BARRIER SOIL LINER
                  MATERIAL TEXTURE NUMBER   0
     THICKNESS                    =     18.00   INCHES
     POROSITY                     =      0.4190 VOL/VOL
     FIELD CAPACITY               =      0.3070 VOL/VOL
     WILTING POINT                =      0.1800 VOL/VOL
     INITIAL SOIL WATER CONTENT   =      0.4190 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                                LAYER  5
                                --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   0
     THICKNESS                    =   3000.00   INCHES
     POROSITY                     =      0.6710 VOL/VOL
     FIELD CAPACITY               =      0.2920 VOL/VOL
     WILTING POINT                =      0.0770 VOL/VOL
     INITIAL SOIL WATER CONTENT   =      0.2920 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-04 CM/SEC


                                LAYER  6
                                --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   1
     THICKNESS                    =     24.00   INCHES
     POROSITY                     =      0.4170 VOL/VOL
     FIELD CAPACITY               =      0.0450 VOL/VOL
     WILTING POINT                =      0.0180 VOL/VOL
     INITIAL SOIL WATER CONTENT   =      0.0450 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.999999978000E-02 CM/SEC


                                LAYER  7
                                --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER   0
     THICKNESS                    =      0.25   INCHES
     POROSITY                     =      0.8500 VOL/VOL
     FIELD CAPACITY               =      0.0100 VOL/VOL
     WILTING POINT                =      0.0050 VOL/VOL
     INITIAL SOIL WATER CONTENT   =      0.0100 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.409999996000     CM/SEC
     SLOPE                        =      2.00   PERCENT
     DRAINAGE LENGTH              =    300.0    FEET
```

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	= 0.06	INCHES
POROSITY	= 0.0000	VOL/VOL
FIELD CAPACITY	= 0.0000	VOL/VOL
WILTING POINT	= 0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	= 0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	= 0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	= 0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	= 4.00	HOLES/ACRE
FML PLACEMENT QUALITY	= 3 - GOOD	

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	= 24.00	INCHES
POROSITY	= 0.4270	VOL/VOL
FIELD CAPACITY	= 0.4180	VOL/VOL
WILTING POINT	= 0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	= 0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	= 0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #10 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 33.% AND A SLOPE LENGTH OF 150. FEET.

SCS RUNOFF CURVE NUMBER	= 87.20		
FRACTION OF AREA ALLOWING RUNOFF	= 100.0	PERCENT	
AREA PROJECTED ON HORIZONTAL PLANE	= 1.000	ACRES	
EVAPORATIVE ZONE DEPTH	= 22.0	INCHES	
INITIAL WATER IN EVAPORATIVE ZONE	= 6.379	INCHES	
UPPER LIMIT OF EVAPORATIVE STORAGE	= 8.756	INCHES	
LOWER LIMIT OF EVAPORATIVE STORAGE	= 2.992	INCHES	
INITIAL SNOW WATER	= 0.000	INCHES	
INITIAL WATER IN LAYER MATERIALS	= 901.907	INCHES	
TOTAL INITIAL WATER	= 901.907	INCHES	
TOTAL SUBSURFACE INFLOW	= 0.00	INCHES/YEAR	

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM MACON GEORGIA

STATION LATITUDE	= 32.42	DEGREES
MAXIMUM LEAF AREA INDEX	= 2.00	
START OF GROWING SEASON (JULIAN DATE)	= 61	
END OF GROWING SEASON (JULIAN DATE)	= 330	
EVAPORATIVE ZONE DEPTH	= 22.0	INCHES
AVERAGE ANNUAL WIND SPEED	= 7.70	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	= 69.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	= 69.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	= 77.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	= 72.00	%

NOTE: PRECIPITATION DATA FOR ATLANTA GEORGIA WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR MACON GEORGIA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
46.60	49.20	56.50	65.30	72.70	78.90
81.40	81.00	76.00	65.20	55.30	48.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR MACON GEORGIA AND STATION LATITUDE = 32.42 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1974 THROUGH 1978

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	6.16	3.94	6.21	2.94	4.96	3.39
	4.79	4.05	2.08	3.34	4.50	3.76
STD. DEVIATIONS	1.82	3.60	3.57	1.25	2.19	1.23
	2.28	2.33	1.81	1.90	1.47	0.98
RUNOFF						
TOTALS	1.322	0.428	0.985	0.222	0.393	0.107
	0.284	0.281	0.062	0.374	0.665	0.247
STD. DEVIATIONS	1.565	0.663	1.281	0.277	0.570	0.100
	0.263	0.329	0.096	0.449	0.877	0.194
EVAPOTRANSPIRATION						
TOTALS	1.831	2.047	3.082	3.404	4.635	4.036
	3.731	3.984	2.149	1.495	1.173	1.346
STD. DEVIATIONS	0.109	0.446	0.278	0.662	1.259	1.019
	1.654	1.676	1.435	0.656	0.113	0.108
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	3.6908	2.1185	1.5962	0.9366	0.0397	0.0082
	0.0930	0.0651	0.0062	0.3629	1.0786	1.9733
STD. DEVIATIONS	0.9219	2.3415	1.4957	0.6203	0.0835	0.0075
	0.1760	0.1004	0.0069	0.5227	1.4657	1.1578
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.0011	0.0007	0.0005	0.0003	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0001	0.0003	0.0006
STD. DEVIATIONS	0.0003	0.0007	0.0004	0.0002	0.0000	0.0000
	0.0001	0.0000	0.0000	0.0002	0.0004	0.0003

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1974 THROUGH 1978

	INCHES	CU. FEET	PERCENT
PRECIPITATION	50.13 (9.333)	181971.9	100.00
RUNOFF	5.369 (2.8244)	19489.59	10.710
EVAPOTRANSPIRATION	32.911 (3.9484)	119466.68	65.651
LATERAL DRAINAGE COLLECTED FROM LAYER 2	11.96908 (4.61522)	43447.762	23.87608
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00003 (0.00001)	0.119	0.00007
AVERAGE HEAD ON TOP OF LAYER 3	0.000 (0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	0.00003 (0.00001)	0.114	0.00006
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000 (0.00000)	0.006	0.00000

AVERAGE HEAD ON TOP OF LAYER 8	0.000 (0.000)		
CHANGE IN WATER STORAGE	-0.119 (0.7080)	-432.30	-0.238

PEAK DAILY VALUES FOR YEARS 1974 THROUGH 1978

	(INCHES)	(CU. FT.)
PRECIPITATION	6.80	24684.000
RUNOFF	3.986	14468.7168
DRAINAGE COLLECTED FROM LAYER 2	0.88296	3205.14136
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000002	0.00673
AVERAGE HEAD ON TOP OF LAYER 3	0.008	
MAXIMUM HEAD ON TOP OF LAYER 3	0.030	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 7	0.00000	0.00767
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000000	0.00003
AVERAGE HEAD ON TOP OF LAYER 8	0.000	
MAXIMUM HEAD ON TOP OF LAYER 8	0.007	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	1.24	4514.7563

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3548

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1360

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1978

LAYER	(INCHES)	(VOL/VOL)
1	6.4371	0.2682
2	0.0026	0.0104
3	0.0000	0.0000
4	7.5420	0.4190
5	875.9999	0.2920
6	1.0800	0.0450
7	0.0025	0.0100
8	0.0000	0.0000
9	10.2480	0.4270
SNOW WATER	0.000	

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ATTACHMENT B-4

Leachate Collection and Removal System Design Calculations: Pipe Structural Stability

Prepared by:	R. Mijares	Date:	4/1/2017	Reviewed by:	R. Joshi	Date:	4/4/2017
Client:	Waste Management	Project:	Turkey Run Landfill CCR Management Plan	Project No.:	GR6304	Phase No.:	02/04

ATTACHMENT B4
LEACHATE COLLECTION AND REMOVAL SYSTEM
DESIGN CALCULATIONS: PIPE STRUCTURAL STABILITY

INTRODUCTION

The Guidance Document for Coal Combustion Residuals (CCR) Management Plans by Georgia Environmental Protection Division (EPD) dated 22 December 2016 requires that the CCR Management Plan must address landfill design considerations due to acceptance of CCR. This includes design consistency on the leachate collection and removal system (LCRS) which requires that its pipes must able to support the weight of the comingled CCR and MSW, without damage.

PIPE STRUCTURAL STABILITY

The design calculations performed by Richardson Smith Gardner & Associates, Inc. (RSG), dated 6 November 2007, as part of the permitted landfill design package (Permit No. 099-019 D(MSWL)) [RSG, 2007], recommended an 8-inch diameter, high density polyethylene (HDPE) SDR-11 leachate collection pipes. To ensure the structural stability of the pipes, wall crushing and wall buckling of the leachate collection pipes were evaluated by RSG.

Under a total depth of 295 ft (i.e., 3.5 ft of final cover and 291.5 ft of waste), RSG have demonstrated that the SDR-11 pipe proposed for the leachate collection pipes would be able to support the overburden load and would be able to withstand wall crushing and wall buckling with adequate factors of safety. In the design calculations, RSG assumed a waste unit weight of 70 pcf. As discussed in Attachment B1 of the CCR Management Plan, the estimated unit weight of comingled CCR and MSW (with maximum CCR to MSW ratio of 1:9, by weight) is approximately 71.5 pcf. Hence, the design calculations performed by RSG were updated using the revised unit weight (see Appendix B4-A).

As shown in the marked-up RSG calculations presented in Appendix B4-A, the leachate collection pipes would be able to support the weight of comingled CCR and MSW (with maximum CCR to MSW ratio of 1:9, by weight) with adequate factors of safety.

SUMMARY AND CONCLUSIONS

The proposed leachate collection pipes would be able support the weight of the comingled CCR and MSW (with maximum CCR to MSW ratio of 1:9, by weight) with adequate factors of safety.

REFERENCES

RSG, 2007. Leachate Collection/Protective Cover System Evaluation, Turkey Run MSW Landfill, Richardson Smith Gardner & Associates, Inc. (6 November 2007).

APPENDIX B4-A

UPDATES TO RSG (2007) CALCULATIONS

b. Burial Design of Leachate Collection Pipe

Leachate Collection Pipe in the Turkey Run MSW Landfill serves as one of the conveyance devices whereby leachate is gravity drained. The leachate collection pipe is encased in ASTM No. 57 gravel encasement. This gravel encasement serves the dual purpose of bedding and a secondary means of leachate transport. The open spaces in the gravel provide an additional porous transport pathway.

In order to assure that the leachate collection pipe does not collapse, wall crushing and wall buckling calculations should be performed and the safety factor should not be less than 1.5. A sample calculation is provided as an example which incorporates the specific conditions for the worst case condition which is in Cell No. 2. The calculations and safety factor for Cell No. 2 are provided below since the construction of this cell will result in the greatest depth of waste being located over the pipes.

Wall Crushing

Wall crushing would theoretically occur when the stress in a pipe wall, due to the external vertical pressure, exceeds the long-term compressive strength of the pipe material. To ensure that the wall is strong enough to endure the external pressure the following check should be made:

$$S_A = \frac{(SDR - 1)}{2} P_t$$

Where: S_A = Actual compressive strength, psi
SDR = Standard Dimension Ratio
P_t = External Pressure, psi

Safety Factor = 1500 psi ÷ S_A where 1500 is the Compressive Yield Strength of the pipe.

Wall Crushing Calculation - Cell No. 2 (Worst Case)

a. Calculate Total External Pressure = P_t (psi)

Assume live loads - 0 psi
Maximum depth = 295' (3.5' final cover + 291.5' waste)
Waste Unit Weight = 70 lbs. per cu. ft.
Final Cover Unit Weight = 110 lbs. per cu. ft.

P_t = (waste unit weight x maximum depth, 291.5') + (final cover unit weight x 3.5')

~~= 291.5 (70) + 3.5 (110)~~
~~= 20,790 PSF = 144 PSI~~

= 291.5(71.5) + 3.5(110)
= 21,227.25 PSF = 147.41 PSI

Total External Pressure = ~~144 PSI~~ 147.41 PSI

b. Calculate S_A

S_a = Actual compression stress, psi
SDR = Standard Dimension Ratio
P_t = External Pressure, psi

$$S_A = \frac{(SDR - 1)(P_t)}{2}$$

SDR = 11 for Cell 2

$$S_A = \frac{(11 - 1)(144)}{2} = 720 \text{ PSI}$$

$$= \frac{(11-1)(147.41)}{2} = 737.05 \text{ PSI}$$

Actual Compression Stress = ~~720 PSI~~ 737.05 PSI

c. Determine Safety Factor

$$\text{Safety Factor} = \frac{\text{Comprehensive Yield Strength of pipe}}{\text{Actual Compression Stress}}$$

1500 psi = Compressive Yield Strength of Pipe, psi

$$\text{Safety Factor} = \frac{1500}{720} = 2.1 \text{ (ok)}$$

$$= \frac{1500}{737.05} = 2.0 \text{ (ok)}$$

Wall Buckling

Wall buckling is a longitudinal wrinkling of the pipe wall. Buckling can be forced to occur over the long term in non-pressurized pipe if the total external soil pressure, P_t, is allowed to exceed the pipe-soil system's critical buckling pressure, P_{CB}. A calculated, conservative value for the critical buckling pressure may be obtained by the following formula obtained from the Driscopipe Design Manual. This calculation is performed for Cell No. 2, where the greatest depth of waste is projected.

$$P_{CB} = 0.8\sqrt{E' \times P_C}$$

Where: P_{CB} = Critical buckling soil pressure at the top of the pipe (PSI)
E' = Soil modulus in PSI calculated as the ratio of the vertical soil pressure to vertical soil strain at a specified density
P_C= Hydrostatic, critical collapse differential pressure (PSI)

$$P_C = \frac{2.32\,E}{(SDR)^3}$$

Where: E = Stress and time dependent tensile modulus of elasticity – Chart 25 of Driscopipe Manual (psi)

Safety Factor = P_{CB} / P_t should be ≥ 1.0

a. Calculate P_C

P_C = Hydrostatic, Critical Collapse Differential Pressure
E = Modulus of Elasticity (E = 15,147 for Cell No. 2)
SDR = Standard Dimension Ratio (SDR = 11 for Cell No. 2)

$$P_C = \frac{2.32\,E}{(SDR)^3}$$

$$P_C = \frac{2.32\,(15{,}147)}{(11)^3} = 26.40\ PSI$$

b. Determine P_{CB}

P_{CB} = Critical buckling soil pressure at the top of the pipe (*PSI*)

E′ = Modulus of elasticity in soil (±3,000 for gravel)

$$P_{CB} = 0.8\sqrt{E' \times P_C}$$

$$P_{CB} = 0.8\sqrt{(3000) \times (26.4)} = 225\ PSI$$

c. Calculate Safety Factor

$$\text{Safety Factor} = \frac{\text{Critical Buckling Soil Pressure}}{\text{Total External Pressure}}$$

Safety Factor = 225 / 144 = 1.6 (okay) = 225 / 147.41 = 1.5 (okay)

The cells meet or exceed the minimum 1.0 required safety factor. (The reason the minimum safety factor equals 1.0 in burial applications is because of the margin of safety provided by the arching action of the soil.)

Gravity Flow

Gravity Flow systems are typified by industrial and municipal waste and sewer lines as well as water and slurry pipelines. Some may operate with full flow and some may operate partially full. Because of the superior wall smoothness and excellent flow characteristics of Driscopipe, an efficient system can be designed.

Smaller diameters to carry a given flow mean reduced costs. Because Driscopipe does not "age", maintenance costs are less. Reduced operating costs supported by the reliability of Driscopipe can mean improved service.

Full Flow: Three things are required to select and size Driscopipe for a full flow gravity system: (1) GPM flow-rate requirements, (2) the slope of the pipeline and (3) a selection of an appropriate pipe I.D.

Based upon a full flow situation, the GPM flow rate can be calculated from the Manning equation as follows:

$$Q = 98.3\, A\, R_h^{2/3} S^{1/2}$$

Where: Q = Flow in gpm
R_h = Hydraulic radius (ID ÷ 4) (inches)
S = Slope (ft./foot)
A = Cross sectional area of pipe I.D. in sq. inches
V = Velocity (ft./sec.)
ID = Inside diameter in inches
(Note: Above formula includes $\eta = .009$)

The velocity can be calculated by:

$$V = 31.5\, R_h^{2/3} S^{1/2} = \left(\frac{.320\, Q}{A}\right)$$

The inside diameter by:

$$I.D. = \sqrt[2.67]{\frac{.03279\, Q}{S^{1/2}}}$$

And the slope by:

$$S = \frac{.001075\, Q^2}{I.D.^{5.34}}$$

All of this has been simplified and reduced into Chart 7. By use of this nomogram, the designer can specify a pipe I.D., slope, and the flow rate matched to the system requirements. By considering elevation changes, etc., the proper SDR can be selected. All I.D. and O.D. dimensions for each SDR can be found on Driscopipe dimensional charts.

Note: Beyond 122.8 inches (10.2 ft.) the soil friction will overcome the tensile force developed by thermal contraction of the pipeline. This is calculated by dividing the tensile force in the pipe by the frictional resistance of the soil (ie: 781.3 lbs. ÷ 6.363 lbs./in. = 122.8 Inches)

Theoretical Movement of *Unrestrained* Ends:

$\Delta L = L \cdot \varepsilon$

ΔL = (122.8 ins.)(.0024 in./in.) = .295 in.

Design of Collar:

By sidewall fusing branch saddles capable of taking the shear force onto the pipe near the terminal connection, and then pouring a square concrete collar around the pipe and branch saddles into undisturbed soil, the tensile force of 781.3 lbs. is removed from the pipe connection and is evenly distributed into the soil. Assume a collar 12 inches square and 6 inches wide is used.

Area of Collar = (12" × 12") – (Cross Sectional Area of Pipe)

A = (144 – 16) sq.in.

A = 128 sq. in. surface area

Compressive Stress on soil due to load transfer by collar face:

S = F ÷ A

S = 71.3 lbs. ÷ 128 sq. in. = 6.1 psi

EXAMPLE DESIGN SUMMARY

Under a 20°F instantaneous temperature change, a 4" SDR 15.5 pipeline 1000 ft. long buried five feet deep will try to change length .295" at each end. The pipe is restrained by soil friction from further contraction. A concrete collar with a square face of 12" × 12" will absorb the tensile force of 781.3 lbs. due to thermal contraction, and distribute it into the soil at a compressive soil stress of 6.1 psi.

Circumferential coefficient of expansion is 0.6×10^{-4} in/in/°F.

Chart 16

Driscopipe Pressure Rating (psi) vs. Temperature (°F)

Temp. °F	Hoop Stress (psi)	Pipe SDR								
		32.5	26	21	19	17	15.5	13.5	11	9.3
50	1820	58	73	90	100	113	125	145	180	215
60	1730	55	69	86	96	108	119	138	170	207
73.4	**1600**	**51**	**64**	**80**	**90**	**100**	**110**	**128**	**160**	**190**
80	1520	48	60	76	85	95	105	122	150	182
90	1390	44	56	70	77	87	96	111	140	167
100	1260	40	50	63	70	79	87	101	125	150
110	1130	36	45	57	63	71	78	90	113	135
120	1000	32	40	50	56	63	69	80	100	120
130	900	28	36	45	50	56	62	72	90	108
140	800	25	32	40	45	50	55	64	80	96

Chart 17
Instantaneous Modulus of Elasticity vs. Temperature

140°F	50,000 psi
100°F	100,000 psi
73.4°F	110,000 psi
50°F	165,000 psi
32°F	200,000 psi
0°F	260,000 psi
–20°F	300,000 psi

Simplified Burial Design: A conservative estimate of the ability of Driscopipe pipelines to perform in a buried environment is found in Chart 24. It is based on a minimum 2:1 safety factor and 50 year design service life. A detailed burial design starts on page 37. The detailed design should be used for critical or marginal applications or whenever a more precise solution is desired.

Detailed Burial Design:

Design by Wall Crushing: Wall crushing would theoretically occur when the stress in a pipe wall, due to the external vertical pressure, exceeded the long-term compressive strength of the pipe material. To ensure that the Driscopipe wall is strong enough to endure the external pressure the following check should be made:

$$S_A = \frac{(SDR - 1)}{2} P_T$$

Values of E′

Based on Soil Type (ASTM D2321) and Degree of Compaction

Soil Type of Initial Backfill Embedment Material	Description	E′ (psi) for Degree of Compaction (Proctor Density, %) Loose	Slight (70-85%)	Moderate (85-95%)	High (95%)
I	Manufactured angular, granular materials (crushed stone or rock, broken coral, cinders, etc.)	1,000	3,000	3,000	3,000
II	Coarse grained soils with little or no fines	N.R.	1,000	2,000	3,000
III	Coarse grained soils with fines	N.R.	N.R.	1,000	2,000
IV	Fine-grained soils	N.R.	N.R.	N.R.	N.R.
V	Organic soils (peat, muck, clay, etc.)	N.R.	N.R.	N.R.	N.R.

N.R. = Not Recommended for use by ASTM D2321 for pipe wall support

Chart 24

SDR	Maximum Burial Depth, ft. in dry soil of 100 lbs/cu. ft. Soil Modulus, psi*			Maximum External Pressure psi Soil Modulus, psi*			Maximum Deflection, % after installation Soil Modulus, psi*		
	1000	2000	3000	1000	2000	3000	1000	2000	3000
32.5	25	32	37	17	22	26	1.7	0.9	0.6
26	33	45	52	23	31	36	2.3	1.2	0.8
21	46	61	71	32	42	49	3.2	1.6	1.1
19	52	69	81	36	48	56	3.6	1.8	1.2
17	61	121	181	42	84	126	4.2	2.1	1.4
15.5	56	112	168	39	78	117	3.9	2.0	1.3
13.5	49	98	147	34	68	102	3.4	1.7	1.1
11	39	78	117	27	54	81	2.7	1.4	0.9
9.3	33	68	101	23	47	70	2.3	1.2	0.8
8.3	30	61	89	21	42	62	2.1	1.1	0.7
7.3	26	52	79	18	36	55	1.8	0.9	0.6

*assumes no external loads

Where: S_A = Actual compressive stress, psi
SDR = Standard Dimension Ratio
P_T = External Pressure, psi

Safety Factor = 1500 psi ÷ S_A where 1500 psi is the Compressive Yield Strength of Driscopipe.

Design by Wall Buckling: Local wall buckling is a longitudinal wrinkling of the pipe wall. Tests of *non-pressurized* Driscopipe show that buckling and collapse do not occur when the soil envelope is in full contact with the pipe and is compacted to a dense state. However, it can be forced to occur over the long term in *non-pressurized* pipe if the total external soil pressure, P_t, is allowed to exceed the pipe-soil system's critical buckling pressure, P_{cb}. If $P_t > P_{cb}$, gradual collapse may occur over the long term. A calculated, conservative value for the critical buckling pressure may be obtained by the following approximate formula. All pipe diameters with the same SDR in the same burial situation have the same critical collapse and critical buckling endurance

$$P_{cb} = 0.8\sqrt{E' \times P_c}$$

Where:

P_t = Total vertical soil pressure at the top of the pipe, psi

P_{cb} = Critical buckling soil pressure at the top of the pipe, psi

E' = Soil modulus in psi calculated as the ratio of the vertical soil pressure to vertical soil strain at a specified density

P_C = Hydrostatic, critical-collapse differential pressure, psi

$$P_C = \frac{2E\,(t/D)^3\,(D_{MIN}/D_{MAX})^3}{(1-\mu^2)}$$

$$P_c = \frac{2.32\,E}{(SDR)^3}$$

Where: $(D_{MIN}/D_{MAX}) = .95$
μ = Poission's Ratio
μ = .45 for Driscopipe
E = stress and time dependent tensile modulus of elasticity, psi

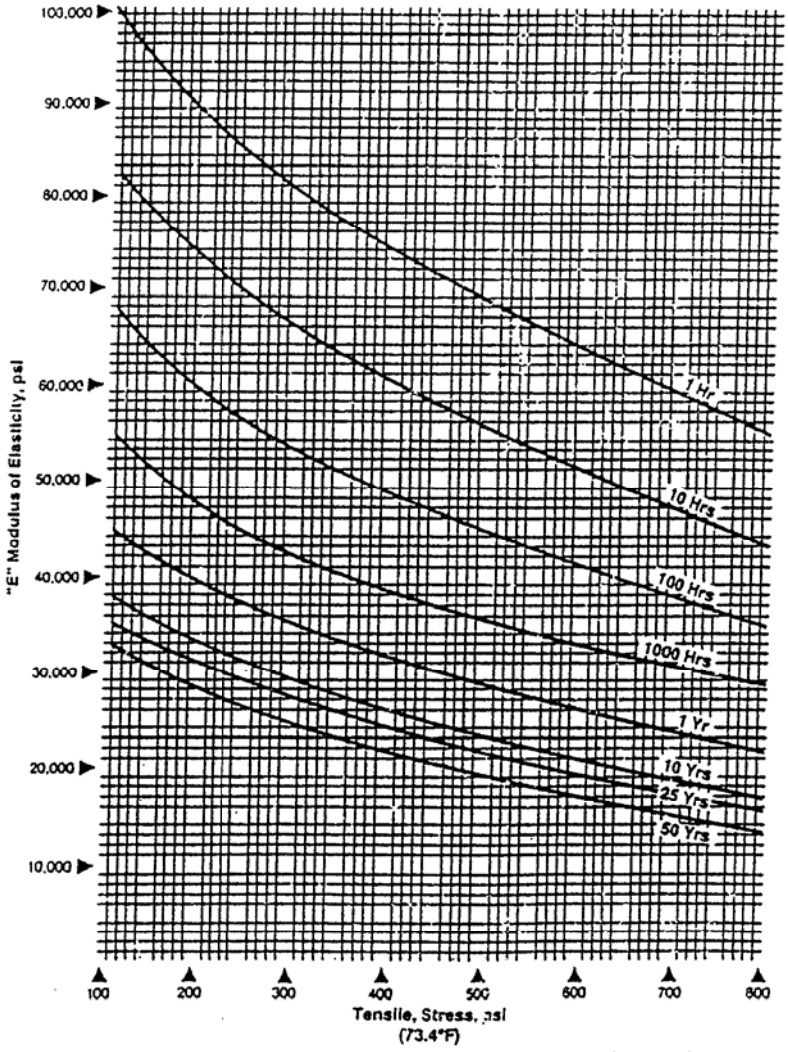
In a direct burial pressurized pipeline, the internal pressure is usually great enough to exceed the external critical-buckling soil pressure. When a pressurized line is to be shut down for a period, wall buckling should be examined.

Design by Wall Buckling Guidelines:
Although wall buckling is seldom the limiting factor in the design of a Driscopipe system, a check of non-pressurized pipelines can be made according to the following steps to insure $P_t < P_{cb}$.

1. Calculate or estimate the total soil pressure, P_t, at the top of the pipe.
2. Calculate the stress "S_A" in the pipe wall according to the formula:
$$S_A = \frac{(SDR - 1)\,P_t}{2}$$
3. Based upon the stress "S_A" and the estimated time duration of non-pressurization, use Chart 25 to find the value of the pipe's modulus of elasticity, E, in psi.

Chart 25

Time Dependent Modulus of Elasticity for Polyethylene Pipe vs. Stress Intensity (73.4°F)



NOTE: The short term modulus of elasticity of Driscopipe per ASTM D 638 is approximately 100,000 psi. Due to the cold flow (creep) characteristic of the pipe material, this modulus is dependent upon the stress intensity and the time duration of the applied stress.

4. Based upon the pipe SDR and the value of the polyethylene modulus of elasticity, E, calculate the pipe's hydrostatic, critical-collapse differential pressure, P_C:

$$P_C = \frac{2.32\,(E)}{(SDR)^3}$$

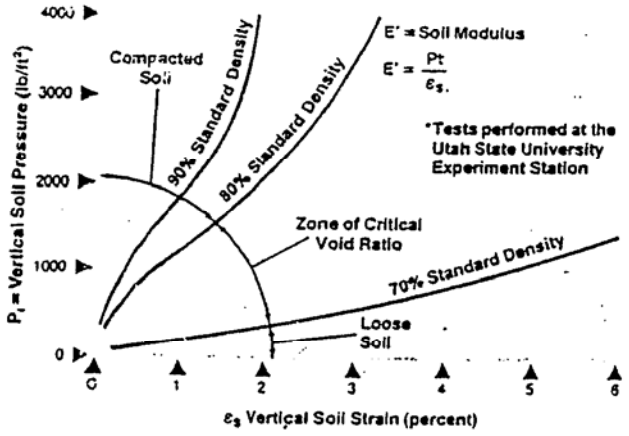
5. Calculate the soil modulus, E', by plotting the total external soil pressure, P_t, against a specified soil density to derive the soil strain as shown in the example problem on Chart 26.
6. Calculate the critical buckling pressure at the top of the pipe by the formula:

$$P_{cb} = 0.8\sqrt{E' \times P_c}$$

7. Calculate the Safety Factor: $S.F. = P_{cb} \div P_t$
In burial applications, a safety factor of 1.0 may be considered a minimum because of the margin of safety provided by the arching action of the soil. However, Driscopipe endorses using a more conservative value approaching or exceeding a 2.0 safety factor.
8. The above procedures could be reversed to derive the minimum pipe SDR required for a given soil pressure and an estimated soil density. However, this procedure should permit the engineer to optimize the system design quickly by examining several combinations.

Chart 26

Plot of Vertical Stress-Strain Data for Typical Trench Backfill (Except Clay) from Actual Tests*



EXAMPLE
Find: E' @ 2000 PSF and 80% Density
Formula: $E' = P_t / \varepsilon_s$
Calculations: E' = 2000 PSF / .018 = 111111 PSF = 771 psi

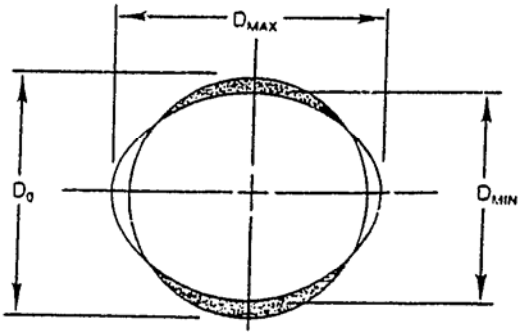
Note: The curves shown on this chart are sample curves for a granular soil. If other types of soil are used for backfill, such as clay or clay loam, curves should be developed from laboratory test data for the material used. Soil pressures greater than 4000 psf may be examined by extrapolating the slope of the curve or by generating curves by testing at those higher soil pressures. Probable error of curves is about half the distance between adjacent lines.

Design by Ring Deflection: Ring deflection is defined as the ratio of the vertical change in diameter to the original diameter. It is often expressed as a percentage. Ring deflection for buried Driscopipe is conservatively the same as (no more than) the vertical compression of the soil envelope around the pipe. Design by ring deflection matches the ability of Driscopipe to accommodate, without structural distress, the vertical compression of the soil enveloping the buried pipeline. *Design by ring deflection comprises a calculation of vertical soil strain to ensure it will be less than the allowable ring deflection of the pipe.* See Chart 27. The tabulation shows that with lower values of SDR, the allowable deflection is less. For installations which require this thicker wall to resist the external soil pressure, actual ring deflection can easily be limited to the tabular values by proper compaction of the backfill around the pipe. The recommended allowable deflection for the various SDR s are:

Chart 27

SDR	Allowable Ring Deflection
32.5	8.1%
26.0	6.5%
21.0	5.2%
19.0	4.7%
17.0	4.2%
15.5	3.9%
13.5	3.4%
11.0	2.7%

The allowable ring deflection of polyethylene pipe is a function of the allowable tangential strain in the outer surface of the pipe wall. A conservative limit of 1-1½% tangential strain in the outer surface of the pipe wall due to vertical deflection of the pipe "ring" by soil compression can be understood by comparing two pipes of the same diameter but different wall thickness.



$$\% \text{ Ring Deflection} = \left(1 - \frac{D_{MIN}}{D_o}\right) \times 100\%$$

NOTE: 5% deflection decreases flow-area by ¼%. 10% deflection decreases flow-area by 1%.

ATTACHMENT C

Liner System Compatibility Analysis

Prepared by:	Z. Islam	Date:	3/30/2017	Reviewed by:	M. Saadi	Date:	4/4/2017
Client:	Waste Management	Project:	Turkey Run Landfill CCR Management Plan	Project No.:	GR6304	Phase No.:	02/01

COAL COMBUSTION RESIDUALS (CCR) LINER SYSTEM COMPATIBILITY ANALYSIS

INTRODUCTION

Georgia Environmental Protection Division (EPD) guidance document for Coal Combustion Residuals (CCR) Management Plans states that the CCR Management Plan must address landfill design considerations to account for of acceptance of CCR. The CCR Management Plan is requested to demonstrate that the liner system of the landfill is designed to account for chemical exposure to CCR-generated leachate. A demonstration on the chemical compatibility of the liner system components to CCR-generated leachate is described below.

LINER SYSTEM COMPONENTS AT TURKEY RUN LANDFILL

The geosynthetic components of the liner system at Turkey Run Landfill consist of (from bottom to top) (i) reinforced geosynthetic clay liner (GCL); (ii) high density polyethylene (HDPE) geomembrane liner; and (iii) drainage geocomposite. Chemical compatibility of the GCL, HDPE geomembrane, geotextile components of the GCL and the drainage geocomposite, and the geonet componenet of the drainage geocomposite is described below. The liner system at the Turkey Run Landfill also consists of a compacted clay liner underneath the reinforced GCL. The compacted clay component of the liner system has not been evaluated here as the compacted clay is not anticipated to react adversely with the CCR-generated leachate.

CHEMICAL COMPATIBILITY OF THE GCL

GCL Composition

GCLs consist of a thin layer of clay (i.e., bentonite) typically sandwiched between two geotextiles. GCLs were developed as an alternative to compacted clay liners – normally specified as a low permeability hydraulic barrier (Gates et al., 2009). The most common composition of the clay layer in a GCL is sodium (Na) bentonite (Petrov and Rowe, 1997; Jo et al., 2005; Rauen and Benson, 2008). The bentonite is generally composed of at least 70% montmorillonite (Jo et al., 2004). Bentonites containing high montmorillonite content are the most desirable in the production of GCLs. The swelling characteristics of montmorillonite-rich bentonites promote lower hydraulic conductivity.

GCL Hydraulic Conductivity

The performance of GCLs as hydraulic barriers depends on the hydraulic conductivity of the bentonite layer. As previously stated, the most common composition of the clay layer in a GCL is sodium-bentonite containing at least 70% montmorillonite. Montmorillonite is characterized by large specific surface and large net negative charge (Mitchel, 1993), resulting in high adsorption of hydrated cations as well as water molecules. These hydrated cations and water molecules comprise a significant fraction of the pore space and are essentially immobile (Mitchell, 1993, Shackelford et al., 2000), resulting in consistently low hydraulic conductivity, i.e., $\leq 10^{-8}$ cm/s (Shackelford et al., 2000) to water.

The replacement of sodium in the exchange complex of sodium-bentonite with other ions directly affects the thickness of the diffuse double layer (DDL), thereby affecting swelling and hydraulic conductivity of bentonite in GCLs (Shackelford et al., 2000). Specifically, the Na^{+} exchange for multivalent cations (e.g., Ca^{+2}) reduces the osmotic swell (Jo et al., 2004), resulting in the contraction of the interlayer region and increase of inter-particle flow paths, increasing hydraulic conductivity (Shackelford et al., 2000; Rauen and Benson, 2008; Benson and Meer, 2009). This section presents the effects of multivalent cations on the hydraulic conductivity. Specifically, the ratio between monovalent and multivalent cation concentration in the permeant liquid is discussed.

Effect of Cationic Concentration

Cationic concentration can be used to distinguish between dilute (e.g., water) and non-standard permeating solutions (e.g., leachate), directly affecting hydraulic conductivity. Changes in hydraulic conductivity are directly related to the rate at which cation exchange occurs, that is, higher concentrations yield faster changes. This occurs because more cations are available for exchange in addition to larger concentration gradient between the permeant liquid and the interlayer space (Jo et al. 2004). The cationic strength (I_c) of a permeating liquid provides a measure of the concentration of the positively charged ions in the solution and is defined as follows (Rauen and Benson, 2008):

$$I_c = \frac{1}{2}\sum C_i Z_i^2 \qquad \text{(C-1)}$$

Where C is the molar concentration of the cation and Z is the valence of the cation.

When the concentration of cations in the permeant liquid increases, the concentration gradient induced by the elevated concentration in the permeant liquid causes water to move out of the interlayer region (Jo et al., 2001). Additionally, the thickness of the DDL decreases, reducing the

swell volume. Consequently, the pore space available for flow increases, increasing hydraulic conductivity (Shackelford et al. 2000). Generally, the hydraulic conductivity of a GCL permeated with a high cation concentration solution is higher than a GCL permeated with a dilute solution so long as hydration conditions and stress levels are maintained the same (Shackelford et al., 2000; Benson and Meer, 2009).

Effect of Cation Valence

The ratio between monovalent and divalent (multivalent) cations (RMD) in the permeating liquid provides a measure of the relative abundance of monovalent and multivalent cations, defined as follows (Rauen and Benson, 2008; Benson and Meer, 2009):

$$RMD = \frac{M_m}{\sqrt{M_d}} \qquad \text{(C-2)}$$

where M_m is the total molarity of monovalent cations and M_d is the molarity of divalent (multivalent) cations in the permeating solution.

Based on Equation (C-2), higher RMD values characterize permeating solutions with an abundance of monovalent cations while lower RMD values are characteristic of solutions having greater abundance of multivalent cations. Kolstad et al. (2004) conducted several long term hydraulic conductivity tests with multiple multivalent salt solutions to study the effects of leachate chemistry on GCL performance. Based on the test results correlations were estimated between a GCL's hydraulic conductivity, ionic strength (I_c), and the ratio of monovalent to divalent ions (RMD) in the leachate. Their results show that hydraulic conductivity increases with the increase of ionic strength of the permeant and decreases with the increase of RMD of the permeant. Benson (2014) provided a summary of industrial liquids and leachates for various sources, including CCR leachates as a function of RMD and cationic strength. The data provided by Benson (2014) was compiled with an empirical model developed by Kolstad et al. (2004), and used to estimate the hydraulic conductivity of standard GCLs as a function of cationic strength and RMD to an inorganic chemical solution. Figure C-1 presents the data presented by Benson (2014) combined with the model from Kolstad et al. (2004). It can be seen that the majority of the MSW and CCR leachate resulted hydraulic conductivity values of less than 10^{-8} cm/s.

No site-specific leachate data was available to compare the data presented in Figure C-1. However, data provided by Waste Management (WM) for another landfill site accepting CCR from the same CCR generating company and disposing of the CCR in a monofill cell was utilized. The cationic strength was calculated to be 12.08 mM for the leachate of that site. Based on the leachate data of WM's other landfill site and the monovalent cation data presented in Table C-2 for different ash leachates (monovalent cation data was not available from WM's other landfill site), the cationic

strength and RMD values were calculated to be 13.4 mM and 13.4 $M^{1/2}$, respectively. Comparing these values with the data presented in Figure C-1, the hydraulic conductivity of the GCL is predicted to be less than 10^{-9} cm/s.

It is noted that the above analysis is performed assuming leachate generation from CCR only. The Turkey Run Landfill is expected to be accepting CCR and comingling with municipal solid waste (MSW) with a maximum CCR to MSW ratio of 1:9, by weight. Therefore, it is noted that the above analysis is conservative. It is further noted that the hydraulic conductivity of the reinforced GCL in the permitted Design and Operations (D&O) Plan for the landfill is required to be less than 5.3×10^{-9} cm/s. Based on the above analysis, the hydraulic conductivity of the reinforced GCL at the Turkey Run Landfill is expected to be less than 10^{-9} cm/s and is therefore consistent with the currently permitted design considerations and will not require any design changes to the GCL component.

CHEMICAL COMPATIBILITY OF THE HDPE GEOMEMBRANE

No site-specific chemical characteristics of leachate were available. The chemical compatibility of the HDPE geomembrane liner, i.e., the resistance of the geomembrane to chemical degradation, is evaluated by assessing the typical chemical characteristics of leachate from other CCR containment facilities, followed by evaluating the resistance of HDPE geomembranes to degradation by liquids with these chemical characteristics.

Chemical Characteristics of Leachates from CCR Containment Facilities

CCR leachates typically contain a range of inorganic constituents and have a neutral to alkaline pH (Electric Power Research Institute [EPRI], 2006). EPRI (1998) presents the results of a field and laboratory study of the constituents leached from CCR in landfills and surface impoundments. The chemical composition data for porewater (leachate) from 125 core samples collected at eight active CCR landfills is presented in Table C-1 (EPRI, 1998). The CCR had been generated from combustion of various types of coal. A subsequent study by EPRI (2006) includes chemistry data from 13 landfills and 15 surface impoundments in the U.S.A. Samples from facilities that did not contain flue gas desulfurization (FGD) waste were classified as ash leachate, otherwise the samples were classified as FGD leachate. Ash and FGD leachate constituent data from the EPRI (2006) report are summarized in Table C-2. Transition metals presented at the highest concentrations in CCR and FGD leachates in the two EPRI studies are iron, manganese, and molybdenum. It is noted, however, that FGD will not be accepted at the Turkey Run Landfill facility and therefore the chemical characteristics of FGD leachate are not applicable for the purpose of this analysis.

Overview of Chemical Compatibility of HDPE Geomembrane

HDPE geomembranes consist of, by weight percentage, 96% to 97% polyethylene resin, 2% to 3% carbon black, and approximately 0.5% to 1% antioxidants. Polyethylene used for producing geomembranes is essentially chemically inert (Apse, 1989) and does not undergo a change in its molecular structure with organic chemicals such as solvents (USEPA, 1988). Carbon black is added to HDPE geomembranes to reduce penetration of ultraviolet light into the HDPE polymeric compound. Antioxidants are also added to prevent polymer degradation during processing and to extend their service life by delaying polymer degradation caused by oxidation reactions (Hsuan and Koerner, 1998).

The reaction of HDPE geomembranes with chemicals has probably been studied more than any other liner degradation mechanism (Koerner et al., 1990; Rowe et al., 2009; Rowe et al., 2010a,b). In accelerated chemical compatibility testing of geomembranes conducted in the laboratory and in field investigations of geomembranes that have been installed as long as several decades, polyethylene geomembranes have been found to have good resistance to a wide variety of chemicals, including aliphatic and aromatic hydrocarbons, chlorinated and oxygenated solvents, crude petroleum solvents, alcohols, organic and inorganic acids, heavy metals, and salts (Matrecon, Inc., 1988; Hsuan et al., 1991; Brady et al., 1994; Eith and Koerner, 1998; Koerner and Hsuan, 2002; Sangam and Rowe, 2002; Koerner, 2005; Rowe et al., 2010b).

For HDPE geomembranes, the primary degradation mechanisms from chemical exposure is oxidative degradation. With respect to oxidative degradation, HDPE generally does not react with most chemicals because it does not have reactive sites. In addition, HDPE is non-polar and thus does not react readily with polar substances such as water, other inorganic chemicals, and some organic chemicals, such as acetone (Scheirs, 2009). HDPE is relatively inert in both acidic and basic environments, with the exception of oxidizing acids at high concentrations (e.g., sulfuric acid at a concentration greater than 70% (pH of 0.3) (Brydson, 1999; Scheirs, 2009). Further, Rowe et al. (2008) examined the effects of pH on HDPE geomembrane degradation by immersing geomembrane specimens in simulated leachate and distilled water with pHs of 4, 6, 8, and 10 at 185°F for approximately 4.5 months. Their results show no significant difference in antioxidant depletion time for samples in simulated leachate and distilled water over the considered pH range.

Compatibility of HDPE Geomembrane with Transition Metals

Transition metals can catalyze abiotic oxidation of polyethylene, resulting in a product that is more susceptible to biodegradation (Corti et al., 2010; Roy et al., 2011; Zheng et al., 2005). However, transition metals are not commonly found in landfill leachates at concentrations that typically cause chemical compatibility issues. In immersion testing of HDPE geomembrane with different

leachates, including some that included transition metals in a trace metal solution with a total concentration greater than 3,000 mg/L, Rowe et al. (2008) found the presence of transition metals to have little or no effect on the rate of antioxidant depletion.

Compatibility of HDPE Geomembrane with CCR Leachate

It is noted that the above analysis is performed assuming leachate generation from only CCR. The Turkey Run Landfill will be accepting CCR and comingling with MSW with a maximum CCR to MSW ratio of 1:9, by weight. Therefore, the chemical characteristics of the leachate will be more pronounced for MSW than for CCR and therefore the analysis is conservative.

Based on the extensive chemical compatibility studies that have been conducted with HDPE materials and leachates, the HDPE geomembrane liner used at the Turkey Run Landfill is expected to be chemically compatible with the leachate generated in the landfill. Furthermore, the expected pH of the CCR leachate is much higher than 0.3. Thus, it is not a strong acid, which could accelerate oxidative degradation of HDPE. Lastly, based on the chemical composition data for CCR leachates summarized in Tables C-1 and C-2, the concentrations of transition metals in the CCR leachate are expected to be low (i.e., typically concentration less than 500 mg/L) and less than those that could potentially cause transition metal-related degradation of the HDPE geomembrane. Therefore, the HDPE geomembrane liner is concluded to be chemically compatible with the leachate for the Turkey Run Landfill.

CHEMICAL COMPATIBILITY OF THE GEOTEXTILE COMPONENT OF THE GCL AND THE DRAINAGE GEOCOMPOSITE

The degradation of geotextile is generally evaluated by conducting laboratory tests. Several researchers performed laboratory tests to assess potential degradation of geotextiles due to oxidation or chemical interaction. Hsuan (2000) reported data on oxidation degradation of polyolefin geotextiles at oxygen concentrations of 8% and 20% and at temperatures of 70°C and 80°C. At an oxygen concentration of 8% (which is the typical oxygen concentration in water), the geotextile tensile strength did not decrease within 475 days of exposure. For buried liner applications, oxygen content is expected to be low (estimated by Hsuan [2000] to be less than 8%) and the temperature is expected to be lower than 15°C. Therefore, it may be assumed that degradation of the geotextile due to oxidation will not be significant. SI Geosolutions has performed several studies (e.g., Boschuk [1993] and Narejo [1995]) on the compatibility of polypropylene nonwoven geotextiles with leachate. Laboratory immersion tests were conducted at elevated temperatures (50^{o}C) to accelerate behavior. Variables such as temperature, moisture, and oxygen content were controlled in the lab and samples were removed at 30-, 60-, 90-, and 120-day intervals. The results show reductions in the puncture, tear, and tensile strengths of the

geotextiles were not significant after 120 days at 50°C. The leachate generated at the Turkey Run Landfill due to comingling of CCR and MSW with a maximum CCR to MSW ratio of 1:9, by weight, is not expected to be more aggressive than typical MSW leachate in terms of oxidative degradation and chemical interaction. Therefore, the geotextile component of the GCL and the drainage geocomposite is anticipated to perform as designed.

CHEMICAL COMPATIBILITY OF THE GEONET COMPONENT OF THE DRAINAGE GEOCOMPOSITE

The geonet component of the drainage geocomposite is made of HDPE. HDPE is generally resistant to CCR leachate as discussed above. Therefore, the geonet component of the drainage geocomposite is anticipated to work as designed at the Turkey Run Landfill.

CONCLUSIONS

The compatibility of the geosynthetic components of liner system with CCR-generated leachate at the Turkey Run Landfill was evaluated. It is concluded that no adverse effects are anticipated on the liner system geosynthetic components due to leachate generated from comingling of CCR and MSW (with a maximum CCR to MSW ratio of 1:9, by weight) and that the liner system components at the Turkey Run Landfill will perform their intended function as designed.

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TABLES

Table C-1. Chemical Composition of Porewater Samples from Eight CCR Landfills (modified from EPRI, 1998)

Parameter	Units	Minimum	Maximum	Mean	Median	Std. Deviation	No. of Samples	% of ND Samples
Aluminum	mg/L	ND	763	29.1	1.5	113.8	102	11%
Arsenic	mg/L	ND	5.126	0.308	0.039	0.653	119	31%
Barium	mg/L	ND	12.10	0.24	0.10	1.10	123	26%
Boron	mg/L	ND	173.0	12.8	3.4	25.2	125	5%
Bromide	mg/L	ND	50.49	6.02	1.00	9.75	64	27%
Cadmium	mg/L	ND	0.40	0.062	0.008	0.097	105	68%
Calcium	mg/L	2.8	1318	414	503	276	124	0%
Chloride	mg/L	0.32	1384	77.1	12.0	176.4	123	0%
Chromium	mg/L	ND	6.72	0.211	0.069	0.810	112	52%
Copper	mg/L	ND	5.780	0.204	0.025	0.683	105	53%
Fluoride	mg/L	ND	3.9	1.228	1.010	1.030	86	42%
Iron	mg/L	ND	2540	267.6	0.20	615	93	35%
Lead	mg/L	ND	0.039	0.006	0.005	0.006	68	75%
Magnesium	mg/L	ND	614.5	48.9	8.0	85.5	123	8%
Manganese	mg/L	ND	24.0	2.433	0.026	5.044	110	34%
Molybdenum	mg/L	ND	6.7	1.4	1.0	1.6	105	50%
Nickel	mg/L	ND	8.40	0.423	0.043	1.147	103	36%
Nitrate	mg/L	ND	26.40	2.947	0.862	4.701	123	33%
Nitrite	mg/L	ND	5.082	0.714	0.600	0.819	101	94%
Phosphate	mg/L	ND	1.84	0.81	0.25	2.24	64	95%
Potassium	mg/L	ND	1436	107.1	35.3	235.6	116	3%
Selenium	mg/L	ND	4.930	0.308	0.053	0.746	65	22%
Silicon	mg/L	ND	84.10	13.11	5.58	16.78	119	3%
Silver	mg/L	ND	ND	ND	ND	ND	50	100%
Sodium	mg/L	ND	2875	200	46	396	123	2%
Strontium	mg/L	0.122	54.10	6.463	5.825	5.953	123	0%
Sulfate	mg/L	1.68	12567	2220	1611	2209	125	0%
Sulfite	mg/L	ND	47.97	7.06	1.50	9.51	88	80%
Vanadium	mg/L	ND	1.360	0.161	0.122	0.184	64	6%
Zinc	mg/L	ND	40.0	0.909	0.052	4.120	109	50%
pH	SU	2.80	12.57	NA	NA	NA	125	0%
Eh	mV	-72.8	684	NA	NA	NA	106	0%

NOTES:

1.) Transition metals are shown in italics.

2.) SU denotes Standard Units, mg/L denotes milligrams per liter, mV denotes millivolts.

3.) ND denotes Not Detected; NA indicates Not Available

Table C-2. Chemical Composition of Ash and FGD Leachates from 13 CCR Landfills and 15 Surface Impoundments (modified from EPRI, 2006)

		Ash Leachate					FGD Leachate				
Parameter	Units	Minimum	Maximum	Median	No. of Samples	% of ND Samples	Minimum	Maximum	Median	No. of Samples	% of ND Samples
Aluminum	mg/L	<0.002	44.4	0.114	67	16	<0.024	0.890	0.179	14	14
Antimony	mg/L	<0.0001	0.059	0.0024	67	3	<0.0001	0.022	0.001	14	29
Arsenic	mg/L	0.0014	1.380	0.025	67	0	0.011	0.230	0.028	14	0
Barium	mg/L	<0.018	0.657	0.108	67	4	<0.030	0.158	0.073	14	7
Beryllium	mg/L	<0.0002	0.0086	<0.0004	67	94	<0.0002	0.0015	<0.0008	14	93
Bicarbonate	mg/L	0.042	535	53	63	0	0.50	87	7.5	14	0
Boron	mg/L	0.207	112	2.16	67	0	1.45	98.5	9.61	14	0
Cadmium	mg/L	<0.0002	0.065	0.0015	67	12	0.0005	0.013	0.0018	14	0
Calcium	mg/L	<2.2	681	55	66	2	234	730	589	14	0
Carbonate	mg/L	<0.01	152	0.60	63	13	<0.010	21	1.0	14	21
Carbonic acid	mg/L	<0.01	3.4	<0.01	63	87	<0.010	0.041	<0.010	14	93
Chloride	mg/L	4.5	92	25	66	0	19	2330	921	14	0
Chromium	mg/L	<0.0002	5.10	0.0006	67	45	<0.0002	0.053	<0.0005	14	64
Cobalt	mg/L	<0.00004	0.133	0.001	67	31	<0.000028	0.078	0.001	14	36
Copper	mg/L	<0.0002	0.494	0.003	67	19	<0.00026	0.044	0.0026	14	14
Iron	mg/L	<0.003	25.6	<0.050	67	52	<0.0046	1.2	<0.050	14	71
Lead	mg/L	<0.0001	0.008	<0.0002	67	73	<0.00014	0.0035	<0.0002	14	64
Lithium	mg/L	<0.001	23.6	0.129	67	13	<0.020	7.07	3.06	14	14
Magnesium	mg/L	<0.05	236	13	66	8	<0.05	5810	8.9	14	14
Manganese	mg/L	<0.0001	4.17	0.055	67	21	<0.0001	1.17	0.113	14	14
Mercury	mg/L	0.00000025	0.000061	0.0000038	22	0	0.00000082	0.000079	0.0000083	8	0
Molybdenum	mg/L	<0.0082	39.6	0.405	67	3	0.164	60.8	0.341	14	0
Nickel	mg/L	<0.0006	0.189	0.0058	67	13	<0.002	0.597	0.0034	14	36
Potassium	mg/L	<2.2	277	11	66	3	10	609	425	14	0
Selenium	mg/L	0.000071	1.76	0.019	67	0	0.0011	2.36	0.0062	14	0
Silicon	mg/L	0.221	19.0	4.65	67	0	0.4	45.4	2.48	14	0
Silver	mg/L	<0.0002	0.002	<0.0002	67	93	<0.0002	<0.0002	<0.0002	14	100
Sodium	mg/L	3.8	3410	52	66	0	108	4630	322	14	0
Strontium	mg/L	<0.030	12	0.83	67	1	1.5	16.9	5.2	14	0
Sulfate	mg/L	45	6690	339	66	0	836	30,500	1615	14	0
Thallium	mg/L	<0.0001	0.018	0.00036	67	46	<0.0001	0.0029	<0.00022	14	86
Uranium	mg/L	<0.00001	0.061	0.0012	67	19	<0.00001	0.016	0.0002	14	36
Vanadium	mg/L	<0.00042	5.02	0.045	67	3	<0.00069	0.4	0.0041	14	21
Zinc	mg/L	<0.0015	0.289	0.005	67	46	<0.002	0.068	<0.005	14	57
pH	SU	4.3	12.0	7.9	64	0	6.2	12.0	9.0	14	0
ORP	mV	-41	411	241	63	2	1.5	356	201	14	0
EC	µmho/cm	174	12,760	990	64	0	2190	26,140	6461	14	0

NOTES:

1.) Transition metals are shown in italics.

2.) SU denotes Standard Units, mg/L denotes milligrams per liter, µmho/cm denotes micromhos per centimeter, mV denotes millivolts.

3.) Less than (<) indicates not detected, value given is detection limit

Note: As noted earlier, FGD will not be accepted at the Turkey Run Landfill facility and therefore the chemical characteristics of FGD leachate indicated in Table C-2 are not applicable for the purpose of this analysis.

FIGURE

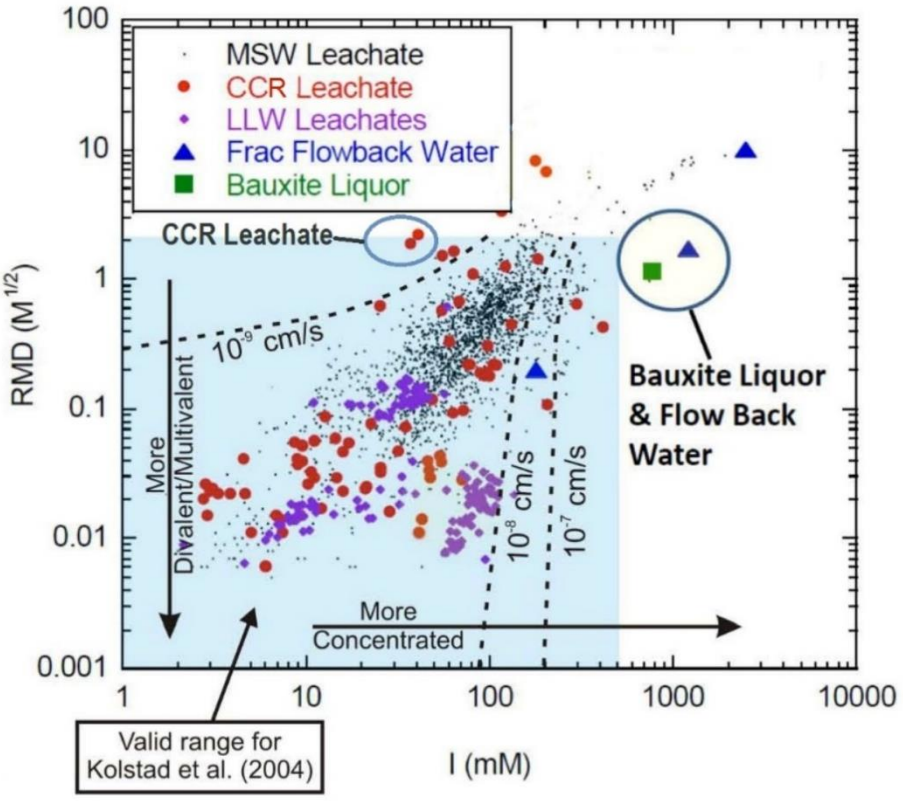

Figure C-1. Hydraulic conductivity contours as a function of RMD and cationic strength (Kolstad et al., 2004) and plot of corresponding cationic strength and RMD for various leachates (Benson, 2014).

ATTACHMENT D

Waste Compatibility Analysis

Prepared by:	**Z. Islam**	Date:	**3/30/2017**	Reviewed by:	**M. Saadi**	Date:	**4/4/2017**
Client:	**Waste Management**	Project:	**Turkey Run Landfill CCR Management Plan**	Project No.:	**GR6304**	Phase No.:	**02/01**

WASTE COMPATIBILITY ANALYSIS

INTRODUCTION

Georgia Environmental Protection Division (EPD) guidance document for Coal Combustion Residuals (CCR) Management Plans requires that the CCR Management Plan must address landfill design considerations to account for acceptance of CCR. The CCR Management Plan is requested to demonstrate that CCR waste is compatible with municipal solid waste (MSW) received at the facility, and that different CCR waste streams received are compatible with one another. A demonstration on the CCR waste compatibility at the Turkey Run Landfill is provided below.

SOURCES OF CCR WASTE STREAMS

Turkey Run Landfill has been receiving CCR from Southern Company. Based on the generator provided information for profiling of CCR accepted at the landfill, the composition of CCR consists of ash, coal, soils, and plant life. The enlisted processes from which the CCR material was generated, as described in the profile, include "Maintenance and Cleaning of Boilers, Buildings, Coal and Ash Handling Equipment and Facilities, Coal Piles and Grounds".

CHEMICAL ANALYSIS OF CCR WASTE STREAMS

CCR is generally produced from the burning of coal in coal-fired power plants. Different types of coal ash are produced based on the mineral components of the coal and the combustion technique used, for example, fly ash, bottom ash, flue gas desulfurization (FGD) material, boiler slag, etc. Fly ash is a fine powdered ferroaluminosilicate material trapped via a particulate control device in the chimney or stack of plants fired with coal. Bottom ash is a coarse and angular material and is too large to be carried in flue gas. FGD material is a natural gypsum-like product obtained from the process of reducing sulfur dioxide emissions from a coal-fired boiler. It is noted, however, that FGD will not be accepted at the Turkey Run Landfill facility and therefore is not considered further in this analysis. Boiler slag material is hard and glassy, and collected at the base of the slag tap and cyclone type furnaces.

The properties of CCR depend on different factors, for example, coal source and quality, combustion process, degree of weathering, particle size and age of the ash, etc. No site-specific chemical analysis was conducted on the CCR that is being received at the Turkey Run Landfill. However, generally, more than 90% of fly ash, bottom ash, and boiler slag is made up of silicon, aluminum, iron, and calcium in their oxide form (EPRI, 2009). Marginal constituents, for example,

magnesium, potassium, sodium, titanium, and sulphur make up approximately 8% of the mineral component of these ashes, on the other hand, trace constituents such as arsenic, cadmium, lead, mercury, and selenium, together account for less than 1% of the total composition (EPRI, 2009). Table D-1 shows the typical range of constituents concentrations in fly ash and bottom ash.

Based on the comparative concentration of silicon dioxide, aluminum oxide, and iron oxide in coal, American Society for Testing and Materials (ASTM) classified coal combustion products into two classes: Class C and Class F. Class F ash contains more than 70% by weight of silicon dioxide, aluminum oxide, and iron oxide and has pozzolanic properties (Thomas, 2007). On the other hand, Class C ash generally contains 50–70% by weight of silicon dioxide, aluminum oxide, and iron oxide and has some self-cementing properties in addition to pozzolanic properties (Thomas, 2007). Class C ash is produced from burning younger lignite or sub-bituminous coal and Class F ash is produced from burning harder, older anthracite, and bituminous coal.

CCR-MSW REACTIVITY

It is noted that the Turkey Run Landfill will be accepting CCR and comingling with MSW with a maximum CCR to MSW ratio of 1:9, by weight. This maximum ratio reflects a relatively small quantity of CCR being comingled with MSW. It is further noted that the Turkey Run Landfill will not be accepting FGD material.

The power plants, from which Turkey Run Landfill is accepting CCR, generate both Class C and Class F fly ash. Both Class C and Class F fly ashes gain strength when they come in contact with water, but the strength gain happens slower in Class F ash compared to Class C ash. The gaining of strength is beneficial to the overall stability of the waste mass in a landfill. The reaction between fly ash constituents and water can generate heat depending on the type, quantity, and disposal method in a landfill. The generation of heat can be measured via landfill gas temperature monitoring. No excessively high temperatures were measured during the routine landfill gas temperature monitoring at the Turkey Run Landfill. Waste Management will be vigilant for higher observed temperature in landfill gas. If high temperature is noticed in the future during landfill gas monitoring, the cause of the high temperature will be evaluated and necessary measures will be taken if the cause is found to be related to addition of CCR in the landfill.

CONCLUSIONS

It is concluded that the CCR waste streams received at the Turkey Run Landfill are anticipated to be compatible with the MSW and that different CCR waste streams currently received at the site are anticipated to be compatible with each other based on observations of no reactivity, no

excessive temperatures, and no excessive odors due to the site operations. Furthermore, the Design and Operation (D&O) Plan for the landfill has been modified (Section 3 on Sheet 32 of Attachment A) to include narrative for CCR Waste Characterization and Compatibility. As stated in the narrative "*If operations indicate CCR reactivity with MSW, bulk samples of CCR from each source will be obtained for characterization and compatibility. Typically, samples will be tested for Toxicity Characteristic Leaching Procedure (TCLP) 8 RCRA metals by SW-846 Method 1311 and a Paint Filter Test by SW-845 Method 9095, or current equivalent method. Other analysis may be conducted as requested by Waste Management Technical Service Center.*"

It is noted that the Turkey Run Landfill will be accepting CCR with a maximum CCR to MSW ratio of 1:9, by weight. The low percentage of CCR compared to the MSW, is anticipated to have negligible to no adverse effects on the overall waste properties at the landfill.

REFERENCES

EPRI (2009). "Coal Ash: Characteristics, Management and Environmental issues", EPRI Report 1019022, Electric Power Research Institute, 11 pp.

Thomas, M. (2007). "Optimizing the Use of Fly Ash in Concrete", Portland Cement Association.

TABLE

Table D-1. Element Concentrations (mg/kg) in Fly Ash and Bottom Ash (modified from EPRI, 2009)

Element	Fly Ash[1]	Bottom Ash[1]
Aluminum	70,000–140,000	59,000–130,000
Calcium	7,400–150,000	5,700–150,000
Iron	34,000–130,000	40,000–160,000
Silicon	160,000–270,000	160,000–280,000
Magnesium	3,900–23,000	3,400–17,000
Potassium	6,200–21,000	4,600–18,000
Sodium	1,700–17,000	1,600–11,000
Sulphur	1,900–34,000	BDL–15,000
Titanium	4,300–9,000	4,100–7,200
Antimony	BDL[2]–16	All BDL
Arsenic	22–260	2.6–21
Barium	380–5100	380–3600
Beryllium	2.2 - 26	0.21–14
Boron	120–1000	BDL–335
Cadmium	BDL–3.7	All BDL
Chromium	27–300	51–1100
Copper	62–220	39–120
Lead	21–230	8.1–53
Manganese	91–700	85–890
Mercury	0.01–0.51	BDL–0.07
Molybdenum	9.0–60	3.8–27
Nickel	47–230	39–440
Selenium	1.8–18	BDL–4.2
Strontium	270–3100	270–2000
Thallium	BDL–45	All BDL
Uranium	BDL–19	BDL–16
Vanadium	BDL–360	BDL–250
Zinc	63–680	16–370

Notes:

(1) Source for most fly ash and bottom ash data is EPRI CP-INFO Database. Beryllium, thallium, mercury (bottom ash only) and boron (bottom ash only) are from the EPRI PISCES Database

(2) BDL = Below Detection Limit

ATTACHMENT E

Dust Suppression Plan

Prepared for

Turkey Run MSW Landfill

7144 Loan Oak Road
Hogansville, GA 30230

DUST SUPPRESSION PLAN

Permit No. 4953-199-0025-E-01-0

Prepared by

Geosyntec consultants
engineers | scientists | innovators

1255 Roberts Blvd
Kennesaw, GA 30144

Project Number GD4610-01

March 29, 2010

TABLE OF CONTENTS

LIST OF APPENDICES

1. BACKGROUND

Turkey Run MSW Landfill (Turkey Run) is located at 7144 Lone Oak Road, Hogansville, GA (Meriwether County). Greenbow, LLC (Greenbow) received approval of solid waste Permit No. 099-19D(MSWL) for Turkey Run on December 21, 2007. On February 8, 2008, Greenbow applied for an air permit and later received the construction and operating Permit No. 4953-199-0025-E-01-0 (effective June 3, 2008). Since these permits were issued, Greenbow has been purchased and is now a wholly owned subsidiary of Waste Management. The maximum design capacity was reported as 31,190,847 cubic yards (yd^3) in the March 2008 Initial Design Capacity report. Since the landfill was constructed after May 30, 1991 and has a design capacity that exceeds 2.5 million m^3 and 2.5 million Mg, the Landfill is subject to federal New Source Performance Standards (NSPS) for MSW landfills (Subpart WWW).

2. INTRODUCTION

Permit condition 7.12 of Air Quality Permit No. 4953-199-0025-E-OI-0 requires the development of a Dust Suppression Plan to control fugitive emissions addressed in condition 3.1 and 3.2 of the Permit. This document was developed to meet the requirements of the Dust Suppression Plan as mentioned above. If recordkeeping is required for a specific dust control measure, it is noted in the text. Example record keeping forms are included in Appendix A.

3. DUST CONTROL MEASURES

Precautions will be taken to prevent dust from becoming airborne.

3.1 General Erosion Control

Clearing and grading activities will be limited to the current phase of waste cell areas, borrow areas, stockpile areas, site facility areas (i.e. administration and operational buildings onsite), road and pond construction and leachate collection system installation.

Recordkeeping Required: None

3.2 Cover Erosion Control

Intermediate and final cover areas left exposed and inactive shall be covered on the following schedule:

- Vegetation/grass –shall take place within two weeks after the final cover is completed.
- Temporary vegetation/grass – shall take place within 90 days if used as intermediate cover.

Recordkeeping Required: None

3.3 Roads

Gravel, Asphalt or concrete will be used to pave the entrance and perimeter roads to maintain dust control.

Recordkeeping Required: None

3.4 Watering

Active access roads will be sprayed with water by a water truck as needed.

Recordkeeping Required: Water Truck Log

3.5 Equipment

A water truck will be available onsite for watering as needed for dust suppression.

Recordkeeping Required: None

3.6 Speed Limit

Maximum speed limit signs will be posted on main entrance road and primary access roads for waste hauling and construction vehicles.

Recordkeeping Required: None

APPENDIX A

Water Truck Log

TURKEY RUN LANDFILL WATER TRUCK LOG

Date	Applied (water/polymer)	Driver's Initials	Active Access Roads
Example: 1/31/2010	water	A.K.M	Entrance and II.

ATTACHMENT F

Emergency Stand Down Flyer

South Atlantic

Post Collection Emergency Stand Down Procedure

Purpose

To establish a standard operational protocol structured to stop all workface activity with specific actions required by all personnel. This stand down procedure is intended to provide a means to prevent accidents and injuries without verbal communication.

Procedure

The operator will activate the siren alarm located in the cab of the dozer or compactor when he or she identifies a potential safety hazard at the working face.

When an operator sounds the alarm, **all equipment, including trucks, will halt** and heavy equipment blades are to be lowered to the ground until an “all clear” is given by the operator who signaled the alarm.

When the Safety Stand Down Alarm is activated, personnel at the working face will notify the scale attendant. The scale attendant will stop all traffic from entering the working face. Traffic will be held until “all clear” is given and the scale attendant is notified.

ATTACHMENT G

Typical CCR Waste Profiles

National Account Customer

WASTE MANAGEMENT

EZ Profile™

Requested Facility: Turkey Run Landfill ☐ Unsure Profile Number: 375200GASCH

☐ Multiple Generator Locations (Attach Locations) ☐ Request Certificate of Disposal ☑ Renewal? Original Profile Number: 375200GASCH

A. GENERATOR INFORMATION (MATERIAL ORIGIN)

1. Generator Name: Georgia Power Plant Scherer
2. Site Address: 10986 HWY 87
   (City, State, ZIP) Juliette GA 31046
3. County: Monroe
4. Contact Name: Todd Cross
5. Email: racross@southernco.com
6. Phone: (404) 608-5271 7. Fax: (404) 608-5212
8. Generator EPA ID: _____ ☑ N/A
9. State ID: _____ ☑ N/A

B. BILLING INFORMATION ☐ SAME AS GENERATOR

1. Billing Name: Georgia Power Strategic Accounts
2. Billing Address: 415 Day Hill road
   (City, State, ZIP) Windsor CT 06095-5725
3. Contact Name: Heather Sidmore
4. Email: hsidmore@wm.com
5. Phone: (603) 463-0344 6. Fax: (866) 723-5759
7. WM Hauled? ☐ Yes ☑ No
8. P.O. Number: _____
9. Payment Method: ☑ Credit Account ☐ Cash ☐ Credit Card

C. MATERIAL INFORMATION

1. Common Name: Coal Ash and Coal Contaminated Waste
   Describe Process Generating Material: ☐ See Attached
   Maintenance and Cleaning of Boilers, Buildings, Coal and Ash Handling Equipment and Facilities, Coal Piles and Grounds.
2. Material Composition and Contaminants: ☐ See Attached

1. Ash	0-100 %
2. Coal	0-100 %
3. soils	0-50 %
4. Plant Life	0-10 %
Total comp. must be equal to or greater than 100%	≥100%

3. State Waste Codes: _____ ☑ N/A
4. Color: Black,Brown
5. Physical State at 70°F: ☑ Solid ☐ Liquid ☐ Other: _____
6. Free Liquid Range Percentage: _____ to _____ ☑ N/A
7. pH: _____ to _____ ☑ N/A
8. Strong Odor: ☐ Yes ☑ No Describe: _____
9. Flash Point: ☐ <140°F ☐ 140°–199°F ☐ ≥200° ☑ N/A

D. REGULATORY INFORMATION

1. EPA Hazardous Waste? ☐ Yes* ☑ No
   Code: _____
2. State Hazardous Waste? ☐ Yes ☑ No
   Code: _____
3. Is this material non-hazardous due to Treatment, Delisting, or an Exclusion? ☐ Yes* ☑ No
4. Contains Underlying Hazardous Constituents? ☐ Yes* ☑ No
5. From an industry regulated under Benzene NESHAP? ☐ Yes* ☑ No
6. Facility remediation subject to 40 CFR 63 GGGGG? ☐ Yes* ☑ No
7. CERCLA or State-mandated clean-up? ☐ Yes* ☑ No
8. NRC or State-regulated radioactive or NORM waste? ☐ Yes* ☑ No

***If Yes, see Addendum (page 2) for additional questions and space.**

9. Contains PCBs? → If Yes, answer a, b and c. ☐ Yes ☑ No
   a. Regulated by 40 CFR 761? ☐ Yes ☐ No
   b. Remediation under 40 CFR 761.61 (a)? ☐ Yes ☐ No
   c. Were PCB imported into the US? ☐ Yes ☐ No
10. Regulated and/or Untreated Medical/Infectious Waste? ☐ Yes ☑ No
11. Contains Asbestos? ☐ Yes ☑ No
    → If Yes: ☐ Non-Friable ☐ Non-Friable – Regulated ☐ Friable

E. ANALYTICAL AND OTHER REPRESENTATIVE INFORMATION

1. Analytical attached ☐ Yes
   Please identify applicable samples and/or lab reports:
2. Other information attached (such as MSDS)? ☐ Yes

F. SHIPPING AND DOT INFORMATION

1. ☐ One-Time Event ☑ Repeat Event/Ongoing Business
2. Estimated Quantity/Unit of Measure: 100
   ☑ Tons ☐ Yards ☐ Drums ☐ Gallons ☐ Other: _____
3. Container Type and Size: _____
4. USDOT Proper Shipping Name: ☑ N/A

G. GENERATOR CERTIFICATION (PLEASE READ AND CERTIFY BY SIGNATURE)

By signing this EZ Profile™ form, I hereby certify that all information submitted in this and all attached documents contain true and accurate descriptions of this material, and that all relevant information necessary for proper material characterization and to identify known and suspected hazards has been provided. Any analytical data attached was derived from a sample that is representative as defined in 40 CFR 261 - Appendix 1 or by using an equivalent method. All changes occurring in the character of the material (i.e., changes in the process or new analytical) will be identified by the Generator and be disclosed to Waste Management prior to providing the material to Waste Management.

If I am an agent signing on behalf of the Generator, I have confirmed with the Generator that information contained in this Profile is accurate and complete.

Name (Print): Todd Cross Date: 04/14/2016

Title: Environmental Technician

Company: Georgia Power Company

Certification Signature

Todd Cross

THINK GREEN.®

QUESTIONS? CALL 800 963 4776 FOR ASSISTANCE

Revised June 30, 2015

WASTE MANAGEMENT

EZ Profile™

Requested Facility: Turkey Run Landfill ☐ Unsure Profile Number: 375200GAWAN
☐ Multiple Generator Locations (Attach Locations) ☐ Request Certificate of Disposal ☑ Renewal? Original Profile Number: 375200GAWAN

A. GENERATOR INFORMATION (MATERIAL ORIGIN)

1. Generator Name: Georgia Power Plant Wansley
2. Site Address: 1371 Liberty Church Road
   (City, State, ZIP) Carrollton GA 30116
3. County: Carroll
4. Contact Name: Andy Foster
5. Email: RAFOSTER@southernco.com
6. Phone: (404) 608-5271 7. Fax: (404) 608-5212
8. Generator EPA ID: ☑ N/A
9. State ID: ☑ N/A

B. BILLING INFORMATION ☐ SAME AS GENERATOR

1. Billing Name: Georgia Power Strategic Accounts
2. Billing Address: 415 Day Hill road
   (City, State, ZIP) Windsor CT 06095-5725
3. Contact Name: Heather Sidmore
4. Email: hsidmore@wm.com
5. Phone: (603) 463-0344 6. Fax: (866) 723-5759
7. WM Hauled? ☐ Yes ☑ No
8. P.O. Number:
9. Payment Method: ☐ Credit Account ☐ Cash ☐ Credit Card

C. MATERIAL INFORMATION

1. Common Name: Coal Ash and Coal Contaminated Waste
   Describe Process Generating Material: ☐ See Attached
   Maintenance and Cleaning of Boilers, Buildings, Coal and Ash Handling Equipment and Facilities, Coal Piles and Grounds.
2. Material Composition and Contaminants: ☐ See Attached

1. Ash	0-100 %
2. Coal	0-100 %
3. soils	0-50 %
4. Plant Life	0-10 %
Total comp. must be equal to or greater than 100%	≥100%

3. State Waste Codes: ☑ N/A
4. Color: Black, Brown
5. Physical State at 70°F: ☑ Solid ☐ Liquid ☐ Other:
6. Free Liquid Range Percentage: ____ to ____ ☑ N/A
7. pH: ____ to ____ ☑ N/A
8. Strong Odor: ☐ Yes ☑ No Describe:
9. Flash Point: ☐ <140°F ☐ 140°–199°F ☐ ≥200° ☑ N/A

D. REGULATORY INFORMATION

1. EPA Hazardous Waste? ☐ Yes* ☑ No
   Code:
2. State Hazardous Waste? ☐ Yes ☑ No
   Code:
3. Is this material non-hazardous due to Treatment, Delisting, or an Exclusion? ☐ Yes* ☑ No
4. Contains Underlying Hazardous Constituents? ☐ Yes* ☑ No
5. From an industry regulated under Benzene NESHAP? ☐ Yes* ☑ No
6. Facility remediation subject to 40 CFR 63 GGGGG? ☐ Yes* ☑ No
7. CERCLA or State-mandated clean-up? ☐ Yes* ☑ No
8. NRC or State-regulated radioactive or NORM waste? ☐ Yes* ☑ No

***If Yes, see Addendum (page 2) for additional questions and space.**

9. Contains PCBs? → If Yes, answer a, b and c. ☐ Yes ☑ No
   a. Regulated by 40 CFR 761? ☐ Yes ☐ No
   b. Remediation under 40 CFR 761.61 (a)? ☐ Yes ☐ No
   c. Were PCB imported into the US? ☐ Yes ☐ No
10. Regulated and/or Untreated Medical/Infectious Waste? ☐ Yes ☑ No
11. Contains Asbestos? ☐ Yes ☑ No
    → If Yes: ☐ Non-Friable ☐ Non-Friable – Regulated ☐ Friable

E. ANALYTICAL AND OTHER REPRESENTATIVE INFORMATION

1. Analytical attached ☐ Yes
   Please identify applicable samples and/or lab reports:
2. Other information attached (such as MSDS)? ☐ Yes

F. SHIPPING AND DOT INFORMATION

1. ☐ One-Time Event ☑ Repeat Event/Ongoing Business
2. Estimated Quantity/Unit of Measure: 100
   ☑ Tons ☐ Yards ☐ Drums ☐ Gallons ☐ Other:
3. Container Type and Size:
4. USDOT Proper Shipping Name: ☑ N/A

G. GENERATOR CERTIFICATION (PLEASE READ AND CERTIFY BY SIGNATURE)

By signing this EZ Profile™ form, I hereby certify that all information submitted in this and all attached documents contain true and accurate descriptions of this material, and that all relevant information necessary for proper material characterization and to identify known and suspected hazards has been provided. Any analytical data attached was derived from a sample that is representative as defined in 40 CFR 261 - Appendix 1 or by using an equivalent method. All changes occurring in the character of the material (i.e., changes in the process or new analytical) will be identified by the Generator and be disclosed to Waste Management prior to providing the material to Waste Management.

If I am an agent signing on behalf of the Generator, I have confirmed with the Generator that information contained in this Profile is accurate and complete.

Name (Print): Richard Foster Date: 09/20/2016
Title: Environmental Analyst, Sr.
Company: Georgia Power Company

Certification Signature

R. A Ft

THINK GREEN.

QUESTIONS? CALL 800 963 4776 FOR ASSISTANCE

Revised June 30, 2015

National Account Customer

WASTE MANAGEMENT

EZ Profile™

Requested Facility: Turkey Run Landfill ☐ Unsure Profile Number: 375200GAYAT

☐ Multiple Generator Locations (Attach Locations) ☐ Request Certificate of Disposal ☑ Renewal? Original Profile Number: 375200GAYAT

A. GENERATOR INFORMATION (MATERIAL ORIGIN)

1. Generator Name: Georgia Power Yates
2. Site Address: 708 Dyer Road
   (City, State, ZIP) Newnan GA 30263
3. County: Coweta
4. Contact Name: Todd Cross
5. Email: racross@southernco.com
6. Phone: (404) 608-5271 7. Fax: (404) 608-5212
8. Generator EPA ID: _____ ☑ N/A
9. State ID: _____ ☑ N/A

B. BILLING INFORMATION ☐ SAME AS GENERATOR

1. Billing Name: Georgia Power Strategic Accounts
2. Billing Address: 415 Day Hill road
   (City, State, ZIP) Windsor CT 06095-5725
3. Contact Name: Heather Sidmore
4. Email: hsidmore@wm.com
5. Phone: (603) 463-0344 6. Fax: (866) 723-5759
7. WM Hauled? ☐ Yes ☑ No
8. P.O. Number: _____
9. Payment Method: ☑ Credit Account ☐ Cash ☐ Credit Card

C. MATERIAL INFORMATION

1. Common Name: Coal Ash and Coal Contaminated Waste
   Describe Process Generating Material: ☐ See Attached

   Maintenance and Cleaning of Boilers, Buildings, Coal and Ash Handling Equipment and Facilities, Coal Piles and Grounds.

2. Material Composition and Contaminants: ☐ See Attached

1. Ash	0-100 %
2. Coal	0-100 %
3. soils	0-50 %
4. Plant Life	0-10 %
Total comp. must be equal to or greater than 100%	≥100%

3. State Waste Codes: _____ ☑ N/A
4. Color: Black,Brown
5. Physical State at 70°F: ☑ Solid ☐ Liquid ☐ Other: _____
6. Free Liquid Range Percentage: _____ to _____ ☑ N/A
7. pH: _____ to _____ ☑ N/A
8. Strong Odor: ☐ Yes ☑ No Describe: _____
9. Flash Point: ☐ <140°F ☐ 140°–199°F ☐ ≥200° ☑ N/A

D. REGULATORY INFORMATION

1. EPA Hazardous Waste? ☐ Yes* ☑ No
   Code: _____
2. State Hazardous Waste? ☐ Yes ☑ No
   Code: _____
3. Is this material non-hazardous due to Treatment, Delisting, or an Exclusion? ☐ Yes* ☑ No
4. Contains Underlying Hazardous Constituents? ☐ Yes* ☑ No
5. From an industry regulated under Benzene NESHAP? ☐ Yes* ☑ No
6. Facility remediation subject to 40 CFR 63 GGGGG? ☐ Yes* ☑ No
7. CERCLA or State-mandated clean-up? ☐ Yes* ☑ No
8. NRC or State-regulated radioactive or NORM waste? ☐ Yes* ☑ No

***If Yes, see Addendum (page 2) for additional questions and space.**

9. Contains PCBs? → If Yes, answer a, b and c. ☐ Yes ☑ No
   a. Regulated by 40 CFR 761? ☐ Yes ☐ No
   b. Remediation under 40 CFR 761.61 (a)? ☐ Yes ☐ No
   c. Were PCB imported into the US? ☐ Yes ☐ No
10. Regulated and/or Untreated Medical/Infectious Waste? ☐ Yes ☑ No
11. Contains Asbestos? ☐ Yes ☑ No
    → If Yes: ☐ Non-Friable ☐ Non-Friable – Regulated ☐ Friable

E. ANALYTICAL AND OTHER REPRESENTATIVE INFORMATION

1. Analytical attached ☐ Yes
   Please identify applicable samples and/or lab reports:
2. Other information attached (such as MSDS)? ☐ Yes

F. SHIPPING AND DOT INFORMATION

1. ☐ One-Time Event ☑ Repeat Event/Ongoing Business
2. Estimated Quantity/Unit of Measure: 100
   ☑ Tons ☐ Yards ☐ Drums ☐ Gallons ☐ Other: _____
3. Container Type and Size: _____
4. USDOT Proper Shipping Name: ☑ N/A

G. GENERATOR CERTIFICATION (PLEASE READ AND CERTIFY BY SIGNATURE)

By signing this EZ Profile™ form, I hereby certify that all information submitted in this and all attached documents contain true and accurate descriptions of this material, and that all relevant information necessary for proper material characterization and to identify known and suspected hazards has been provided. Any analytical data attached was derived from a sample that is representative as defined in 40 CFR 261 - Appendix 1 or by using an equivalent method. All changes occurring in the character of the material (i.e., changes in the process or new analytical) will be identified by the Generator and be disclosed to Waste Management prior to providing the material to Waste Management.

If I am an agent signing on behalf of the Generator, I have confirmed with the Generator that information contained in this Profile is accurate and complete.

Name (Print): Todd Cross Date: 08/10/2015

Title: Environmental Technician

Company: Georgia Power Company

Certification Signature

Todd Cross

THINK GREEN.

QUESTIONS? CALL 800 963 4776 FOR ASSISTANCE

Revised June 30, 2015

ATTACHMENT H

Minor Modification Form

DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

REQUEST FOR MINOR MODIFICATION TO SOLID WASTE HANDLING PERMIT

Instructions This form must accompany all requests by the Permittee requiring a minor modification for the subject facility. Attached modifications of the Design and Operation (D&O) Plan must be factual and complete. This form and supporting documents must be submitted directly to the EPD Regional office to which the facility is assigned. For modifying a D&O Plan, please include three (3) copies of all pertinent sheets. **Follow-up submittals require the Permittee to submit a new request form.**

APPLICANT TO COMPLETE THE REVERSE SIDE

FOR EPD USE ONLY

Official Facility Name _____

Permit No. _____ Modification Type _____

Review Deadline Date _____

Received By	Date	Comments*
Reviewed By	**Date**	**Comments***
Action By	**Date**	**Comments***

*Disposition: Approved/Denied/Incomplete

Reply to Appropriate EPD District Office

1 Georgia EPD Mountain District
P.O. Box 3250
Cartersville, Georgia 30120
(770) 387-4900
ATTN: Mr. James Cooley, Mgr.

2 Georgia EPD West Central District
2640 Shurling Drive
Macon, Georgia 31202
(478) 751-6612
ATTN: Mr. Todd Bethune, Mgr.

3 Georgia EPD Northeast District
745 Gaines School Road
Athens, Georgia 30605
(706) 369-6376
ATTN: Mr. Don McCarty, Mgr.

4 Georgia EPD East Central District
3524 Walton Way Ext.
Augusta, GA 30909
(706) 667-4343
ATTN: Mr. Jeff Darley, Mgr.

5 Georgia EPD Coastal District
400 Commerce Center Drive
Brunswick, Georgia 31523-8251
(912) 264-7284
ATTN: Mr. Bruce Foisy, Mgr.

6 Georgia EPD Southwest District
2024 Newton Road
Albany, Georgia 31708
(229) 430-4144
ATTN: Ms. Mary Sheffield, Mgr.

NOTE: All minor modifications for private industrial facilities, except for those facilities located ir the Coastal District, should be directed to:
Georgia Environmental Protection Division
Solid Waste Management Program
4244 International Parkway, Suite 104
Atlanta, Georgia 30354
(404) 362-2692
ATTN: Solid Waste Management Program

FACILITY Turkey Run Landfill PERMIT NO. 099-019D(MSWL)

Pursuant to the requirements of the Georgia Comprehensive Solid Waste Management Act, O.C.G.A 12-8-20, et seq. and the Rules of the Georgia Department of Natural Resources, Chapter 391-3-4-.02(4), Solid Waste Management, both as amended, the undersigned hereby:

1 Requests a minor modification as represented in the attached modified D&O Plan, and/or supporting documents;

2 Certifies that the Permittee is the rightful owner of the facility and can verify that this proposed modification shall conform to all local zoning/land use ordinances; and

3 Certifies that the information provided in or submitted by the facility Permittee as part of this request form and modified D&O Plan is true and correct, and if approved, the facility Permittee agrees to comply with provisions of this minor modification to the D&O Plan, provisions of the Act Rules, and conditions of the Permit.

I PERMITTEE Greenbow, LLC

ADDRESS 1850 Parkway Place, Suite 600 PHONE 770-590-3308

CITY Marietta STATE GA ZIP 30067

AUTHORIZED OFFICIAL Mr. Shawn Carroll

SIGNATURE Shawn P. Carroll DATE 4/5/2017

TITLE Senior Environmental Protection Manager

MAILING ADDRESS 1850 Parkway Place, Suite 600

CITY Marietta STATE GA ZIP 30067

II Briefly describe the exact changes to be made to the permit conditions and explain why the change is needed.

This Minor Modification Application represents provision of a Coal Combustion Residuals (CCR) Management Plan for the referenced facility. Solid Waste Management Rule 391-3-4-.07(5) requires a CCR Management Plan to be submitted to Georgia EPD for review and approval. This CCR Management Plan includes revisions to the D&O Plan, Design Calculations, and other analysis, information or documentation as requested within the Guidance Document for CCR Management Plans issued by Georgia EPD on December 22, 2016.
Revisions to D&O Plan include revisions to Water Monitoring Plan, Operations Plan, Closure/Post-Closure Care Plan. Revisions to Design Calculations include revisions to Slope Stability Analysis, Settlement Analysis, LCS Pipe Structural Stability Analysis, and Maximum Leachate Head on Liner System. Additionally, Waste Compatibility Analysis and Liner Compatibility Analysis are included.

III Attached documents include:

Cover Letter
Attachment A - Revised D&O Plan
Attachment B - Design Calculations Updates
Attachment C - Liner System Compatibility Analysis
Attachment D - Waste Compatibility Analysis
Attachment E - Dust Suppression Plan
Attachment F - Emergency Stand Down Flyer
Attachment G - Typical CCR Waste Profiles
Attachment H - Minor Modification Form (this form)