Permit No.	Scan Date	DIN
8503-INDUS-1984	**February 26, 2016**	**25674**

RECEIVED
February 25, 2016
Solid Waste Section
Asheville Regional Office

Belews Creek Steam Station
3195 Pine Hall Road
Belews Creek, NC 27009
336-445-0610
336-669-2994

February 25, 2016

North Carolina Department of Environmental Quality
Division of Waste Management
Solid Waste Section
2090 U.S. Highway 70
Swannanoa, North Carolina 28778
Attn: Mr. Larry Frost

Re: Pine Hall Road Landfill Cover System Modification Plan
Permit No.: 8503-INDUS-, Belews Creek Pine Hall Rd Landfill
Belews Creek Steam Station
Stokes County
Belews Creek, North Carolina 27009

Dear Mr. Frost,

The attached drawings, specifications, and Construction Quality Assurance (CQA) Plan are for the cover system modification at the Belews Creek Steam Station Pine Hall Road Landfill.

Duke Energy is submitting this package to the Division for approval. Please note that the plan calls for a one acre laydown area that may require being expanded. Should expansion of the laydown area increase beyond three acres, Duke will notify the Division. An Erosion and Sediment Control permit for this scope will be obtained from the Division of Land Quality.

Duke Energy is committed to excellent environmental stewardship and cooperation with the Division regarding the operation, maintenance, safety, and integrity of all of its facilities. We look forward to continuing to work with you regarding environmental concerns.

If there are any questions regarding this request, please contact me at (336) 445-0610.

Respectfully submitted,

Melonie Martin
*Environmental Services*att:

Attachments: Cover System Modifications Drawings
Technical Specifications
Construction Quality Assurance Plan

cc (via e-mail): Ed Mussler, NCDEQ
Shawn McKee, NCDEQ
Evan Andrews, Duke Energy
Will Harrison, Duke Energy
Kimberlee Witt, Duke Energy
Ed Sullivan, Duke Energy

COVER SYSTEM MODIFICATIONS

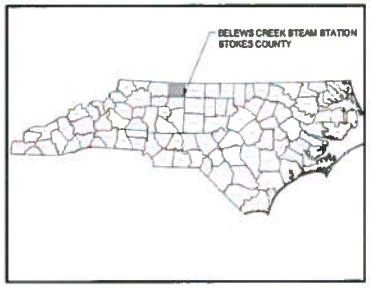
CLOSED PINE HALL ROAD ASH LANDFILL

DUKE ENERGY - BELEWS CREEK STEAM STATION

STOKES COUNTY, NORTH CAROLINA

PREPARED FOR:

DUKE ENERGY CAROLINAS, LLC



SITE VICINITY MAP
NOT TO SCALE

SITE AERIAL IMAGE
1"=1000

SHEET LIST TABLE	
SHEET NUMBER	SHEET TITLE
000	TITLE SHEET
012	EXISTING CONDITIONS
029	PROPOSED MODIFICATIONS
040	MODIFICATION DETAILS 1
041	MODIFICATION DETAILS 2
042	EROSION AND SEDIMENTATION CONTROL DETAILS 1
043	EROSION AND SEDIMENTATION CONTROL DETAILS 2

Environment & Infrastructure

amec foster wheeler

SEAL

TITLE
COVER SYSTEM MODIFICATIONS
CLOSED PINE HALL ROAD ASH LANDFILL
TITLE SHEET

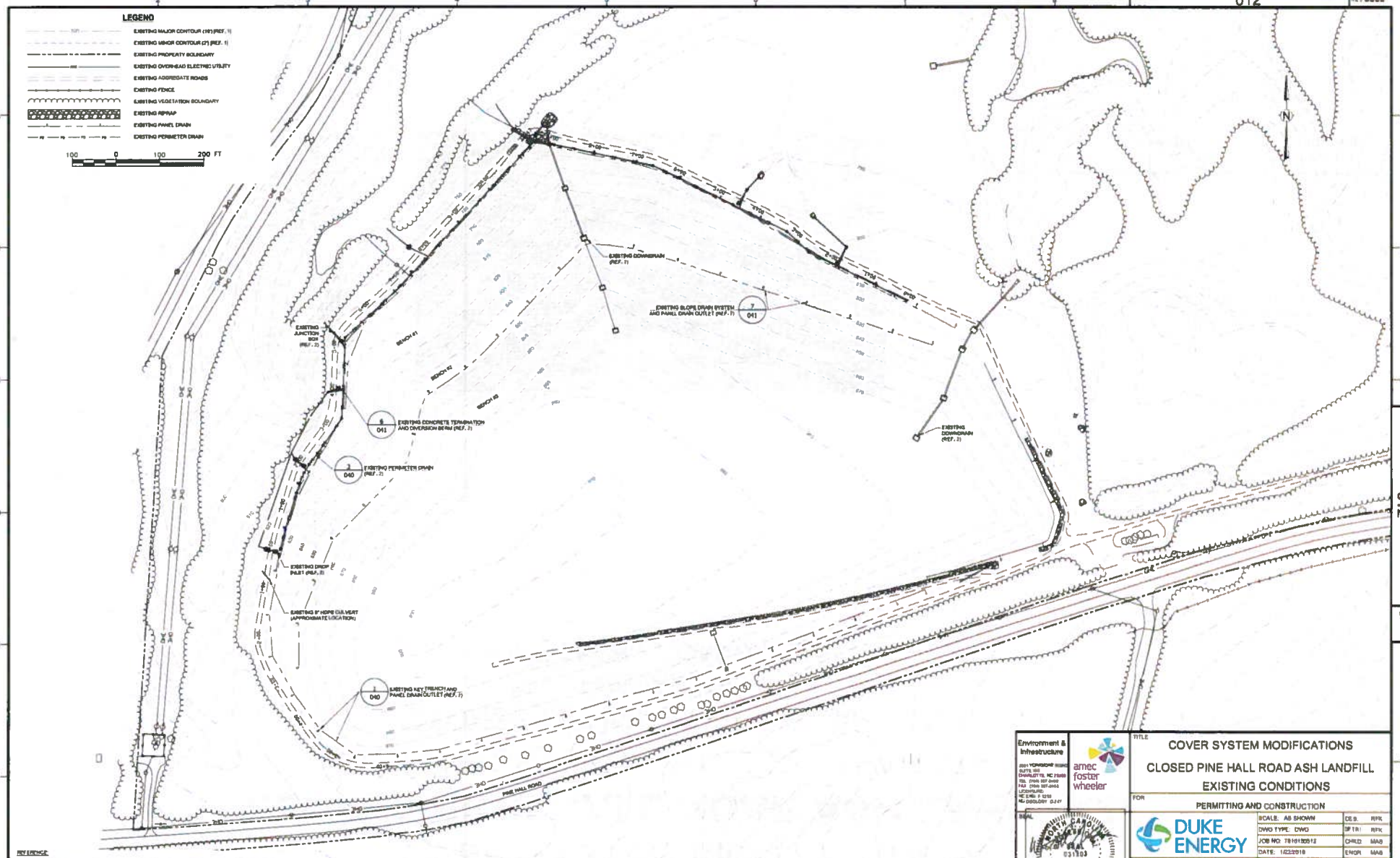
FOR
PERMITTING AND CONSTRUCTION

DUKE ENERGY

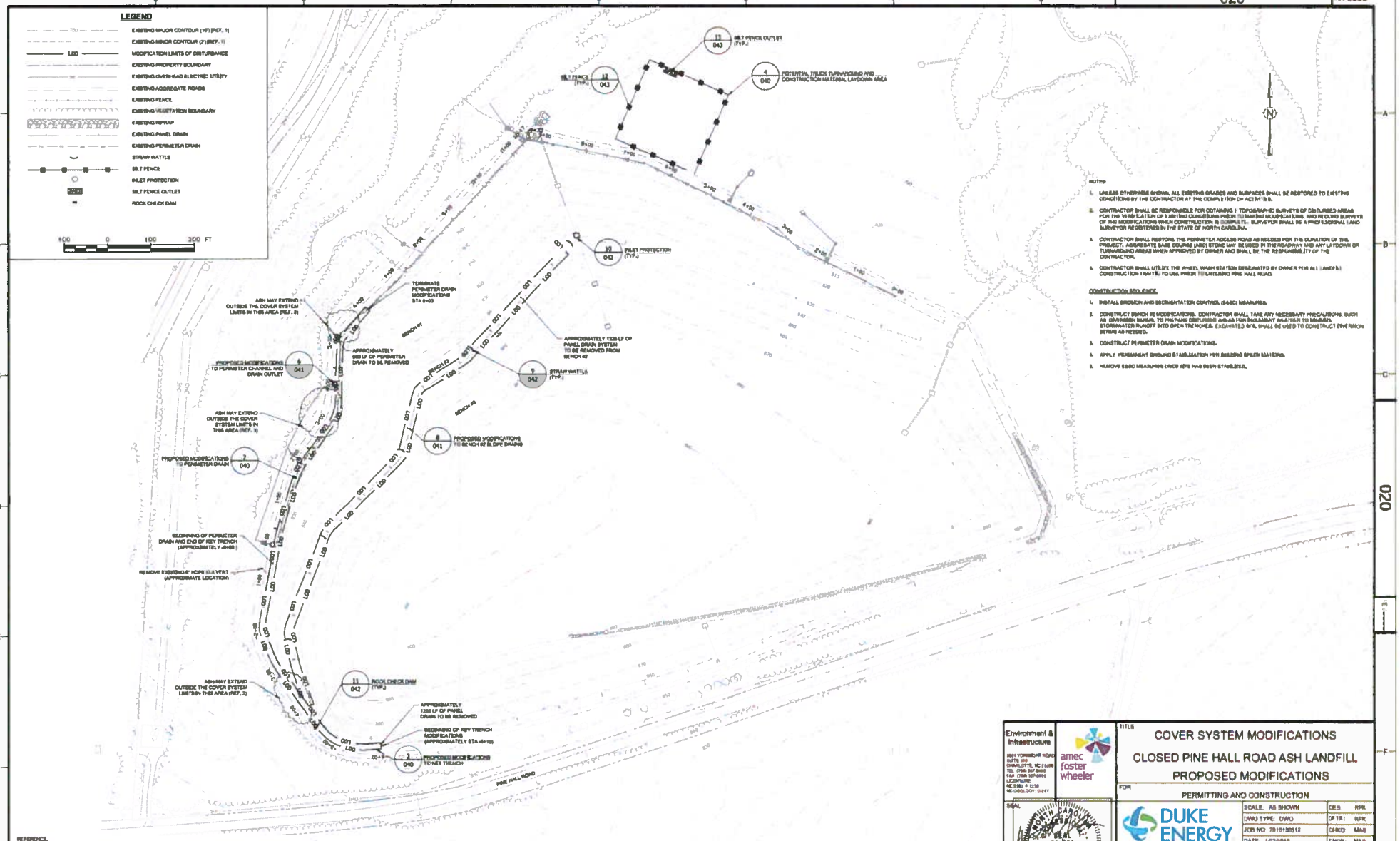
SCALE: AS SHOWN		DES:	RPR
DWG TYPE: DWG		DFTR:	RPR
JOB NO: 791125512		CHKD:	MAB
DATE: 1/22/2016		ENGR:	MAB
FILE NAME: 000 TITLE SHEET.dwg		APPD:	KRD
DWG SIZE: ANSI D 22"x34"	DRAWING NO: 000	REVISION:	0

REV	DATE	JOB NO	PROJECT TYPE	DES	DFTR	CHKD	ENGR	APPD	DESCRIPTION
0									

ABSAT ISSUE #	DATE	DESIGN


LEGEND
EXISTING MAJOR CONTOUR (10') (REF. 1)
EXISTING MINOR CONTOUR (2') (REF. 1)
EXISTING PROPERTY BOUNDARY
EXISTING OVERHEAD ELECTRIC UTILITY
EXISTING AGGREGATE ROADS
EXISTING FENCE
EXISTING VEGETATION BOUNDARY
EXISTING RIPRAP
EXISTING PANEL DRAIN
EXISTING PERIMETER DRAIN
100 0 100 200 FT
EXISTING DOWNDRAIN (REF. 2)
EXISTING SLOPE DRAIN SYSTEM AND PANEL DRAIN OUTLET (REF. 7)
EXISTING JUNCTION BOX (REF. 2)
EXISTING CONCRETE TERMINATION AND DIVERSION BERM (REF. 2)
EXISTING PERIMETER DRAIN (REF. 2)
EXISTING DROP INLET (REF. 2)
EXISTING 8" HDPE CULVERT (APPROXIMATE LOCATION)
EXISTING KEY TRENCH AND PANEL DRAIN OUTLET (REF. 7)
PINE HALL ROAD
N
012
Environment & Infrastructure
amec foster wheeler
TITLE
COVER SYSTEM MODIFICATIONS
CLOSED PINE HALL ROAD ASH LANDFILL
EXISTING CONDITIONS
FOR
PERMITTING AND CONSTRUCTION
DUKE ENERGY
SCALE: AS SHOWN
DWG TYPE: DWG
JOB NO: 78101/0912
DATE: 1/22/2016
FILE NAME: 012 EXISTING CONDITIONS.dwg
DWG SIZE
ANSI D 22"x34"
DRAWING NO
012
REVISION

REFERENCE:
1 EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY OBTAINED ON APRIL 14, 2014 BY NEW GLOBAL INC.
2 EXISTING STORMWATER FEATURES TAKEN FROM SAME DRAWING BC 1030-00.00 AS-BUILT DATED OCTOBER 18 2012.
REV DATE JOB NO. PROJECT TYPE DESCRIPTION
1/22/16



NOTES

1. UNLESS OTHERWISE SHOWN, ALL EXISTING GRADES AND SURFACES SHALL BE RESTORED TO EXISTING CONDITIONS BY THE CONTRACTOR AT THE COMPLETION OF ACTIVITIES.
2. CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING 1 TOPOGRAPHIC SURVEYS OF DISTURBED AREAS FOR THE VERIFICATION OF EXISTING CONDITIONS PRIOR TO MAKING MODIFICATIONS, AND RECORD SURVEYS OF THE MODIFICATIONS WHEN CONSTRUCTION IS COMPLETE. SURVEYOR SHALL BE A PROFESSIONAL LAND SURVEYOR REGISTERED IN THE STATE OF NORTH CAROLINA.
3. CONTRACTOR SHALL MAINTAIN THE PERIMETER ACCESS ROAD AS NEEDED FOR THE DURATION OF THE PROJECT. AGGREGATE BASE COURSE (ABC) STONE MAY BE USED IN THE ROADWAY AND ANY LAYDOWN OR TURNAROUND AREAS WHEN APPROVED BY OWNER AND SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
4. CONTRACTOR SHALL UTILIZE THE WHEEL WASH STATION DESIGNATED BY OWNER FOR ALL (LANDFILL) CONSTRUCTION TRAFFIC TO USE PRIOR TO EXITING PINE HALL ROAD.

CONSTRUCTION SEQUENCE

1. INSTALL BROKEN AND SEDIMENTATION CONTROL (BASIC) MEASURES.
2. CONSTRUCT BENCH 02 MODIFICATIONS. CONTRACTOR SHALL TAKE ANY NECESSARY PRECAUTIONS, SUCH AS DRY-WEEN SUMP, TO MINIMIZE DISTURBED AREAS FOR INCLEMENT WEATHER TO MINIMIZE STORMWATER RUNOFF INTO OPEN TRENCHES. EXCAVATED SOIL SHALL BE USED TO CONSTRUCT TEMPORARY BERMS AS NEEDED.
3. CONSTRUCT PERIMETER DRAIN MODIFICATIONS.
4. APPLY PERMANENT GROUND STABILIZATION PER SEEDING SPECIFICATIONS.
5. REMOVE BASIC MEASURES ONCE SITE HAS BEEN STABILIZED.

REFERENCE

1. EXISTING TOPOGRAPHIC INFORMATION WAS PRODUCED FROM PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY OBTAINED ON JULY 14, 2014 BY WEP GLOBAL INC.
2. EXISTING STORMWATER FEATURES TAKEN FROM SAME DRAWING SC-1535.00 00 AS-BUILT DATED OCTOBER 16, 2012
3. APPROXIMATE LIMITS OF ASH TAKEN FROM EDGE OF ASH MARKER DRAWING DATED MARCH 8, 2010 BY SAME

REV	DATE	JOB NO.	PROJECT TYPE	DES	DFTR	CHKD	APPD	DESCRIPTION
0								

Environment & Infrastructure
2801 YORKMONT ROAD
SUITE 100
CHARLOTTE, NC 28208
TEL (704) 357-8600
FAX (704) 357-8614
LICENSURE
NC ENG. # 2258
NC GEOLOGY: C-247

amec foster wheeler

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 031303 ENGINEER
1/22/16

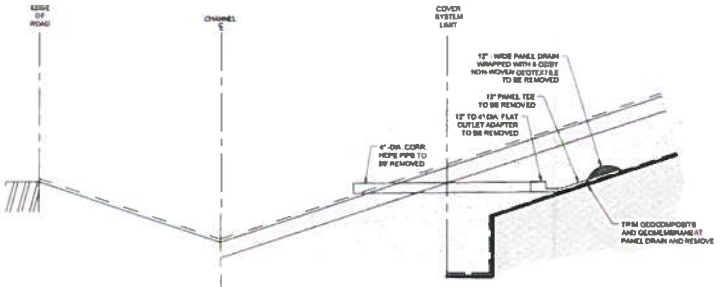
TITLE
COVER SYSTEM MODIFICATIONS
CLOSED PINE HALL ROAD ASH LANDFILL
PROPOSED MODIFICATIONS

FOR
PERMITTING AND CONSTRUCTION

DUKE ENERGY

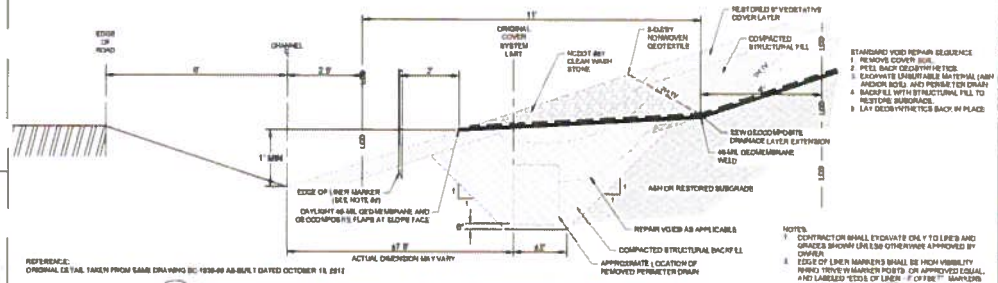
SCALE: AS SHOWN		DES:	RFR
DWG TYPE: DWG		DFTR:	RFR
JOB NO: 781128912		CHKD:	MAB
DATE: 1/22/2016		ENGR:	MAB
FILENAME: 020 PROPOSED MODIFICATIONS.dwg		APPD:	JRD
DWG SIZE: ANSI D 22"x34"	DRAWING NO: 020	REVISION:	---

020



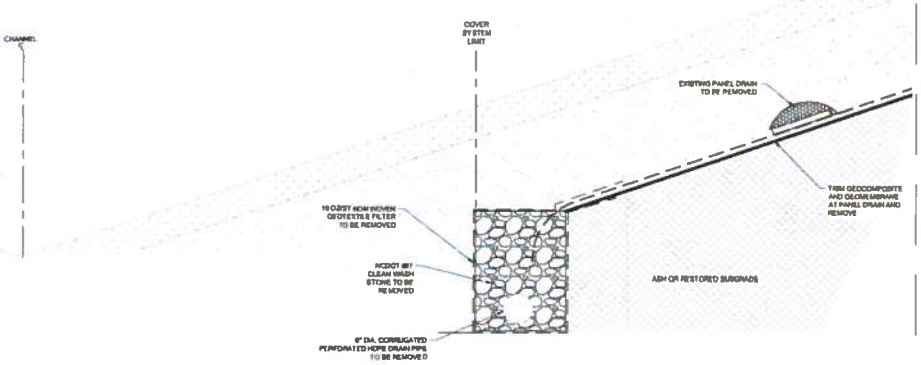
1 040 EXISTING COVER SYSTEM PERIMETER - KEY TRENCH
SCALE 1" = 2'
STATION -6+10 TO -0+50

REFERENCE:
ORIGINAL DETAIL TAKEN FROM SAME DRAWING BC-1639-00 AS-BUILT DATED OCTOBER 18, 2012.



REFERENCE:
ORIGINAL DETAIL TAKEN FROM SAME DRAWING BC-1639-00 AS-BUILT DATED OCTOBER 18, 2012

7 040 MODIFIED COVER SYSTEM PERIMETER (KEY TRENCH AND PERIMETER DRAIN) & VOID REPAIRS INSIDE MODIFICATION AREA
SCALE 1" = 2'
STATION -6+10 TO 6+00



3 040 EXISTING PERIMETER DRAIN
SCALE 1" = 1'
STATION -0+50 TO 6+00

REFERENCE:
ORIGINAL DETAIL TAKEN FROM SAME DRAWING BC-1639-00 AS-BUILT DATED OCTOBER 18, 2012

NOTES:
1 CONTRACTOR SHALL NOT EXCAVATE BELOW THE 6" VEGETATIVE COVER LAYER
2 STONE PAD TO REMAIN AFTER PROJECT COMPLETION

4 040 TEMPORARY TURNAROUND / LAYDOWN AREA SECTION
SCALE 1" = 2'

Environment & Infrastructure
amec foster wheeler

TITLE
COVER SYSTEM MODIFICATIONS
CLOSED PINE HALL ROAD ASH LANDFILL
MODIFICATION DETAILS 1

FOR
PERMITTING AND CONSTRUCTION

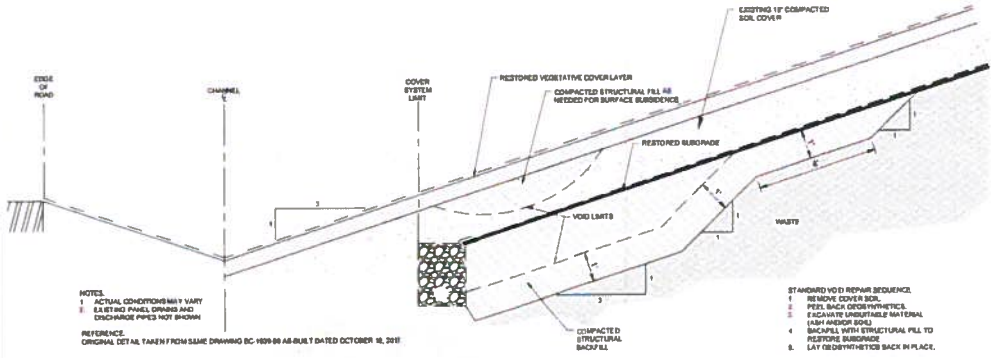
DUKE ENERGY

SCALE: AS SHOWN		DES:	RPK
DWG TYPE: DWG		DFTR:	RPK
JOB NO: 7910150512		CHKD:	MAB
DATE: 1/22/2016		ENGR:	MAB
FILE NAME: 040 DETAILS 1.dwg		APPD:	KRD
DWG SIZE: ANSI D 22"x34"	DRAWING NO: 040	REVISION:	----

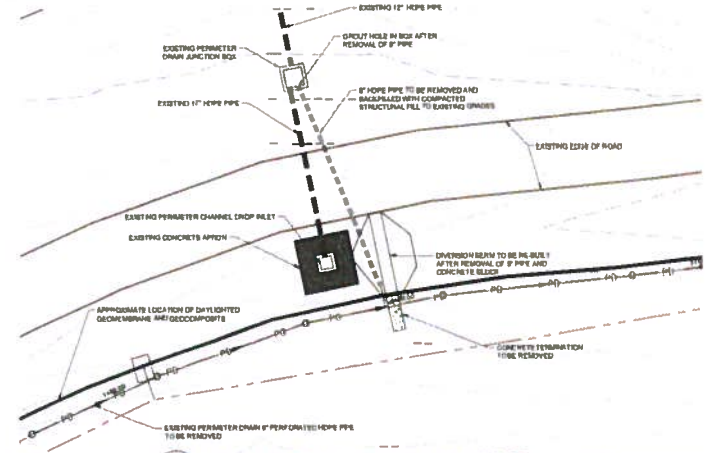
SEAL: NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 031303 MARTIN A. SHUMATE 1/22/16

040

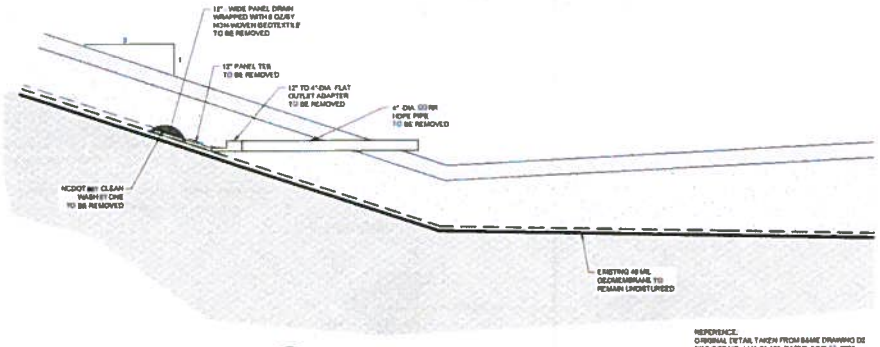
041



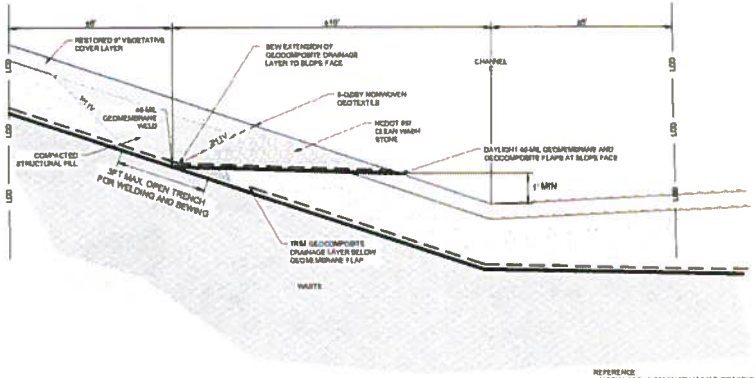
5 / 041 TYPICAL VOID REPAIR
SCALE: 1" = 2'



6 / 041 PLAN - PERIMETER CHANNEL AND DRAIN OUTLET (TYPICAL PD3 - PD6)
SCALE: 1" = 10'



7 / 041 EXISTING SLOPE DRAIN DETAIL (BENCH 2 ONLY)
SCALE: 1" = 2'



8 / 041 MODIFIED SLOPE DRAIN DETAIL (BENCH 2 ONLY)
SCALE: 1" = 2'

Environment & Infrastructure
amec foster wheeler

SEAL: NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 031303 MARK A. SHUMPERT 1/22/16

TITLE: COVER SYSTEM MODIFICATIONS
CLOSED PINE HALL ROAD ASH LANDFILL
MODIFICATION DETAILS 2

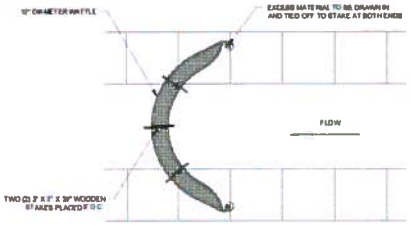
FOR: PERMITTING AND CONSTRUCTION

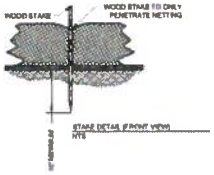
DUKE ENERGY

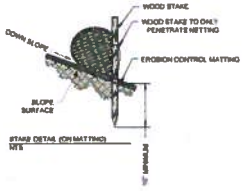
SCALE: AS SHOWN	DES: RPK
DWG TYPE: DWG	DFTR: RPK
JOB NO: 7810128012	CHKD: MAB
DATE: 1/22/2016	ENGR: MAB
FILENAME: 041 DETAILS PROPOSED.dwg	APPD: KRD
DWG SIZE: ANSI D 22"x34"	DRAWING NO: 041
	REVISION: ----

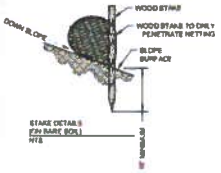
ISSUE # | DATE | DESIGN

REV | DATE | JOB NO | PROJECT TYPE | DES | DFTR | CHKD | ENGR | APPD | DESCRIPTION









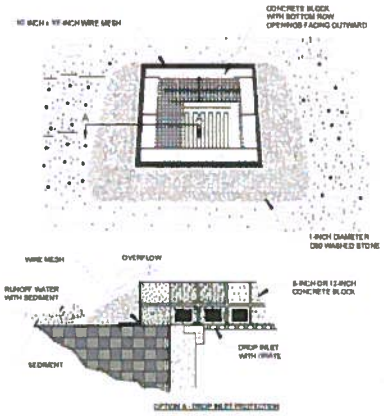
GENERAL NOTES:

1. WATTLES SHALL BE INSTALLED AS NEEDED BASED ON FIELD CONDITIONS.
2. ADJOINING SECTIONS OF WATTLES SHALL BE OVERLAPPED A MINIMUM 18 INCHES AND STAKED AT THE OVERLAP

INSPECTION AND MAINTENANCE NOTES:

1. ALL SEDIMENT AND EROSION CONTROL DEVICES AND PLANTED AREAS SHALL BE INSPECTED EVERY SEVEN (7) CALENDAR DAYS AND AFTER EACH RAINFALL OCCURRENCE THAT EXCEEDS ONE HALF (1/2) INCH WITHIN A 24-HOUR PERIOD. DAMAGED OR INEFFECTIVE DEVICES SHALL BE REPAIRED OR REPLACED, AS NECESSARY AS SOON AS PRACTICAL.
2. REMOVE ACCUMULATED SEDIMENT WHEN IT REACHES 1/3 THE HEIGHT OF THE DEVICE.
3. REMOVED SEDIMENT SHALL BE PLACED IN STOCKPILE STORAGE AREAS OR SPREAD THINLY ACROSS DISTURBED AREA. STABILIZE THE REMOVED SEDIMENT AFTER IT IS RELOCATED
4. REMOVE TEMPORARY E&SC MEASURES UPON STABILIZATION OF THE TRIBUTARY DRAINAGE AREA. REMOVE ALL CONSTRUCTION MATERIAL AND SEDIMENT AND DISPOSE OF THEM PROPERLY. COMPOST SOCKS MAY BE ABANDONED BY CUTTING THE SOCK MATERIAL AND SPREADING THE COMPOST IN PLACE. GRADE THE DISTURBED AREA TO DRAIN AND STABILIZE ACCORDINGLY.

9 / 042 STRAW WATTLE
(NORTH AMERICAN GREEN SEDIMAX-SW12 OR APPROVED EQUAL)



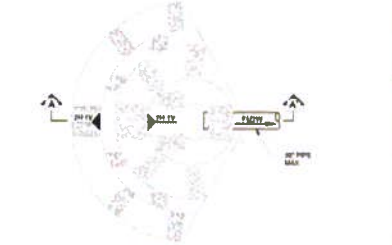
OPTION A - BLOCK INLET PROTECTION

GENERAL NOTES:

1. DROP INLET PROTECTION OR ROCK PIPE INLET PROTECTION SHALL BE INSTALLED WHERE SHOWN ON THE DRAWINGS AND AS NEEDED BASED ON FIELD CONDITIONS
2. BLOCK AND GRAVEL FILTERS CAN BE USED WHERE HEAVY FLOWS AND HIGHER VELOCITIES ARE EXPECTED AND WHERE AN OVERFLOW CAPACITY IS NECESSARY TO PREVENT EXCESSIVE PONDING AROUND THE STRUCTURE.
3. GRAVEL SHALL CONSIST OF 1-INCH CBD WASHED STONE AND SHOULD EXTEND TO HEIGHT EQUAL TO THE ELEVATION OF THE TOP OF THE BLOCKS
4. PLACE THE BOTTOM ROW OF THE CONCRETE BLOCKS LENGTHWISE ON THEIR SIDE, SO THAT THE OPEN END FACES OUTWARD, NOT UPWARD
5. THE HEIGHT OF THE BARRIER CAN BE VARIED, DEPENDING UPON DESIGN NEEDS BY STACKING A COMBINATION OF BLOCKS THAT ARE 8- TO 12-INCHES WIDE.
6. WIRE MESH SHOULD BE PLACED OVER THE OUTSIDE VERTICAL FACE OF THE CONCRETE BLOCKS TO PREVENT STONES FROM BEING WASHED THROUGH THE HOLES IN THE BLOCKS. HARDWARE CLOTH OR COMPARABLE WIRE MESH WITH A INCH X INCH OPENINGS SHOULD BE USED.

INSPECTION AND MAINTENANCE NOTES:

1. ALL SEDIMENT AND EROSION CONTROL DEVICES AND PLANTED AREAS SHALL BE INSPECTED EVERY SEVEN (7) CALENDAR DAYS AND AFTER EACH RAINFALL OCCURRENCE THAT EXCEEDS ONE HALF (1/2) INCH WITHIN A 24-HOUR PERIOD. DAMAGED OR INEFFECTIVE DEVICES SHALL BE REPAIRED OR REPLACED, AS NECESSARY AS SOON AS PRACTICAL.
2. REMOVE ACCUMULATED SEDIMENT WHEN IT REACHES 1/3 THE HEIGHT OF THE BLOCKS. IF A SUMP IS USED, SEDIMENT SHOULD BE REMOVED WHEN IT FILLS APPROXIMATELY 1/2 THE DEPTH OF THE HOLE.
3. REMOVED SEDIMENT SHALL BE PLACED IN STOCKPILE STORAGE AREAS OR SPREAD THINLY ACROSS DISTURBED AREA. STABILIZE THE REMOVED SEDIMENT AFTER IT IS RELOCATED
4. IF THE STONE FILTER BECOMES CLOGGED WITH SEDIMENT, THE STONES MUST BE PULLED AWAY FROM THE INLET AND CLEANED OR REPLACED WITH FRESH STONE.
5. REMOVE TEMPORARY E&SC MEASURES UPON STABILIZATION OF THE TRIBUTARY DRAINAGE AREA. REMOVE ALL CONSTRUCTION MATERIAL AND SEDIMENT AND DISPOSE OF THEM PROPERLY. GRADE THE DISTURBED AREA TO THE ELEVATION OF THE DROP INLET STRUCTURE OR BEST



OPTION B - ROCK PIPE INLET PROTECTION

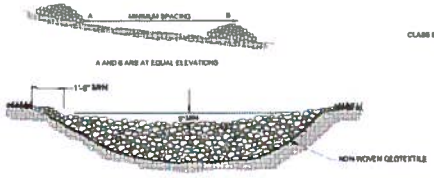
GENERAL NOTES:

1. ROCK PIPE INLET PROTECTION OR DROP INLET PROTECTION SHALL BE INSTALLED AS NEEDED BASED ON FIELD CONDITIONS
2. STRUCTURAL STONE SHALL BE CLASS B RIPRAP
3. SEDIMENT CONTROL STONE SHALL BE NO. 8 OR NO. 57 STONE.
4. DIMENSIONS ARE MINIMUM ACCEPTABLE UNLESS OTHERWISE SPECIFIED BY THE ENGINEER.

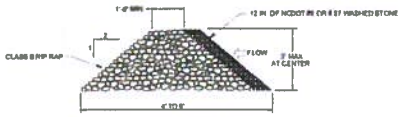
INSPECTION AND MAINTENANCE NOTES:

1. ALL SEDIMENT AND EROSION CONTROL DEVICES AND PLANTED AREAS SHALL BE INSPECTED EVERY SEVEN (7) CALENDAR DAYS AND AFTER EACH RAINFALL OCCURRENCE THAT EXCEEDS ONE HALF (1/2) INCH WITHIN A 24-HOUR PERIOD. DAMAGED OR INEFFECTIVE DEVICES SHALL BE REPAIRED OR REPLACED, AS NECESSARY AS SOON AS PRACTICAL.
2. REMOVE ACCUMULATED SEDIMENT WHEN IT REACHES 1/3 THE HEIGHT OF THE DEVICE
3. REMOVED SEDIMENT SHALL BE PLACED IN STOCKPILE STORAGE AREAS OR SPREAD THINLY ACROSS DISTURBED AREA. STABILIZE THE REMOVED SEDIMENT AFTER IT IS RELOCATED
4. IF THE STONE FILTER BECOMES CLOGGED WITH SEDIMENT, THE STONES MUST BE PULLED AWAY FROM THE INLET AND CLEANED OR REPLACED WITH FRESH STONE.
5. REMOVE TEMPORARY E&SC MEASURES UPON STABILIZATION OF THE TRIBUTARY DRAINAGE AREA. REMOVE ALL CONSTRUCTION MATERIAL AND SEDIMENT AND DISPOSE OF THEM PROPERLY. GRADE THE DISTURBED AREA TO DRAIN AND STABILIZE ACCORDINGLY.

10 / 042 INLET PROTECTION



PLAN



CROSS SECTION

GENERAL NOTES:

1. CHECK DAMS SHALL BE INSTALLED WHERE SHOWN ON THE DRAWINGS AND AS NEEDED BASED ON FIELD CONDITIONS
2. STONE SHOULD BE PLACED OVER THE CHANNEL BANKS TO KEEP WATER FROM CUTTING AROUND THE DAM

INSPECTION AND MAINTENANCE NOTES:

1. ALL SEDIMENT AND EROSION CONTROL DEVICES AND PLANTED AREAS SHALL BE INSPECTED EVERY SEVEN (7) CALENDAR DAYS AND AFTER EACH RAINFALL OCCURRENCE THAT EXCEEDS ONE-HALF (1/2) INCH WITHIN A 24-HOUR PERIOD. DAMAGED OR INEFFECTIVE DEVICES SHALL BE REPAIRED OR REPLACED, AS NECESSARY AS SOON AS PRACTICAL.
2. REMOVE ACCUMULATED SEDIMENT WHEN IT REACHES 1/3 THE HEIGHT OF THE DEVICE
3. REMOVED SEDIMENT SHALL BE PLACED IN STOCKPILE STORAGE AREAS OR SPREAD THINLY ACROSS DISTURBED AREA. STABILIZE THE REMOVED SEDIMENT AFTER IT IS RELOCATED
4. IF THE STONE FILTER BECOMES CLOGGED WITH SEDIMENT, THE STONES MUST BE PULLED AWAY AND CLEANED OR REPLACED WITH FRESH STONE.
5. REMOVE TEMPORARY E&SC MEASURES UPON STABILIZATION OF THE TRIBUTARY DRAINAGE AREA. REMOVE ALL CONSTRUCTION MATERIAL AND SEDIMENT AND DISPOSE OF THEM PROPERLY. GRADE THE DISTURBED AREA TO DRAIN AND STABILIZE ACCORDINGLY.

11 / 042 ROCK CHECK DAM

ASBUILT ISSUE #	DATE	DESIGN

REV	DATE	JOB NO	PROJECT TYPE	DES	DFTR	CHKD	ENGR	APPD	DESCRIPTION
0									

Environment & Infrastructure
2801 YORKMONT ROAD
SUITE 100
CHARLOTTE, NC 28208
TEL (704) 357-8089
FAX (704) 357-8094
LICENSURE:
NC ENG: P-1236
NC GEOLOGY: C-247

amec foster wheeler

SEAL
NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 031903 MARTIN A. SHUMAKER
1/22/16

TITLE
COVER SYSTEM MODIFICATIONS
CLOSED PINE HALL ROAD ASH LANDFILL
EROSION AND SEDIMENTATION CONTROL DETAILS 1

FOR
PERMITTING AND CONSTRUCTION

DUKE ENERGY

SCALE: AS SHOWN		DES	RFK
DWG TYPE: DWG		DFTR	RFK
JOB NO: 7810132612		CHKD	MAB
DATE: 1/22/2016		ENGR	MAB
FILENAME: 042 EROSION AND SEDIMENTATION CONTROL DETAILS.dwg		APPD	KRD
DWG SIZE: ANSI D 22"x34"	DRAWING NO: 042	REVISION: ----	

DEFINITION
CONTROLLING RUNOFF AND EROSION ON DISTURBED AREAS BY ESTABLISHING PERENNIAL VEGETATIVE COVER WITH SEED

PURPOSE
TO REDUCE EROSION AND DECREASE SEDIMENT YIELD FROM DISTURBED AREAS, AND TO PERMANENTLY STABILIZE SUCH AREAS IN A MANNER THAT IS ECONOMICAL, ADAPTS TO SITE CONDITIONS, AND ALLOWS SELECTION OF THE MOST APPROPRIATE PLANT MATERIALS

SPECIFICATIONS

SEEDBED REQUIREMENTS
ESTABLISHMENT OF VEGETATION SHOULD NOT BE ATTEMPTED ON SITES THAT ARE UNSUITABLE DUE TO EXCESSIVE SOIL COMPACTION, INAPPROPRIATE SOIL TEXTURE, POOR DRAINAGE, CONCENTRATED OVERLAND FLOW, OR STEEPNESS OF SLOPE UNTIL MEASURES HAVE BEEN TAKEN TO CORRECT THESE PROBLEMS.

TO MAINTAIN A GOOD STAND OF VEGETATION, THE SOIL MUST MEET CERTAIN MINIMUM REQUIREMENTS AS A GROWTH MEDIUM. THE EXISTING SOIL SHOULD HAVE THESE CRITERIA.

- ENOUGH FINE-GRAINED (SILT AND CLAY) MATERIAL TO MAINTAIN ADEQUATE MOISTURE AND NUTRIENT SUPPLY (AVAILABLE WATER CAPACITY OF AT LEAST .05 INCHES WATER TO 1 INCH OF SOIL)
- SUFFICIENT PORE SPACE TO PERMIT ROOT PENETRATION
- SUFFICIENT DEPTH OF SOIL TO PROVIDE AN ADEQUATE ROOT ZONE. THE DEPTH TO ROCK OR IMPERMEABLE LAYERS SUCH AS HARDPANS SHOULD BE 12 INCHES OR MORE, EXCEPT ON SLOPES STEEPER THAN 2:1 WHERE THE ADDITION OF SOIL IS NOT FEASIBLE
- A FAVORABLE PH RANGE FOR PLANT GROWTH, USUALLY 6.0 - 6.5
- FREE FROM LARGE ROOTS, BRANCHES, STONES, LARGE CLODS OF EARTH, OR TRASH OF ANY KIND. CLODS AND STONES MAY BE LEFT ON SLOPES STEEPER THAN 3:1 IF THEY ARE TO BE HYDRO SEEDED.

IF ANY OF THE ABOVE CRITERIA ARE NOT MET - I.E., IF EXISTING SOIL IS TOO COARSE, DENSE, SHALLOW OR ACIDIC TO FOSTER VEGETATION - SPECIAL AMENDMENTS ARE REQUIRED. THE SOIL CONDITIONERS DESCRIBED BELOW MAY BE BENEFICIAL OR, PREFERABLY, TOPSOIL MAY BE APPLIED

SEEDBED PREPARATION
INSTALL NECESSARY MECHANICAL EROSION AND SEDIMENTATION CONTROL PRACTICES BEFORE SEEDING, AND COMPLETE GRADING ACCORDING TO THE APPROVED PLAN

LIME AND FERTILIZER NEEDS SHOULD BE DETERMINED BY SOIL TESTS. DIRECTIONS, SAMPLE CARTONS, AND INFORMATION SHEETS ARE AVAILABLE THROUGH COUNTY AGRICULTURAL EXTENSION OFFICES. TESTING IS ALSO DONE BY COMMERCIAL LABORATORIES.

WHEN SOIL TESTS RESULTS ARE NOT AVAILABLE, FOLLOW RATES SUGGESTED IN THE SEEDING SPECIFICATIONS SHOWN AT RIGHT. APPLICATION RATES USUALLY FALL INTO THE FOLLOWING RANGES.

- GROUND AGRICULTURAL LIMESTONE: LIGHT-TEXTURED, SANDY SOILS: 1 TO 1-1/2 TONS/ACRE; HEAVY-TEXTURED, CLAYEY SOILS: 2-3 TONS/ACRE
- FERTILIZER: GRASSES: 800-1200 LB/ACRE OF 10-10-10 (OR THE EQUIVALENT); GRASS-LEGUME MIXTURES: 800-1200 LB/ACRE OF 5-10-10 (OR THE EQUIVALENT)

APPLY LIME AND FERTILIZER EVENLY AND INCORPORATE INTO THE TOP 4-6 INCHES OF SOIL BY DISKING OR OTHER SUITABLE MEANS. OPERATE MACHINERY ON THE CONTOUR. WHEN USING A HYDRO SEEDER, APPLY LIME AND FERTILIZER TO A ROUGH, LOOSE SURFACE.

ROUGHEN SURFACES PRIOR TO SEEDING.

COMPLETE SEEDBED PREPARATION BY BREAKING UP LARGE CLODS AND RAKING INTO A SMOOTH, UNIFORM SURFACE (SLOPES LESS THAN 3:1). FILL IN OR LEVEL DEPRESSIONS THAT CAN COLLECT WATER. BROADCAST SEED INTO A FRESHLY LOOSENED SEEDBED THAT HAS NOT BEEN SEALED BY RAINFALL.

SEEDING
SEEDING DATES GIVEN IN THE SEEDING MIXTURE SPECIFICATIONS ARE DESIGNATED AS "BEST" OR "POSSIBLE". SEEDINGS PROPERLY CARRIED OUT WITHIN THE "BEST" DATES HAVE A HIGH PROBABILITY OF SUCCESS. IT IS ALSO POSSIBLE TO HAVE SATISFACTORY ESTABLISHMENT WHEN SEEDING OUTSIDE THESE DATES. HOWEVER, AS YOU DEVIATE FROM THEM, THE PROBABILITY OF FAILURE INCREASES RAPIDLY. SEEDING ON THE LAST DATE SHOWN UNDER "POSSIBLE" MAY REDUCE CHANCES OF SUCCESS BY 30-50%. ALWAYS TAKE THIS INTO ACCOUNT IN SCHEDULING LAND-DISTURBING ACTIVITIES.

USE CERTIFIED SEED FOR PERMANENT SEEDING WHENEVER POSSIBLE.

LABELING OF NON-CERTIFIED SEED IS ALSO REQUIRED BY LAW. LABELS CONTAIN IMPORTANT INFORMATION ON SEED PURITY, GERMINATION, AND PRESENCE OF WEED SEEDS. SEEDS MUST MEET STATE STANDARDS FOR CONTENT OF NOXIOUS WEEDS. DO NOT ACCEPT SEED CONTAINING "PROHIBITED" NOXIOUS WEED SEED.

INOCULATE LEGUME SEED WITH THE RHIZOBIUM BACTERIA APPROPRIATE TO THE SPECIES OF LEGUME. APPLY SEED UNIFORMLY WITH A CYCLONE SEEDER, DROP-TYPE SPREADER, DRILL, CULTIPACKER SEEDER, OR HYDRO SEEDER ON A FIRM, FRIABLE SEEDBED.

WHEN USING A DRILL OR CULTIPACKER SEEDER, PLANT SMALL GRAINS NO MORE THAN 1 INCH DEEP. GRASSES AND LEGUMES NO MORE THAN 1/2 INCH. EQUIPMENT SHOULD BE CALIBRATED IN THE FIELD FOR THE DESIRED SEEDING RATE.

WHEN USING BROADCAST-SEEDING METHODS, SUBDIVIDE THE AREA INTO WORKABLE SECTIONS AND DETERMINE THE AMOUNT OF SEED NEEDED FOR EACH SECTION. APPLY ONE HALF THE SEED WHILE MOVING BACK AND FORTH ACROSS THE AREA, MAKING A UNIFORM PATTERN. THEN APPLY THE SECOND HALF IN THE SAME WAY, BUT MOVING AT RIGHT ANGLES TO THE FIRST PASS.

MULCH ALL PLANTINGS IMMEDIATELY AFTER SEEDING.

HYDRO SEEDING
SURFACE ROUGHENING IS PARTICULARLY IMPORTANT WHEN HYDRO SEEDING, AS A ROUGHENED SLOPE WILL PROVIDE SOME NATURAL COVERAGE FOR LIME, FERTILIZER, AND SEED. THE SURFACE SHOULD NOT BE COMPACTED OR SMOOTH. FINE SEEDBED PREPARATION IS NOT NECESSARY FOR HYDRO SEEDING OPERATIONS. LARGE CLODS, STONES, AND IRREGULARITIES PROVIDE CAVITIES IN WHICH SEEDS CAN LODGE.

RATE OF WOOD FIBER (CELLULOSE) APPLICATION SHOULD BE AT LEAST 2,000 LB/ACRE.

APPLY LEGUME INOCULANTS AT FOUR TIMES THE RECOMMENDED RATE WHEN ADDING INOCULANT TO A HYDRO SEEDER SLURRY.

IF A MACHINERY BREAKDOWN OF 1/2 TO 2 HOURS OCCURS, ADD 50% MORE SEED TO THE TANK, BASED ON THE PROPORTION OF THE SLURRY REMAINING. THIS SHOULD COMPENSATE FOR DAMAGE TO SEED. BEYOND 2 HOURS, A FULL RATE OF NEW SEED MAY BE NECESSARY.

LIME IS NOT NORMALLY APPLIED WITH A HYDRAULIC SEEDER BECAUSE IT IS ABRASIVE. IT CAN BE BLOWN ONTO STEEP SLOPES IN DRY FORM.

MAINTENANCE
GENERALLY, A STAND OF VEGETATION CANNOT BE DETERMINED TO BE FULLY ESTABLISHED UNTIL SOIL COVER HAS BEEN MAINTAINED FOR ONE FULL YEAR FROM PLANTING. INSPECT SEEDED AREAS FOR FAILURE AND MAKE NECESSARY REPAIRS AND RESEEDINGS WITHIN THE SAME SEASON, IF POSSIBLE.

RESEEDING - IF A STAND HAS INADEQUATE COVER, RE-EVALUATE CHOICE OF PLANT MATERIALS AND QUANTITIES OF LIME AND FERTILIZER. RE-ESTABLISH THE STAND AFTER SEEDBED PREPARATION OR OVER-SEED THE STAND. CONSIDER SEEDING TEMPORARY, ANNUAL SPECIES IF THE TIME OF YEAR IS NOT APPROPRIATE FOR PERMANENT SEEDING.

IF VEGETATION FAILS TO GROW, SOIL MUST BE TESTED TO DETERMINE IF ACIDITY OR NUTRIENT IMBALANCE IS RESPONSIBLE.

FERTILIZATION - ON THE TYPICAL DISTURBED SITE, FULL ESTABLISHMENT USUALLY REQUIRES RE-FERTILIZATION IN THE SECOND GROWING SEASON. FINE TURF REQUIRES ANNUAL MAINTENANCE FERTILIZATION. USE SOIL TESTS IF POSSIBLE OR FOLLOW THE GUIDELINES GIVEN FOR THE SPECIFIC SEEDING MIXTURE.

TEMPORARY SEEDING SPECIFICATIONS

SEEDING MIXTURE (FALL)

SPECIES	RATE (LB/ACRE)
RYE GRAIN (*SECALE CEREALE*)	120

SEEDING MIXTURE (LATE WINTER/EARLY SPRING)

SPECIES	RATE (LB/ACRE)
RYE GRAIN (*SECALE CEREALE*)	120

SEEDING MIXTURE (SUMMER)

SPECIES	RATE (LB/ACRE)
GERMAN MILLET (*SETARIA ITALICA*)	40

SEEDING DATES (PIEDMONT)

FALL	AUG. 15 - DEC. 30
LATE WINTER (EARLY SPRING)	JAN. 1 - MAY 1 LATE
SUMMER	MAY 1 - AUG. 15

SOIL AMENDMENTS
FOLLOW RECOMMENDATIONS OF SOIL TESTS OR APPLY 2,000 LB/ACRE GROUND AGRICULTURAL LIMESTONE AND 750 LB/ACRE 10-10-10 FERTILIZER.

MULCH
APPLY 4,000 LB/ACRE STRAW. ANCHOR MULCH BY TACKING WITH ASPHALT, ROVING OR A MULCH ANCHORING TOOL. A DISK WITH BLADES SET NEARLY STRAIGHT CAN BE USED AS A MULCH ANCHORING TOOL.

MAINTENANCE
RE-FERTILIZE IF GROWTH IS NOT FULLY ADEQUATE. RESEED, RE-FERTILIZE AND MULCH IMMEDIATELY FOLLOWING EROSION OR OTHER DAMAGE.

PURSUANT TO G.S. 113A-57(2), THE ANGLE FOR GRADED SLOPES AND FILLS SHALL BE NO GREATER THAN THE ANGLE THAT CAN BE RETAINED BY VEGETATIVE COVER OR OTHER ADEQUATE EROSION-CONTROL DEVICES OR STRUCTURES. IN ANY EVENT, 3H:1V OR GREATER SLOPES LEFT EXPOSED WILL, WITHIN 7 CALENDAR DAYS OF COMPLETION OF ANY PHASE OF GRADING, BE PLANTED OR OTHERWISE PROVIDED WITH TEMPORARY OR PERMANENT GROUND COVER, DEVICES, OR STRUCTURES SUFFICIENT TO RESTRAIN EROSION.

PURSUANT TO G.S. 113A-57(3), PROVISIONS FOR PERMANENT GROUNDCOVER SUFFICIENT TO RESTRAIN EROSION MUST BE ACCOMPLISHED FOR ALL DISTURBED AREAS WITHIN 14 WORKING DAYS FOLLOWING COMPLETION OF CONSTRUCTION OR DEVELOPMENT.

*REF: 6.10 A,B AND C, NC EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL, 2013

PERMANENT SEEDING SPECIFICATIONS

SEEDING MIXTURE

SPECIES	RATE (LB/ACRE)
TALL FESCUE (*FESTUCA ARUNDINACEA*) (GRASS LINED CHANNELS)	200
TALL FESCUE (*FESTUCA ARUNDINACEA*) (OTHER AREAS)	100

NURSE PLANTS
BETWEEN MAY 1 AND AUG. 15, ADD 10 LB/ACRE GERMAN MILLET (*SETARIA ITALICA*) OR 15 LB/ACRE SUDAN GRASS. PRIOR TO MAY 1 OR AFTER AUG. 15 ADD 40 LB/ACRE RYE GRAIN (*FESTUCA ARUNDINACEA*)

SEEDING DATES

	BEST	POSSIBLE
FALL	AUG. 25 - SEPT. 15	AUG. 20 - OCT. 25
LATE WINTER	FEB. 15 - MAR. 21	FEB. 1 - APR. 15

SOIL AMENDMENTS
APPLY LIME AND FERTILIZER ACCORDING TO SOIL TESTS, OR APPLY 4,000 LB/ACRE GROUND AGRICULTURAL LIMESTONE AND 1,000 LB/ACRE 10-10-10 FERTILIZER

MULCH
APPLY 4,000-5,000 LB/ACRE GRAIN STRAW OR EQUIVALENT COVER OF ANOTHER SUITABLE MULCHING MATERIAL. ANCHOR MULCH BY TACKING WITH ASPHALT, ROVING, OR NETTING. NETTING IS THE PREFERRED ANCHORING METHOD ON STEEP SLOPES.

MAINTENANCE
RE-FERTILIZE IN THE SECOND YEAR UNLESS GROWTH IS FULLY ADEQUATE. MAY BE MOWED ONCE OR TWICE A YEAR, BUT MOWING IS NOT NECESSARY. RESEED, FERTILIZE, AND MULCH DAMAGED AREAS IMMEDIATELY.

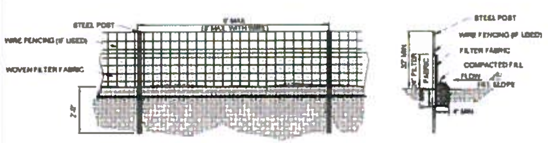
PURSUANT TO G.S. 113A-57(3), PROVISIONS FOR PERMANENT GROUNDCOVER SUFFICIENT TO RESTRAIN EROSION MUST BE ACCOMPLISHED FOR ALL DISTURBED AREAS WITHIN 14 WORKING DAYS.

*REF: 6.11, NC EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL, 2013

Ground Stabilization Requirements

Site Area Description	Stabilization	Timeframe Exceptions
Perimeter dikes, swales, ditches and slopes	7 days	None
High Quality Water (HQW) Zones	7 days	None
Slopes steeper than 3:1	7 days	If slopes are 10' or less in length and are not steeper than 2:1, 14 days are allowed.
Slopes 3:1 or flatter	14 days	7 days for slopes greater than 50' in length
All other areas with slopes flatter than 4:1	14 days	None, except for perimeters and HQW Zones

GENERAL SEEDING SPECIFICATIONS



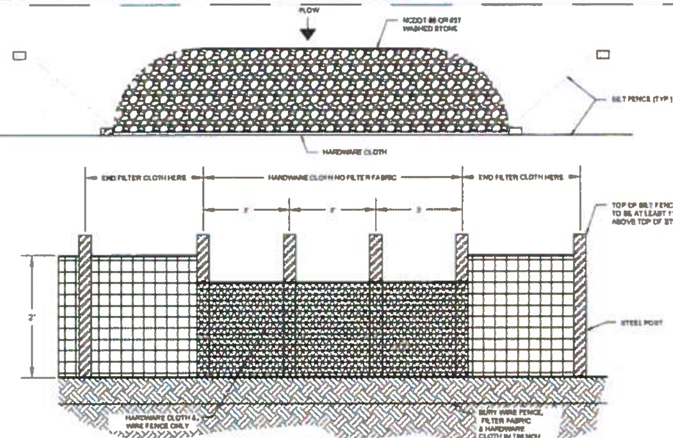
GENERAL NOTES

1. SEDIMENT FENCE SHALL BE INSTALLED WHERE SHOWN ON THE DRAWINGS AND AS NEEDED BASED ON FIELD CONDITIONS.
2. WIRE FENCING SHALL BE A MINIMUM OF 32" IN WIDTH AND SHALL HAVE A MINIMUM OF 6 LINE WIRES WITH 12" STAY SPACING. WIRE FENCING SHALL BE AT LEAST #10 GAGE WITH A MINIMUM OF 6 LINE WIRES WITH 12" STAY SPACING. WIRE MESH SHALL BE MIN. 13 GAGE WITH MAXIMUM 12" OPENINGS.
3. WOVEN FILTER FABRIC BE USED WHERE SILT FENCE IS TO REMAIN FOR A PERIOD OF MORE THAN 30 DAYS.
4. STEEL POSTS SHALL BE 5'-0" IN HEIGHT AND BE OF THE SELF-FASTENER ANGLE STEEL TYPE.
5. TURN SILT FENCE UP SLOPE AT ENDS.
6. ORANGE SAFETY FENCE IS REQUIRED AT BACK OF SILT FENCE WHEN GRADING IS ADJACENT TO SWIM BUFFERS, STREAMS OR WETLANDS (REFER TO SWIM BUFFER GUIDELINES). THE COLOR ORANGE IS RESERVED FOR VISUAL IDENTIFICATION OF ENVIRONMENTALLY SENSITIVE AREAS.
7. DRAINAGE AREA CAN NOT BE GREATER THAN 1/4 ACRE PER 100 FT OF FENCE.

INSPECTION AND MAINTENANCE NOTES

1. ALL SEDIMENT AND EROSION CONTROL DEVICES AND PLANTED AREAS SHALL BE INSPECTED EVERY SEVEN (7) CALENDAR DAYS AND AFTER EACH RAINFALL OCCURRENCE THAT EXCEEDS ONE HALF (1/2) INCH WITHIN A 24-HOUR PERIOD. DAMAGED OR INEFFECTIVE DEVICES SHALL BE REPAIRED OR REPLACED, AS NECESSARY, AS SOON AS PRACTICAL.
2. REMOVE ACCUMULATED SEDIMENT WHEN IT REACHES 1/3 THE HEIGHT OF THE DEVICE.
3. REMOVED SEDIMENT SHALL BE PLACED IN STOCKPILE STORAGE AREAS OR SPREAD THINLY ACROSS DISTURBED AREA. STABILIZE THE REMOVED SEDIMENT AFTER IT IS RELOCATED.
4. REMOVE TEMPORARY E&SC MEASURES UPON STABILIZATION OF THE TRIBUTARY DRAINAGE AREA. REMOVE ALL CONSTRUCTION MATERIAL AND SEDIMENT, AND DISPOSE OF THEM PROPERLY. GRADE THE DISTURBED AREA TO DRAIN AND STABILIZE ACCORDINGLY.

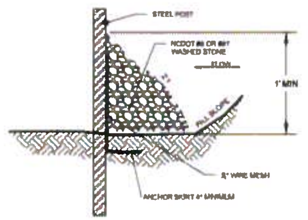
12/043 SILT FENCE



13/043 SILT FENCE OUTLET

GENERAL NOTES:

1. SILT FENCE OUTLETS SHALL BE INSTALLED AS NEEDED BASED ON FIELD CONDITIONS.
2. USE NO. 5 OR NO. 57 STONE FOR SEDIMENT CONTROL.
3. USE HARDWARE CLOTH 20 GAUGE WIRE MESH WITH 1/2" MESH OPENINGS.
4. INSTALL 5' SELF FASTENER ANGLE STEEL POST 2' DEEP MINIMUM.
5. SPACE POST A MAXIMUM OF 4'.



INSPECTION AND MAINTENANCE NOTES:

1. ALL SEDIMENT AND EROSION CONTROL DEVICES AND PLANTED AREAS SHALL BE INSPECTED EVERY SEVEN (7) CALENDAR DAYS AND AFTER EACH RAINFALL OCCURRENCE THAT EXCEEDS ONE HALF (1/2) INCH WITHIN A 24-HOUR PERIOD. DAMAGED OR INEFFECTIVE DEVICES SHALL BE REPAIRED OR REPLACED, AS NECESSARY, AS SOON AS PRACTICAL.
2. REMOVE ACCUMULATED SEDIMENT WHEN IT REACHES 1/3 THE HEIGHT OF THE DEVICE.
3. REMOVED SEDIMENT SHALL BE PLACED IN STOCKPILE STORAGE AREAS OR SPREAD THINLY ACROSS DISTURBED AREA. STABILIZE THE REMOVED SEDIMENT AFTER IT IS RELOCATED.
4. IF THE STONE FILTER BECOMES CLOGGED WITH SEDIMENT, THE STONES MUST BE PULLED AWAY FROM THE INLET AND CLEANED OR REPLACED WITH FRESH STONE.
5. REMOVE TEMPORARY E&SC MEASURES UPON STABILIZATION OF THE TRIBUTARY DRAINAGE AREA. REMOVE ALL CONSTRUCTION MATERIAL AND SEDIMENT, AND DISPOSE OF THEM PROPERLY. GRADE THE DISTURBED AREA TO DRAIN AND STABILIZE ACCORDINGLY.

Environment & Infrastructure	amec foster wheeler
SEAL: NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 031203 MARTIN SHUMPERT 1/22/16	
TITLE	COVER SYSTEM MODIFICATIONS CLOSED PINE HALL ROAD ASH LANDFILL EROSION AND SEDIMENTATION CONTROL DETAILS 2
FOR	PERMITTING AND CONSTRUCTION
DUKE ENERGY	SCALE: AS SHOWN; DWG TYPE: DWG; JOB NO: 7810150812; DATE: 1/22/2016
DES: RFR; DFTR: RFR; CHKD: MAS; ENGR: MAS; APPD: KRD	
FILE NAME: 043 EROSION AND SEDIMENTATION CONTROL DETAILS 2.dwg	
DWG SIZE: ANSI D 22"x34"	DRAWING NO: 043
REVISION: ----	

Technical Specifications

Closed Pine Hall Road Ash Landfill – Cover System Modifications

Duke Energy– Belews Creek Steam Station

Belews Creek, Stokes County, North Carolina

NORTH CAROLINA PROFESSIONAL SEAL 031203 ENGINEER MARTIN A. SHUMPERT

1/22/16

Amec Foster Wheeler Project No. 7810150512

Prepared For:	Duke Energy Carolinas, LLC 526 S. Church St., Charlotte, NC 28202
Date	January 22, 2016
Prepared By:	Amec Foster Wheeler 2801 Yorkmont Rd., Charlotte, NC 28208

TABLE OF CONTENTS
TECHNICAL SPECIFICATIONS FOR
CLOSED PINE HALL ROAD LANDFILL
DUKE ENERGY CAROLINAS, LLC
BELEWS CREEK, STOKES COUNTY, NORTH CAROLINA

SPECIFICATIONS

01 71 23	Construction Surveying
31 10 00	Site Clearing
31 20 00	Earth Moving
31 32 05	LLDPE Geomembrane
31 32 20	Geocomposite Drainage Layer
31 32 40	Nonwoven Geotextile
31 35 20	Erosion and Sedimentation Control
31 37 00	Aggregate & Riprap
32 92 00	Seeding

SECTION 017123 – CONSTRUCTION SURVEYING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: the minimum requirements for completion of the Work associated with surveying for the project, including tasks related to control of the Work during performance, documentation of construction progress (e.g., quantity surveys), and preparation of record survey drawings to be submitted to the Owner. Anticipated survey documents include:

1. Existing Conditions Record Drawing
2. Final Conditions Record Drawing
3. Geomembrane Record Drawing
4. Additional surveys as needed for measurement of quantities

B. Specification section does not include daily surveying tasks that may be required for the Contractor to control or complete the Work or for proper control of construction operations. The Contractor shall be responsible for determining the work tasks required to adequately control the Contractor's construction operations to meet project and specification requirements.

1.2 SUBMITTALS

A. At the completion of the Work, the Contractor shall submit all Record Documents to the Engineer for review and comment within 30 days of substantial completion. The Engineer will review the Record Documents within a period of 3 weeks and either approve the Record Documents or return the Record Documents to the Contractor for revisions. Upon revision, the Record Documents shall be resubmitted to the Engineer for review and comment.

1.3 QUALITY CONTROL

A. The Contractor shall be responsible for tasks required for quality control of the work associated with daily activities not related to record drawing or submittals. Work associated with control of the Contractor's work not related to record documents may be performed by the Contractor's personnel at the Contractor's discretion.

B. Surveys for Record Documents shall be performed by a third-party qualified Professional Land Surveyor (PLS) currently registered in the State of North Carolina as approved by the Owner. The Contractor shall be solely responsible for providing personnel, including subcontractors that meet the required qualifications.

1.4 QUALITY ASSURANCE

A. The Owner may, at their sole discretion, retain an independent surveying firm to provide Quality Assurance (QA) for the project. The Owner shall define the scope of work to be performed by the QA surveying firm.

B. The Contractor shall cooperate with the Owner's QA surveying representative as necessary to complete the Work, including coordinating access to construction work areas. If necessary, the Contractor shall suspend construction operations in the vicinity of the QA surveying work at the Owner's request.

C. Any required re-work due to the Contractor's survey errors will be at the Contractor's sole expense. Any schedule delays or replacement of materials due to the Contractor's survey errors shall be the Contractor's responsibility.

D. Completion of any supplemental surveying work considered necessary by the Owner, at their sole discretion, due to incomplete or inadequate surveying data shall be the Contractor's responsibility.

1.5 SURVEY ACCURACY REQUIREMENTS

A. Surveys shall be performed to the following tolerances:

1. Points shall be reported horizontally and vertically within 0.01 feet.

1.6 SURVEY DATUMS AND REFERENCES

A. The horizontal datum shall be referenced to the North Carolina State Plane Coordinate System, NAD83 or as approved by the Engineer.

B. The vertical datum shall be referenced to NGVD29 or as approved by the Engineer.

C. Surveys shall use the US Survey Foot as the unit of measure.

D. At a minimum, the Contactor shall establish three (3) control points within the work boundary tied to state survey monuments adjacent to the site. The quantity of control points established shall be sufficient for the Contractor to control the Work, including locating and establishing lines and grades as necessary.

E. Once established, the Contractor shall protect survey control points, monuments, or benchmarks during construction. Re-establishment of survey control points, monuments, or benchmarks destroyed or disturbed as a result of the Contractor's construction operations shall be the responsibility of the Contractor.

1.7 SURVEYS FOR QUANTITIES

A. The Contractor shall perform ground surveys as required to define and depict Work performed, including sufficient backup data to allow the Owner to determine measurable quantities of work performed.

B. The Contractor shall perform surveys and calculations as necessary to determine Work performed during each progress payment period. Contractor shall provide sufficient backup information and data to allow the Owner to verify quantities of Work performed.

C. Surveys will include a table summarizing northings, eastings, and elevations for each grid point to provide a comparison for thickness verification.

D. Completion of any supplemental surveying work considered necessary by the Owner, at their sole discretion, due to incomplete or inadequate surveying data shall be the Contractor's responsibility.

PART 2 - PRODUCTS

2.1 SOFTWARE

A. Prior to commencing work associated with surveying requirements, Contractor shall coordinate with Engineer to determine an acceptable electronic format for which all submittals and deliverables will be made.

2.2 PLOTS

A. Prior to commencing work associated with surveying requirements, Contractor shall coordinate with Owner to determine an acceptable format for which all hard copy submittals and deliverables will be made.

B. All hard copy deliverables and submittals shall include, at a minimum, the following information:

1. Project name and location.
2. Contractor's firm name.
3. Survey firm name and names of survey party.
4. Date of survey and submittal.
5. Identifier for revision sequence.
6. Surveying firm's professional certification.

PART 3 - EXECUTION

3.1 GENERAL SURVEY REQUIREMENTS

A. The Work shall be performed in conformance with the lines and grades of the project drawings and the requirements of the Specifications. The Contractor shall notify the Owner of any discrepancies between actual conditions and the drawings, real or perceived, so that the Owner may resolve the discrepancies prior to performance of related Work.

B. Written notice shall be provided to the Owner one week prior to performing any Work associated with data collection related to Record Documents so that the Owner may coordinate QA work activities if necessary.

C. The Owner may require re-work of any task or activity that, in the sole judgment of the Owner, is not adequately documented by acceptable survey data or standards.

D. The Contractor shall be responsible for surveying and recording any deviations from the project drawings or design, whether the deviations are requested by the Owner or Contractor.

E. Utilize recognized engineering survey practices appropriate for obtaining the information specified.

F. Protect and preserve temporary and permanent reference points during construction. Promptly report to Engineer the loss or destruction of any reference point or relocation required because of changes in grades or other reasons. Replace dislocated reference points based on original survey control. Make no changes without prior written notice to Engineer.

G. The Work shall be executed in conformance with the lines and grades shown on the Drawings, unless otherwise approved by the Engineer.

H. Establish elevations, lines and levels required for all items of the Work.

3.2 DOCUMENTATION OF THE WORK

A. Maintain a complete and accurate log of control and survey work as it progresses.

B. Record survey drawings shall be prepared to fully document the Work, as specified in individual specification sections.

C. The surveys shall be performed at the specified grid spacing, and at all changes of grade sufficient to define the subject topography.

D. Promptly submit the drawings (with computer files) to Engineer for review at critical stages of construction as specified in individual specification sections.

E. Contractor's registered land surveyor (RLS) shall prepare and certify the record survey drawings.

3.3 EXISTING CONDITIONS SURVEY

A. The Contractor shall survey the existing topography within the Work Boundary with sufficient detail to define the subject topography.

B. At a minimum, the Contractor shall survey existing conditions with sufficient detail to produce one (1) foot contours that define existing topography, including channels and breaks in slope. At a minimum, survey shall be performed on a grid spacing of 50 feet or as needed to show all breaks in grade. The Contractor may elect to perform a more detailed survey if desired for purposes of defining quantities.

C. Survey data and topographic plots shall be provided to the Owner for review and comment within 14 days of completion of survey of existing topographic conditions. If the Contractor elects to perform the survey of existing conditions in parts, the survey data and topographic plots for portions surveyed shall be provided to the Owner within 14 days of completion of each portion of the total site. The Contractor shall submit a final plot combining all portions of the site if surveyed in multiple parts.

3.4 SUBGRADES

A. The Contractor shall survey finished subgrades, both design and over-excavated, within the Work Boundary with sufficient detail to define the subject topography. The surveys shall be performed at the specified grid spacing and at all changes of grade sufficient to define the subject topography.

B. The Contractor shall survey finished excavation grades with sufficient detail to produce one (1) foot contours that define the subject topography. At a minimum, survey shall be performed on a grid spacing of 50 feet or as needed to show all breaks in grade.

C. Topographic surveys shall be performed on the same grid such that survey point locations are consistent with the survey points of the underlying layer. Subgrade surveys required for thickness verification shall include a table summarizing northings, eastings, and elevations for each grid point.

D. Survey data and topographic plots shall be provided to the Owner for review and comment within 30 days of completion of survey of finished excavation grades. The Contractor may propose an alternate schedule for submission in the Survey Plan if desired subject to Owner approval.

3.5 GEOMEMBRANE SURVEYS

A. The geomembrane surveys shall include panel corners, transitions in panel geometry, repair locations, and other significant features.

B. At the Engineer's discretion, geomembrane surveys may be prepared using a handheld GPS device with sub-foot accuracy.

3.6 FINAL GRADES AND PERMANENT FEATURES

A. The Contractor shall survey final site grades within the Work Boundary with sufficient detail to define the subject topography. The surveys shall be performed at the specified grid spacing and at all changes of grade sufficient to define the subject topography.

B. The Contractor shall survey finished excavation grades with sufficient detail to produce one (1) foot contours that define the subject topography, including channels and breaks in slope. At a minimum, survey shall be performed on a grid spacing of 50 feet or as needed to show all breaks in grade.

C. Survey data and topographic plots shall be provided to the Owner for review and comment within 30 days of completion of survey of final site grades. The Contractor may propose an alternate schedule for submission in the Survey Plan if desired subject to Owner approval.

END OF SECTION 017123

SECTION 311000 – SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes site clearing:

1. Stripping and stockpiling topsoil.
2. Removal of demolished and waste materials.

B. Related Requirements:

1. Section 017123 "Construction Surveying"
2. Section 312000 "Earth Moving."
3. Section 313520 "Erosion and Sedimentation Control."

1.2 SUBMITTALS

A. Topsoil stripping and stockpiling program. Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.3 QUALITY CONTROL

A. Perform Work in accordance with State and local standards and ordinances.

PART 2 - PRODUCTS

2.1 Stripping: removal of top six inches of surficial soil material.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to CQA Engineer and at no additional cost to the Owner.

C. Identify laydown area for placing removed and stockpiled materials. May dispose on site if permitted by Owner in Owner designated area.

3.2 EROSION AND SEDIMENTATION CONTROL

A. Adhere to the approved Erosion and Sediment Control Plan as provided by the Engineer.

3.3 TOPSOIL STRIPPING

A. Strip topsoil to depth of 6 inches and as indicated on the Drawings in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and non-soil materials from topsoil, including clay lumps, gravel, ash material, and other objects larger than 6 inches in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.4 DISPOSAL OF WASTE MATERIALS

A. Remove demolished materials, and waste materials including trash and debris, and stockpile them in designated laydown area.

END OF SECTION 311000

SECTION 312000 – EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes soil earthworks:

1. Excavation.
2. Over-excavation and backfill.
3. Soil stockpiling.
4. Compacted fill placement.

B. Related Requirements:

1. Section 017123 "Construction Surveying"
2. Section 311000 "Site Clearing"
3. Section 313520 "Erosion and Sedimentation Control"

1.2 REFERENCES

A. Construction Quality Assurance (CQA) Plan

B. ASTM International:

1. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
2. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
3. ASTM D2216 – Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
4. ASTM D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
5. ASTM D2937 – Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.
6. ASTM D4959 – Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating.
7. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. The Contractor shall retain a third-party surveyor licensed in North Carolina.

B. The Contractor shall submit record drawings by the Professional Land Surveyor before and after excavation from on-site sources, soil over-excavation, or rock removal.

1.4 QUALITY ASSURANCE

A. Quality assurance will be provided by the Owner as described in the CQA Plan.

PART 2 - PRODUCTS

2.1 EXCAVATION

Excavation shall include the removal of all soil, stone, conduits, pipe, and all other obstacles encountered.

2.2 OVER-EXCAVATION AND BACKFILL

A. Unsuitable Material is any in-place or excavated material which contains undesirable materials, or is in a state which is not appropriate; in the opinion of the CQA Engineer, for the intended use. This may include but not be limited to organic material, waste/refuse, soft, or wet material not meeting required specifications, etc.

B. Unsuitable Materials Excavation (Over-excavation) shall consist of the removal and stockpiling of all unsuitable material located within the limits of construction. Voids identified outside of the limits of construction are subject to this specification. Where excavation to the finished grade shown results in a subgrade or slopes of unsuitable material, the Contractor shall over-excavate such material to below the grade shown on the Drawings or as directed by the Engineer and CQA Engineer

2.3 COMPACTED FILL

A. Compacted fill placement is defined as soil placed as fill and compacted to specified moisture and density requirements.

B. Compacted Fill shall consist of earthen materials classified as SM, SW, SC, SW-SM, SW-SC, SC-SM, ML, or CL under the Unified Soil Classification System per ASTM D2487, and containing no deleterious material. Compacted fill may not consist of coal combustion residuals (CCR).

C. Stones or rock fragments shall not exceed one half the maximum compacted lift thickness shown in Table 312000A.

D. Off-site borrow soil that meets the conditions of 2.3(B) and (C) will be provided by the Owner.

PART 3 - EXECUTION

3.1 COORDINATION

A. Do not commence earth-moving operations until erosion and sedimentation control measures specified in Section 313520 "Erosion and Sediment Control" and Section 311000 "Site Clearing" are permitted, in place and inspected and approved by the governing authority and the Engineer.

B. The Contractor shall conduct Earth Moving activities in such a manner that erosion of disturbed areas and off site sedimentation is absolutely minimized as outlined in Section 313520, Erosion and Sediment Control, of these Specifications.

C. The Contractor shall protect and maintain erosion and sedimentation controls during earth-moving operations including required inspections, monitoring and recordkeeping. For erosion control, conform to the minimum requirements of the Erosion and Sedimentation Control Plan on the Drawings. Additional measures may be required to control erosion of the exposed material, such as the installation of diversion berms, covers, moisture control and sediment fencing as approved by the Owner and Engineer.

D. Potential CCR materials or other industrial-related constituents shall be disposed of in accordance with local, state, and federal requirements and as approved by the Owner or Engineer.

E. Stockpile locations shall be approved by the Owner.

F. The Contractor shall protect all existing facilities including, but not limited to, utilities monitoring wells, existing survey monuments, utilities, pavements or other facilities active or inactive not indicated to be removed.

G. Work shall be performed in a manner that does not disturb the Owner's operation or facilities.

H. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
3. Contractor shall be responsible for damage to roads due to construction traffic.

3.2 DEWATERING

A. The Contractor shall perform dewatering as required for the completion of the work. All surface or ground water removed by dewatering operations shall be disposed of in accordance with all applicable regulations.

B. The Contractor shall take all the steps that he considers necessary to familiarize himself with the surface and subsurface site conditions, and shall obtain the data that is required to analyze the water and soil environment.

C. The Contractor shall control, by acceptable means, all water regardless of source. The entire periphery of the excavation area shall be ditched and diked to prevent surface water from entering the excavation where applicable. The Contractor shall be fully responsible for disposal of the water and shall provide all necessary means at no additional expense to the Owner. The Contractor shall be solely responsible for proper design, installation, proper operation, maintenance, and any failure of any component of the system.

D. The Contractor shall be responsible for and shall repair without cost to the Owner, any damage to work in place and the excavation, including damage to the bottom due to heave and including removal of material and pumping out of the excavated area. The Contractor shall be responsible for damages to any other area or structure caused by his failure to maintain and operate the dewatering system proposed and installed by the Contractor.

E. The Contractor shall not allow water to accumulate in excavations and shall not use excavated trenches as temporary drainage ditches.

3.3 EXCAVATION

A. The Contractor shall excavate to the lines and grades shown on the Drawings and stockpile all suitable excavated materials. As the excavation is made, the materials will be examined and identified to the CQA Engineer.

B. The Contractor will perform all surveys necessary to establish and verify lines and grades for all excavation, including soil over-excavation.

C. Excavated materials may be stockpiled or placed as compacted soil fill as appropriate.

D. During excavation or relocation of soil, the material shall be protected and conditioned to control fugitive dust and to limit erosion of the exposed surface. If the surface is dry and dust is observed, apply water to the material to effectively moisture condition the material as approved by the Owner and Engineer.

E. Shape the graded surfaces to be free from irregular surface changes. Finished grade shall not vary more than 0.10 feet above or below required elevations where shown on the drawings. Material located within 1-foot of geosynthetics shall have a maximum particle size of 3 inches with a maximum protrusion of ¼ inch above surrounding grades.

F. The Contractor shall reconstruct subgrade areas damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by CQA Engineer, without additional compensation.

G. The graded surface shall be surveyed to check that the surface elevations are consistent with the existing conditions Record Drawings and that the surface is suitable for placement of overlying materials. The surveyed elevations shall be reviewed and approved by the Engineer before proceeding with subsequent construction.

3.4 OVER-EXCAVATION AND BACKFILL

A. If Engineer determines that unsuitable soil is present, continue excavation and replace with compacted backfill or other fill material as directed. Unsuitable materials shall be removed by the Contractor to the lengths, widths and depths approved by the CQA Engineer and backfilled with material in accordance with Section 3.6 of this Specification. No additional payment will be made for over-excavation and backfill less than 1 foot below design excavation grade.

B. Over-excavated material shall be stockpiled in a location approved by the Owner.

3.5 STOCKPILING

A. The Contractor shall stockpile the materials in appropriate stockpiles as approved by the CQA Engineer. The Contractor shall use equipment and methods as necessary to maintain the moisture content of soils stockpiled (excluding topsoil) at or near their optimum moisture content.

B. Stockpiles shall be properly sloped and the surfaces sealed by the Contractor at the end of each working day, or during the day in the event of heavy rain, to the satisfaction of the Engineer.

3.6 COMPACTED FILL

A. All placement and compaction of fill shall be performed only when the CQA Engineer is informed by the Contractor of intent to perform such work.

B. Fill shall be placed and compacted to the lines and grades shown on the Drawings. Placement of fill outside the construction limits shall occur only as directed and approved by the Engineer, or for the repair of identified voids.

C. The Contractor will perform all surveys necessary to establish and verify lines and grades for all Compacted Fill.

D. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

E. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by more than 3 percent and is too wet to compact to specified dry density. The Contractor shall be responsible for preparing the materials for Compacted Fill, including but not limited to, in-place drying or wetting of the soil necessary to achieve the compaction criteria of these Specifications.

F. Compacted Fill materials shall be placed in a manner permitting drainage and in continuous, approximately horizontal layers.

G. Lift Thickness and Compaction Requirements:

1. The Contractor shall place and compact Compacted Fill in accordance with the requirements shown in Table 312000A of this section. If Compacted Fill does not meet the specified requirements, the Contractor shall rework the material, as may be necessary

and continue compaction to achieve these requirements, or remove and replace the material to achieve the specified requirements, at Contractor's expense.

2. Each lift shall be compacted prior to placement of succeeding lifts. In confined areas, mechanical equipment, suitable for small areas and capable of achieving the density requirements, shall be required.

3. Lift compaction shall be performed with an appropriately heavy, properly ballasted, penetrating-foot or smooth-drum vibratory compactor depending on soil type. Compaction equipment shall be subject to approval by the CQA Engineer.

H. Compacted Fill that becomes excessively eroded, soft, or otherwise unsuitable shall be removed or repaired by the Contractor as directed by the CQA Engineer, at no cost to the Owner.

I. The exposed surface of Compacted Fill shall be rolled with a smooth-drum roller at the end of each work day to protect from adverse weather conditions.

J. Where Compacted Fill is to be placed and compacted on slopes that are steeper than 3:1, the subgrade shall be benched to a minimum depth of 6 inches and the Compacted Fill shall be placed in horizontal lifts.

K. Backfilling for Structures and Piping:

1. When backfilling around structures, place backfill in a manner to avoid displacement or damage of structures.

3.7 FIELD QUALITY ASSURANCE

Field quality assurance shall be performed by the CQA Engineer as described in the CQA Plan.

3.8 PROTECTION OF WORK

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and re-compact.

Table 312000A Required Compacted Fill Properties

Item	Required % Standard Proctor (ASTM D698)	Required Moisture Content	Maximum Lift Thickness (Compacted) (inches)
Compacted Fill	95	As Required For Compaction	8
Compacted Fill Beneath Structures and Roads	98	As Required For Compaction	8
Compacted Fill Around Structures	95	As Required For Compaction	8

Notes:
1. Determine field density using ASTM D6938, ASTM D1556 or ASTM D2937.
2. Determine field moisture content using ASTM D6938, ASTM D2216 or ASTM D4959.
3. Compacted fill beneath roads shall be considered to include the shoulders and all material within 2 vertical feet of the final surface of road and shoulders.
4. Compacted fill beneath structures shall be considered to include a zone from the foundation of the structure down to natural ground at a 45 degree angle.

END OF SECTION 312000

SECTION 313205 – LLDPE GEOMEMBRANE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. 40-mil linear low-density polyethylene (LLDPE) double sided textured membrane.

B. Related Requirements:

1. Section 017123 "Construction Surveying"
2. Section 312000 "Earth Moving"
3. Section 313220 "Geocomposite Drainage Layer"
4. Section 313240 "Nonwoven Geotextiles"

1.2 REFERENCES

A. Construction Quality Assurance (CQA) Plan

B. ASTM International:

1. ASTM D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
2. ASTM D1004, Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting
3. ASTM D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique
4. ASTM D1603, Standard Test Method for Carbon Black Content in Olefin Plastics
5. ASTM D3895, Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
6. ASTM D4218, Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
7. ASTM D4833, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
8. ASTM D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
9. ASTM D5199, Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
10. ASTM D5321, Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear
11. ASTM D5323, Standard Practice for Determination of 2% Secant Modulus for Polyethylene Geomembranes.
12. ASTM D5596, Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics

13. ASTM D5617, Standard Test Method for Multi-Axial Tension for Geosynthetics.
14. ASTM D5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
15. ASTM D5721, Standard Practice for Air-Oven Aging of Polyolefin Geomembranes
16. ASTM D5820, Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
17. ASTM D5885, Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
18. ASTM D5994, Standard Test Method for Measuring Core Thickness of Textured Geomembrane
19. ASTM D6365, Standard Practice for the Nondestructive Testing of Geomembrane Seams using the Spark Test
20. ASTM D6392, Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
21. ASTM D6693, Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
22. ASTM D7238, Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
23. ASTM D7466, Standard Test Method for Measuring the Asperity Height of Textured Geomembrane

C. Geosynthetic Research Institute (GRI):
1. GRI GM 6 – Pressurized Air Channel Test for Dual Seamed Geomembranes
2. GRI-GM 17, "Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes"
3. GRI-GM 19, "Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes"

1.3 SUBMITTALS

A. Submit the following to the CQA Engineer with the Contractor's bid:

1. A material properties sheet for each geomembrane product, including at a minimum all properties, test methods, and test values as required by this specification.
2. Example Material Warranty and Installation Warranty as required by this specification.
3. The "Geosynthetic Contractor Qualifications Questionnaire" included in the contract bid documents.

B. Submit the following to the Engineer, for review and approval, no later than 30 calendar days prior to shipment of geomembrane to the site:

1. Manufacturer's quality control program manual, or descriptive documentation.
2. The manufacturers' quality control certifications (including results of source quality control testing of the products as required by this specification) to verify that the materials supplied for the project are in compliance with the product specifications in this Section. The certifications shall be signed by a responsible party employed by the manufacturer, such as the geomembrane QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers, and corresponding shipping information.

3. A written certificate from the geomembrane manufacturer stating that the geomembrane was continuously spark tested during manufacturing.
4. A written certificate from the geomembrane manufacturer stating that the resin and geomembrane materials supplied are in compliance with this specification.
5. Documentation of installers' qualifications, as required by this specification.
   a. Submit a list of at least ten completed facilities. For each installation, provide: name and type of facility; its location; the date of installation; name and telephone number of the facility's owner, design engineer, manufacturer, and fabricator, if applicable; name and telephone number of contact at the facility; thickness of geomembrane and surface area of the installed geomembrane; and type of seaming, patching, and tacking equipment.
   b. Submit resumes or qualifications of the Installation Supervisor, Master Seamer and all technicians to be assigned to this project.
6. Manufacturer's instruction manual for geomembrane on-site handling and installation, including but not limited to procedures for storage, transport, placement, seaming, and testing.
7. Submit copies of shop drawings. Shop drawings shall show a proposed installation panel layout identifying seams and details (including sealing of penetrations).

C. On a continuous basis throughout construction, submit the following to the CQA Engineer, for review and approval, with final documents provided no later than 14 calendar days following completion of geosynthetics installation:

1. Geosynthetics Forms
   a. Daily Field Reports
   b. Field Inventory Control, Storage, Inspection, and Cross-Reference Roll Numbers
   c. Subgrade Certification
   d. Geomembrane Trial Seam Log
   e. Geomembrane Panel Deployment Report
   f. Geomembrane Seam Log
   g. Geomembrane Defect and Repair Log
   h. Non-Destructive Seam Testing Log
   i. Geomembrane Field and Laboratory Destructive Test Results
2. Record drawing for each geomembrane layer showing panel corners, transitions in panel geometry, repair locations, destructive test locations, anchor trench breaklines, and other significant features.
3. Certificate stating that the geomembrane has been installed in accordance with the Drawings, Specifications, and the Manufacturer's recommendations.
4. Manufacturer's material warranty as required by this specification.
5. Geomembrane installation warranty as required by this specification.

1.4 QUALIFICATIONS

A. Installer's Qualifications and Crew Requirements:

1. The Geomembrane Installer shall be the manufacturer or an approved contractor qualified to install the manufacturer's geomembrane, and have current AIC status issued by the International Association of Geosynthetic Installers (IAGI).

2. The Geomembrane Installer shall have installed at least 10 million square feet of the specified types of geomembrane during the last five years.
3. Installation shall be performed under the constant direction of a single Field Installation Supervisor who shall remain on site and be in responsible charge, throughout the geomembrane installation, for geomembrane layout, seaming, patching, testing, repairs, and all other activities by the Geomembrane Installer. This Field Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 5 million square feet of geomembrane of the types specified.
4. The Geomembrane Installer shall designate a Master Seamer. The Master Seamer shall be present during all seaming operations and shall have a minimum of 3 million square feet of field seaming experience and hold an IAGI Certified Welding Technician (CWT) welding certification in both extrusion welding and fusion welding.
5. Geosynthetic Contractor Equipment and Personnel:
   a. Quality Control Foreman (QCF)
      1) The Geosynthetics Installer shall provide an individual whose title is "Quality Control Foreman" (QCF) who shall be experienced in all phases of quality control testing and procedures.
      2) The QCF will be dedicated to performing or directing the Geosynthetics Installer's quality control activities, (i.e. air pressure, vacuum box and spark non-destructive testing and field destructive testing).
      3) The QCF and the Superintendent may be the same person if approved by the Engineer.

1.5 QUALITY CONTROL

A. The Manufacturer shall sample and test the LLDPE geomembrane material at a minimum frequency as required by Table 313205A.

B. If the Manufacturer's quality control test results do not conform to the requirements of this specification, retesting to determine conformance or rejection shall be done as set forth in the manufacturer's quality manual at no additional cost to the CQA Engineer or Owner.

C. The Contractor shall perform Quality Control tests in accordance with Table 313205B of this section.

D. The Geomembrane Installer shall follow the procedures and requirements described in this section, including performing and documenting test seams, nondestructive and destructive seam tests, and repairs.

1.6 QUALITY ASSURANCE

A. Quality Assurance will be provided by the Owner as described in the CQA Plan.

B. Conformance Testing

1. The performance of conformance testing shall be the responsibility of the CQA Engineer.
2. Conformance testing shall be performed on material specifically manufactured for this project.

3. Samples shall be taken across the entire width of the roll and shall not include the first three feet. Unless otherwise specified, samples shall be three feet long by the roll width. The machine direction shall be marked on the samples.
4. Required test methods and test frequencies are presented in the CQA Plan.

C. If the conformance test results do not conform to the requirements of this specification, retesting to determine conformance or rejection shall be done as set forth in the CQA Plan at no additional cost to the CQA Engineer or Owner.

D. Any geosynthetic sample that does not conform to the requirements of the specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected roll at no cost to the Owner.

1.7 WARRANTIES

A. The Contractor shall furnish the Owner a warranty from the Geomembrane Manufacturer for the materials used. The warranty shall be for defects or failures related to manufacture. Determination of the cause of defect or failure shall be by a third-party, not by the Geomembrane Manufacturer. The warranty period shall be five years from the date of final material delivery to site. Since five years is far less than the expected service life of the material, the warranty shall not be on a pro rata basis.

B. The Contractor shall furnish the Owner a warranty from the Geomembrane Installer that warrants their workmanship to be free of defects. Determination of the cause of defect or failure shall be by a third-party, not by the Geomembrane Installer. The warranty period shall be five years from the date of completion of installation. Since five years is far less than the expected service life of the installed product, the warranty shall not be on a pro rata basis.

1.8 GEOMEMBRANE PRE-DEPLOYMENT MEETING

A. Geomembrane Pre-Deployment Meeting shall be held at the site prior to installation of the geomembrane. At a minimum, the meeting shall be attended by the Geomembrane Installer, Owner, CQA Engineer, and Contractor.

B. Topics for this meeting shall include, but not be limited to, the following:

1. Responsibilities of each party.
2. Lines of authority and communication.
3. Methods for documenting and reporting, and for distributing documents and reports.
4. Procedures for collecting and packaging archive samples.
5. Review of time schedule for all installation and testing.
6. Review of panel layout and numbering systems for panels, seams, and repairs.
7. Temperature and weather limitations, and installation procedures for adverse weather conditions.
8. Deployment techniques, including plans for controlling expansion, contraction and wrinkling of the geomembrane, access points, acceptable equipment and protection of geosynthetics.
9. Preparation of the geomembrane record survey drawing.

C. The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties.

PART 2 - PRODUCTS

2.1 LLDPE GEOMEMBRANE

A. LLDPE Sheet: Formulated from virgin PE, compounded for use in hydraulic structures, and formed into uniform sheets with material properties complying with this specification.

B. The geomembrane shall consist of new, first quality products designed and manufactured specifically for this type of project, which shall have been satisfactorily demonstrated by prior testing to be suitable and durable for such purposes.

C. Geomembrane shall contain no plasticizers, fillers, chemical additives, or extenders. Sprayed-on texturing of textured polyethylene geomembrane will not be accepted.

D. Geomembrane shall be supplied as continuous sheets with no factory seams in rolls. The roll lengths and widths shall be maximized to provide the largest manageable sheets for the fewest field seams.

E. Geomembrane material shall be produced free of holes, blisters, or contaminants, and leak-free as verified by spark testing using ASTM D6365.

F. Physical, Mechanical and Chemical Property Requirements

1. Textured LLDPE geomembrane sheet shall meet or exceed the values specified in GRI-GM17, as summarized in Table 313205A at the end of this specification.

2.2 EQUIPMENT

A. Welding Equipment: Extrusion welding equipment shall be provided with thermocouples and temperature readout devices which continuously monitor the temperature of the extrudate. Radiant wedge welding equipment shall be provided with thermocouples and temperature readout devices which continuously monitor the temperature of the wedge. Equipment shall be maintained in adequate number to avoid delaying work, and shall be supplied by a power source capable of providing constant voltage under a combined-line load. Use a rub sheet, sand bags, or other method approved by the CQA Engineer to separate the electric generators from the geomembrane.

B. Field Tensiometer: The Geomembrane Installer shall provide a tensiometer for on-site shear and peel testing of geomembrane seams. The tensiometer shall be in good working order, built to ASTM D6693 (Type IV, 2 ipm) specifications, and accompanied by evidence of calibration within the preceding 12 months. The tensiometer shall be motor driven and be equipped with a gauge that measures the force in unit pounds exerted between the jaws as displayed on a digital readout.

C. Vacuum Box: The Geomembrane Installer shall provide vacuum box assemblies consisting of a rigid housing, a transparent viewing window, a soft closed cell neoprene gasket attached to the bottom, a port hole or valve assembly, a vacuum gauge, a vacuum pump assembly equipped with a pressure control, a rubber pressure/vacuum hose with fittings and connections, and a soapy solution and an applicator. The equipment shall be capable of inducing and holding a minimum vacuum of 5 psi. The number of vacuum boxes shall be sufficient to avoid delaying the work.

D. Air Pressure Test: The Geomembrane Installer shall provide the necessary air pump and fittings required to perform the GRI GM6 air pressure test on dual seams.

E. Roll Handling Equipment: The Geomembrane Installer shall provide handling equipment that is adequate and does not pose a risk to the geomembrane rolls, subject to the approval of the CQA Engineer.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Each roll of geomembrane delivered to the Site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, lot number, material thickness, roll number, roll dimensions, and roll weight.

B. Procedures for storage and handling of geomembrane shall conform to ASTM D4873 and the manufacturer instructions, including the following:

1. Geomembrane shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.
2. Rolls shall be stored away from high traffic areas, protected from theft and vandalism.
3. Continuously and uniformly support rolls on a prepared level surface (not on wooden pallets) away from standing water. Rolls shall not be stacked more than two rolls high.

C. Geomembrane shall be observed by the CQA Engineer upon delivery of the product to the Site, and during installation and field seaming. Contractor to provide all labor and equipment required to assist CQA Engineer in the observation of the product.

D. CQA Engineer personnel shall generate an inventory of geomembrane rolls received on-site from the manufacturer/distributor. The inventory shall be updated each day that material is delivered and shall include all the information appearing on the label of each roll, and all observed damage shall be noted.

3.2 SUBGRADE PREPARATION

A. Examine substrates, with Installer present, for compliance with requirements for soil compaction and grading; for subgrade free from angular rocks, rubble, roots, vegetation, debris, voids, protrusions, and ground water; and for other conditions affecting performance of geomembrane liner.

B. The geomembrane subgrade shall be prepared as specified in the Technical Specifications and as shown on the Drawings. The subgrade shall be smooth and uniform, and free of all trash and debris, prior to installation of the geomembrane.

C. Subgrade damaged by erosion, rutting, or other means during geomembrane deployment shall be exposed and the damage repaired. The subgrade shall then be re-approved.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 GEOMEMBRANE PLACEMENT

A. No geomembrane shall be deployed and seamed until the surfaces to be covered have been approved by the CQA Engineer.

B. The Geomembrane Installer and Contractor shall, on a daily basis, provide written acceptance to the CQA Engineer for the surface to be covered by geomembrane in that day's operations. The surface shall be maintained as acceptable during geomembrane installation. A single form shall be used and signed by all parties to document acceptance each day.

C. Geomembrane shall be installed to the required limits over the prepared compacted soil liner as shown on the Drawings and specified in this Section. Install geomembrane in drain modification areas as indicated on the Drawings.

D. No geomembrane material shall be unrolled and deployed if the material temperatures are lower than approximately 32 degrees F unless otherwise approved by the Engineer and unless special precautions are taken such as storing the rolls inside a heated enclosure providing ambient temperatures of 50 degrees F or above. The specified minimum temperature for material deployment may be adjusted by the Engineer based on recommendations by the manufacturer.

E. Geomembrane shall be placed smooth and free of excessive wrinkles and subsequent fishmouths at the field seam interfaces. In general, "Leister" welds or "tack" welds shall not be used to temporarily hold sheets in position; however, "Leister" welds may be used to secure small patches prior to extrusion welding.

F. All geomembrane handling and installation procedures shall be performed by workers wearing shoes that will not damage the geomembrane. Only low ground pressure, rubber-tired, vehicular traffic shall be permitted to travel on the geomembrane. The maximum equipment ground pressure shall be eight pounds per square inch (psi), or as recommended by the geomembrane manufacturer, whichever is more stringent.

G. Only the panels which will be anchored and seamed together in one day shall be deployed.

H. Sand bags shall be used as necessary to hold the geomembrane material in position during installation. Sand bags shall be sufficiently close-knit to preclude fines from working through the bags. Paper bags, whether or not lined with plastic, shall not be used. Burlap bags, if used, must be lined with plastic. Bags shall contain not less than 20 nor more than 60 pounds of sand, and shall be securely closed after filling and not over-filled to prevent sand loss. Bags that are split, torn, or otherwise losing their contents shall be immediately removed from the work area and any spills immediately cleaned up.

I. Panels that become seriously damaged (torn or twisted permanently) shall be replaced. Less serious damage shall be repaired according to the requirements herein. Damaged panels, or portions of the damaged panels which have been rejected, shall be marked and their removal from the work area recorded.

J. Geomembrane shall be installed so that there will be neither tension nor wrinkles at the average expected daily ambient temperature.

K. Geomembrane shall not be allowed to "bridge over" (be pulled taut over) voids or low areas in the subgrade. Geomembrane in these areas shall be cut and patched to provide adequate material to allow the geomembrane to rest on the subgrade surface.

L. In general, seams shall be oriented with the long dimension parallel to (down) the line of the maximum slope. Where seams can only be oriented across the slope, the upper panel shall be lapped over the lower panel. The total length of field seams shall be minimized. In corners and odd shaped geometric locations, the total length of field seams shall be minimized. Seams shall not be located at low points in the subgrade unless geometry requires seaming at such locations, and if approved by CQA Engineer personnel.

M. Geomembrane panels shall be overlapped prior to seaming to whatever extent is necessary to provide a good weld. In no case shall overlaps be less than six inches for fusion welding at the time the welds are made.

N. The Geomembrane Installer shall label panels at the time of deployment. Label date of deployment, roll number, and panel number.

O. The Contractor shall make provision for the CQA Engineer to inspect each panel, after placement and prior to seaming, for damage and/or defects. Defective or damaged panels shall be replaced, or repaired as described in this section if approved by the CQA Engineer.

3.4 SEAMING PROCEDURES

A. Textured LLDPE geomembrane seams shall meet or exceed the values specified in GRI-GM19, as summarized in Table 313205C at the end of this specification.

B. No geomembrane material shall be seamed when ambient temperatures are less than 32 degrees Fahrenheit unless the following conditions are complied with:

1. Seaming of the geomembrane at ambient temperatures below 32 degrees Fahrenheit is allowed if the Geomembrane Installer can demonstrate to the Engineer and the CQA Engineer, using pre-qualification test seams, that field seams complying with the specifications can be fabricated at sub-freezing temperatures. Consistent passing test seams are required.
2. In addition, the Geomembrane Installer shall submit to the Engineer for review, detailed procedures for seaming at low temperatures, including the following: preheating the geomembrane; and providing a tent or other device to prevent heat losses during seaming and rapid heat losses subsequent to seaming.

C. No geomembrane material shall be seamed when the ambient temperature is above 104 degrees Fahrenheit and when the sheet temperature of the material is above 122 degrees Fahrenheit (as measured by an infrared thermometer or surface thermocouple), unless otherwise approved by the Engineer.

D. Geomembrane seaming at temperatures outside the above stated temperature ranges will only be approved if: the manufacturer certifies that the seaming procedure shall not cause physical or chemical modification to the geomembrane; and an increased number of test welds is performed to determine appropriate seaming conditions when required by the CQA Engineer or Engineer. However, should the overall quality of the geomembrane decrease under such conditions, in the opinion of the Engineer, then seaming outside the allowable temperatures shall be discontinued.

E. Seaming is not allowed while precipitation is occurring unless proper precautions are made to allow the seam to be made on dry geomembrane material or the welding process is protected from rain. The surface below the geomembrane shall not be saturated or frozen.

F. Extra care shall be taken to clean and remove dirt, dust and other foreign materials from the surfaces of the geomembrane to be seamed. Surfaces shall be cleaned immediately prior to seaming.

G. Seaming shall be performed using an automatic double wedge fusion welding system, equipment, and techniques. Extrusion welding shall only be used where fusion welding is not possible and as approved by the Engineer.

H. The fusion-welding apparatus shall be an automated device, and shall be equipped with gauges giving applicable temperatures and pressures.

I. The extrusion welding apparatus shall be equipped with gauges giving the temperature in the apparatus and at the nozzle. The extruder shall be purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel. Whenever the extruder is stopped, the barrel shall be purged of all heat degraded extrudate.

J. Equipment used for seaming shall not damage the geomembrane, and the geomembrane shall be protected from damage in areas with heavy traffic. The number of pieces of equipment shall be sufficient to avoid causing delays due to equipment malfunction.

K. The surfaces to be seamed shall be prepared as recommended by the manufacturer.

L. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkles back into the panel so as to effect a flat overlap. The cut fishmouths or wrinkles shall be seamed as completely as possible, and shall then be patched with an oval or round patch of the same geomembrane material extending a minimum of six inches beyond the cut in all directions.

M. The Geomembrane Installer shall label seams at the time of seaming. Label date of seaming, start time, initials of the seaming technician, and the number of the seaming unit.

3.5 FIELD QUALITY CONTROL

A. Prequalification Test Seams

1. CQA Engineer shall be notified when prequalification testing will be performed.
2. Welding machine adjustment and test seams shall be performed by the Geomembrane Installer's personnel and observed by CQA Engineer personnel to verify that seaming conditions are adequate. Test seams shall be conducted by each seamer at the beginning of each seaming period, and as determined by CQA Engineer personnel for each welding machine used that day. Test seaming shall be performed under the same conditions and with the same equipment as production seaming. Each test seam shall be at least ten feet long for hot wedge welding and three feet long for extrusion welding with the seam centered lengthwise.
3. Two adjoining one-inch wide specimens shall be die-cut by the Geomembrane Installer from each opposite end and from the center of the test seam. These specimens shall be tested by the Geomembrane Installer. Each specimen shall be tested in peel. The tests shall be performed using a field tensiometer, and shall not fail in the weld. Both welds of double wedge seams shall be tested in peel. Any failures through the seam shall be considered a failing test, regardless of the stress at failure.
4. The minimum acceptable seam strength values to be obtained for all specimens tested are those indicated in Table 313205C.
5. If a test seam fails, an additional test seam shall be immediately conducted. If the additional test seam fails, the seaming apparatus shall be rejected and not used for production seaming until the deficiencies are corrected and a successful test seam is produced.
6. CQA Engineer personnel shall observe and record testing of prequalification test specimens. Records shall be included in the Daily Field Installation Reports.

B. Non-Destructive Field Seam Testing

1. All field seams shall be non-destructively tested by the Geomembrane Installer over their full length. Each seam shall be assigned a unique number consisting of the adjacent panel numbers (for example, the seam between panels 1 and 3 would be S–1/3).
2. All defects found during testing shall be numbered and marked by CQA Engineer personnel immediately after detection. All defects found shall be repaired, retested and re-marked to indicate completion of the repair and acceptability.
3. Non-destructive testing shall be performed by the Geosynthetics Installer using vacuum boxes (in accordance with ASTM D5641), air pressure testing (in accordance with ASTM D5820), spark testing (in accordance with ASTM D6365), or other test methods approved by the Engineer. All test equipment shall be furnished by the Geomembrane Installer.
4. Non-destructive tests shall be performed by experienced personnel thoroughly familiar with the specified test methods. The Geomembrane Installer shall field demonstrate all test methods to verify to CQA Engineer personnel that the test procedures are valid.
5. Extrusion seams shall be vacuum box tested by the Geomembrane Installer according to the following methods:
   a. Equipment for testing extrusion seams shall be comprised of, but not limited to: a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge; a steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections; a rubber pressure/vacuum hose with fittings and connections; a plastic bucket; sponge or mop; and a soapy solution. The vacuum box shall be similar to the series A 100 Straight Seam Tester as supplied by the American Parts Service Company.
   b. The glass for vacuum box shall be unscratched and clean, and the rubber gasket shall be firmly attached to the box.

c. The vacuum pump shall be charged and the tank pressure adjusted to three to four pounds per square inch, gauge (psig).

d. CQA Engineer personnel shall periodically observe that a leak tight seal is created by the Geomembrane Installer. The Geomembrane Installer shall create the leak tight seal by wetting a strip of geomembrane approximately 12 inches by length of box with a soapy solution, placing the box over the wetted area and then compressing. The Geomembrane Installer shall then close the bleed valve, open the vacuum valve, maintain five psig for a period of approximately 15 seconds, and CQA Engineer personnel shall observe the geomembrane through the viewing window for the presence of soap bubbles. If no bubbles appear after 15 seconds, the area shall be considered leak tight. The box shall be moved over the next adjoining area with a minimum three inches overlap and the process repeated.

e. All areas where soap bubbles appear shall be marked and repaired, and then retested under the observation of CQA Engineer personnel.

f. CQA Engineer personnel shall observe all testing operations for uniformity and completeness, and shall record results at time of testing.

g. All seams that are vacuum tested shall be marked by the Geomembrane Installer at the time of testing. Marking shall consist of the date tested, technician performing the test, and the results of the test.

6. Double Fusion seams with an enclosed space shall be air pressure tested by the Geomembrane Installer according to the following methods:

a. Equipment for testing double fusion seams shall be comprised of, but not limited to: an air pump equipped with a pressure gauge capable of generating and sustaining a pressure of 30 psig, mounted on a cushion to protect the geomembrane; a rubber hose with fittings and connections; and a manometer equipped with a sharp hollow needle, or other approved pressure feed device.

b. The Geomembrane Installer shall perform the testing activities. Both ends of the seam to be tested shall be sealed and a needle or other approved pressure feed device inserted into the tunnel created by the double wedge fusion weld. The air pump pressure shall be adjusted, the valve closed, and the pressure stabilized for two minutes at a pressure of 28 psig. After the stabilization period, pressure shall be maintained for five minutes for the seam to be considered leak tight. The Geomembrane Installer shall remove the seal at the opposite end of the tested seam while CQA Engineer personnel observe the gauge. The needle or other approved pressure feed device shall be removed and the feed hole sealed if not covered by a patch at the end of the seam. Pressure tests shall be conducted in accordance with the procedures outlined in ASTM D5820.

c. If loss of pressure exceeds three psig during testing period, or pressure does not stabilize, the faulty area shall be located, repaired, and retested by the Geomembrane Installer.

d. All seams that are air pressure tested shall be marked by the Geomembrane Installer at the time of testing. Marking shall consist of the date tested, technician performing the test, test start and end times, and test start and end pressures.

7. Non-destructive field seam tests shall be observed by CQA Engineer personnel and recorded at the time of testing. Records shall be included in the Daily Field Installation Reports.

C. Field Destructive Seam Testing

1. A minimum of one destructive test sample per 500 feet of seam length shall be cut by the Geomembrane Installer from a location specified by CQA Engineer personnel. The Geomembrane Installer shall not be informed in advance of the sample location. In order to obtain test results prior to completion of geomembrane installation, samples shall be cut by the Geomembrane Installer as the seaming progresses.
2. CQA Engineer personnel shall mark all samples with their location and seam number at the time of sample collection. CQA Engineer personnel shall observe field testing of the samples and record the date, time, location, seam number, ambient temperatures, and pass or fail description according to ASTM D6392. A copy of the information must be attached to each sample portion. The Geomembrane Installer shall repair all holes in the geomembrane resulting from obtaining the seam samples. All patches shall be vacuum tested. If a permanent patch cannot be installed over the test location the same day of sample collection, a temporary patch shall be tack welded or hot air welded over the opening until a permanent patch can be affixed.
3. Each destructive test sample shall be 12 inches wide by 54 inches long, with the seam centered lengthwise. The sample shall be cut into three sections and distributed as follows: one 18-inch section shall be given to CQA Engineer personnel for testing; one 12-inch section retained by the Geomembrane Installer for field testing; and one 12-inch section shall be set aside for an archive sample. Holes for destructive seam testing shall be repaired as required in this specification.
4. The Geomembrane Installer shall die-cut at least three one-inch wide replicate specimens from the installer's sample for field testing. Replicate specimens will not be required for extrusion welds. The specimens shall be tested for peel strength. Both welds of dual hot-wedge seams shall be tested in peel. To be acceptable, all replicate test specimens shall meet the seam strength requirements as required in this specification. Any specimen that fails through the weld or by partial failure exceeding 50 percent of the weld shall be considered a Non-Film Tear Bond break and shall be considered a failure. Die cutting and field testing of the replicate specimens shall be performed in the presence of CQA Engineer personnel. If the field tests pass, the sample qualifies for testing by the CQA Engineer.
5. Laboratory testing coordinated by the CQA Engineer shall conform to ASTM D6392. Five replicate specimens shall be tested in peel and five replicate specimens shall be tested in shear. Both welds of dual hot-wedge seams shall be tested in peel. To be acceptable, all replicate test specimens shall meet the seam strength requirements as required in this specification.
6. If a destructive sample fails the field or laboratory destructive tests, an additional sample shall be obtained at a distance of approximately 10 feet on each side of the failed sample location. Test specimens shall be obtained and field tested as specified in accordance with destructive field seam testing requirements. The process shall be repeated until the failed area is bounded by samples with passing test results.
7. The Geomembrane Installer shall repair the seam between the two nearest passed test locations with the failed location in between, or as directed by the CQA Engineer.

3.6 REPAIR PROCEDURES

A. Defective seams shall be repaired with a capstrip or extrusion weld over the full length of the defect. Each capstrip shall be numbered, shall be made of the same geomembrane material as for the geomembrane sheet, and shall extend a minimum of six inches beyond both sides of the seam.

B. Blisters, tears and holes in the geomembrane sheet shall be repaired with patches. Each patch shall be numbered by CQA Engineer personnel at the time the defect is identified.

C. Abrasions and other defects and damage of the geomembrane material that are not punctured through the material may be repaired using extrudate, unless otherwise directed by the Engineer or CQA Engineer.

D. Capstrips and patches shall be rounded at the corners, made of the same material as for the geomembrane sheet, and extend a minimum of six inches beyond the edge of defects.

E. Repaired areas shall be numbered and shall be measured and recorded from a known survey point to document location.

F. Verification of Repair Patches and Capstrips: Each repair shall be non-destructively tested using vacuum box testing or air testing. Tests that pass the non-destructive test shall be taken as an indication of an adequate repair. Failed tests shall be reseamed and retested until a passing test results. CQA Engineer personnel shall observe non-destructive testing of repairs.

3.7 GEOMEMBRANE ACCEPTANCE

A. The installed geomembrane will be accepted by the CQA Engineer when:

1. The geomembrane is clean (brooming and washing of the geomembrane surface shall be required if the amount of surface dust or mud inhibits inspection);
2. The entire installation is finished, or an agreed upon subsection of the installation is finished;
3. All documentation of installation is completed;
4. The Contractor has submitted a Certificate from the Geosynthetics Installer to the Owner that the installation has been completed in accordance with the Drawings, Specifications, and the Manufacturer's recommendations;
5. Verification of the adequacy of all field seams and repairs, and associated testing is complete; and
6. A record survey drawing is prepared as required by this specification, and is submitted to and approved by the Engineer.

B. Record Survey Drawing Requirements: Record drawing for each geomembrane layer showing panel corners, transitions in panel geometry, repair locations, destructive test locations, and other significant features shall be surveyed. The survey shall be sealed by a Professional Land Surveyor licensed in North Carolina.

C. Work shall not proceed with any materials which will cover geomembrane seams, capstrips and patches until laboratory destructive seam test results with passing values have been received and the portion of the geomembrane has been accepted in writing by the CQA Engineer.

D. Accepted areas of geomembrane that have not been covered within a reasonable time will require reinspection as determined by the Engineer.

E. Archive samples will be held by the Owner or CQA Engineer until CQA Engineer's approval of the installation and the CQA Engineer Report.

3.8 DISPOSAL OF SCRAP MATERIALS

A. At the end of each work day, all scraps of material and other debris shall be removed from the geomembrane surface.

B. On completion of installation, the Geomembrane Installer shall dispose of all trash and scrap materials off-site, remove equipment used in connection with geomembrane installation, and leave the premises in a neat and acceptable manner. No scrap material shall be allowed to remain on the geomembrane or adjacent areas.

3.9 PROTECTION

A. Protect installed geomembrane according to manufacturer's written instructions. Repair or replace areas of geomembrane damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.

B. Before placement of cover materials, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged geomembrane liner and seams and reinspect repaired work.

3.10 MARKERS

The Contractor shall place markers as shown on the Drawings (limit of waste, limit of liner, limit of final cover, as applicable). These markers shall be considered incidental to geomembrane installation.

3.11 COVER PLACEMENT

Placement of materials over geomembrane shall be performed in a manner to prevent damage to underlying geosynthetics, to minimize slippage of geomembrane on underlying surface, and to prevent excess tensile stresses in the geomembrane. Wrinkles that exceed approximately 6 inches in height or that become crimped shall be cut, repaired and tested by the Geomembrane Installer in accordance with the requirements of this section.

Table 313205A - Linear Low Density Polyethylene (LLDPE) Geomembrane Sheet - Textured [GRI-GM17]

Properties	Test Method	Test Value								Minimum Testing Frequency
		20-mils	30-mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. avg.)	D 5994	nom. (-5%)	nom. (-5%)	nom. (-5%)	nom. (-5%)	nom. (-5%)	nom. (-5%)	nom. (-5%)	nom. (-5%)	per roll
• lowest individual for 8 out of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%	-10%	
• lowest individual for any of the 10 values		-15%	-15%	-15%	-15%	-15%	-15%	-15%	-15%	
Asperity Height mils (min. avg) *(1)*	D 7466	16 mil	16 mil	16 mil	16 mil	16 mil	16 mil	16 mil	16 mil	every 2nd roll *(2)*
Density (max.)	D 1505/D 792	0.939 g/cc	0.939 g/cc	0.939 g/cc	0.939 g/cc	0.939 g/cc	0.939 g/cc	0.939 g/cc	0.939 g/cc	200,000 lb
Tensile Properties (min. avg.) *(3)*	D 6693 Type IV									20,000 lb
• break strength		30 lb/in	45 lb/in	60 lb/in	75 lb/in	90 lb/in	120 lb/in	150 lb/in	180 lb/in	
• break elongation		250%	250%	250%	250%	250%	250%	250%	250%	
2% Modulus (max.)	D 5323	1200 lb/in	1800 lb/in	2400 lb/in	3000 lb/in	3600 lb/in	4800 lb/in	6000 lb/in	7200 lb/in	per formulation
Tear Resistance (min. avg.)	D 1004	11 lb	16 lb	22 lb	27 lb	33 lb	44 lb	55 lb	66 lb	45,000 lb
Puncture Resistance (min. avg.)	D 4833	22 lb	33 lb	44 lb	55 lb	66 lb	88 lb	110 lb	132 lb	45,000 lb
Axi-Symmetric Break Resistance Strain (min.)	D 5617	30%	30%	30%	30%	30%	30%	30%	30%	per formulation
Carbon Black Content (range)	D 4218 *(4)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	45,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	45,000 lb
Oxidative Inductive Time (OIT) (min. avg.) *(6)*										200,000 lb
(a) Standard OIT **OR**	D 3895	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	
(b) High Pressure OIT	D 5885	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	
Oven Aging at 85°C *(7)*	D 5721									per formulation
(a) Standard OIT (min. avg.) - % retained after 90 days **OR**	D 3895	35%	35%	35%	35%	35%	35%	35%	35%	
(b) High Pressure OIT (min. avg.) - % retained after 90 days	D 5885	60%	60%	60%	60%	60%	60%	60%	60%	
UV Resistance *(8)*	D 7238									per formulation
(a) Standard OIT (min. avg.) **OR**	D 3895	N. R. *(9)*	N. R. *(9)*	N. R. *(9)*	N. R. *(9)*	N. R. *(9)*	N. R. *(9)*	N. R. *(9)*	N. R. *(9)*	
(b) High Pressure OIT (min. avg.) - % retained after 1600 hrs *(10)*	D 5885	35%	35%	35%	35%	35%	35%	35%	35%	

NOTES:

(1) Of 10 readings; 8 out of 10 must be ≥ 14 mils, and lowest individual reading must be ≥ 12 mils
(2) Alternate the measurement side for double sided textured sheet
(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Break elongation is calculated using a gage length of 2.0 inches
(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.
(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3
(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane
(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response
(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C
(9) Not recommended since the high temperature of the Std.-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples
(10) UV resistance is based on percent retained value regardless of the original HP-OIT value

Table 313205B - Required Contractor Quality Control Tests			
Properties	**Test Method**	**Required Result at Specified Vertical Stress**	**Minimum Testing Frequency**
Interface Shear Strength (Peak)	D 5321	115 psf at 200 psf load 126 psf at 250 psf load 252 psf at 500 psf load See Note 1	See Note 2

NOTES:

(1) The required results are equivalent to an interface friction angle of 26.7 degrees with good adhesion at low normal loads.

(2) Test each interface to be used on the project using representative samples of materials at indicated normal loads.
The confining load shall be applied for a minimum period of 24 hours prior to conducting interface friction testing.
Interfaces shall be saturated with water.
Interface friction testing should be performed prior to construction using site specific soils and the specified geosynthetic materials proposed for the project.
Soil components shall be compacted and moisture conditioned as may be required by the Technical Specifications.
All geosynthetic-geosynthetic and geosynthetic-soil interfaces shall be tested.
Geosynthetic products may have different texturing or surface treatments on each side. If such a geosynthetic is proposed, then all possible interfaces must be tested.
For tests involving textures geomembranes, the laboratory shall also report the asperity height (GRI GM12).

Table 313205C - Linear Low Density Polyethylene (LLDPE) Geomembrane Seams [GRI-GM19]								
Properties	Test Value							
	20-mils	30-mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils
Hot Wedge Seams *(1)*								
• shear strength *(2)*	30 lb/in	45 lb/in	60 lb/in	75 lb/in	90 lb/in	120 lb/in	150 lb/in	180 lb/in
• shear elongation at break *(3)*	50%	50%	50%	50%	50%	50%	50%	50%
• peel strength *(2)*	25 lb/in	38 lb/in	50 lb/in	63 lb/in	75 lb/in	100 lb/in	125 lb/in	150 lb/in
• peel separation	25%	25%	25%	25%	25%	25%	25%	25%
Extrusion Fillet Seams								
• shear strength *(2)*	30 lb/in	45 lb/in	60 lb/in	75 lb/in	90 lb/in	120 lb/in	150 lb/in	180 lb/in
• shear elongation at break *(3)*	50%	50%	50%	50%	50%	50%	50%	50%
• peel strength *(2)*	22 lb/in	34 lb/in	44 lb/in	57 lb/in	66 lb/in	88 lb/in	114 lb/in	136 lb/in
• peel separation	25%	25%	25%	25%	25%	25%	25%	25%

NOTES:

(1) Also for hot air and ultrasonic seaming methods

(2) Value listed for shear and peel strengths are for 4 out of 5 test specimens; the 5th specimen can be as low as 80% of the listed values

(3) Elongation measurements should be omitted for field testing

END OF SECTION 313205

SECTION 313220 – GEOCOMPOSITE DRAINAGE LAYER

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes geocomposite drainage layer for the following:

1. Landfill cover system.

B. Related Requirements:

1. Section 312000 "Earth Moving".
2. Section 313205 "LLDPE Geomembrane."
3. Section 313240 "Nonwoven Geotextiles."

1.2 REFERENCES

A. Construction Quality Assurance (CQA) Plan

B. ASTM International:

1. ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
2. ASTM D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
3. ASTM D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique
4. ASTM D1603, Standard Test Method for Carbon Black in Olefin Plastics
5. ASTM D4218, Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique
6. ASTM D4354, Standard Practice for Sampling of Geosynthetics for Testing
7. ASTM D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
8. ASTM D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity
9. ASTM D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
10. ASTM D4716, Standard Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
11. ASTM D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile
12. ASTM D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
13. ASTM D5199, Standard Test Method for Measuring the Nominal Thickness of Geosynthetics

14. ASTM D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles
15. ASTM D5321, Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
16. ASTM D5567, Standard Test Method for Hydraulic Conductivity Ratio (HCR) Testing of Soil/Geotextile Systems.
17. ASTM D6241, Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
18. ASTM D7005, Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites
19. ASTM D7273, Standard Guide for Acceptance Testing Requirements for Geonets and Geonet Drainage Geocomposites.

C. Geosynthetic Research Institute (GRI):

1. GRI-GC7, Determination of adhesion and bond strength of geocomposites.
2. GRI-GC8, Determination of the allowable flow rate of a drainage geocomposite.

1.3 SUBMITTALS

A. Submit the following to the CQA Engineer with the Contractor's bid:

1. A material properties sheet for each geocomposite product, including at a minimum all properties, test methods, and test values as required by this specification.

B. Submit the following to the CQA Engineer, for review and approval, no later than 30 calendar days prior to shipment of geocomposite to the Site:

1. Manufacturer's quality control program manual, or descriptive documentation.
2. The manufacturers' quality control certifications (including results of source quality control testing of the products as required by this specification) to verify that the materials supplied for the project are in compliance with the product specifications in this Section. The certifications shall be signed by a responsible party employed by the manufacturer, such as the geocomposite QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers, and corresponding shipping information.
3. A written certificate from the geocomposite manufacturer stating that the resin and geocomposite materials supplied are in compliance with this specification.
4. Manufacturer's instruction manual for geocomposite on-site handling and installation, including but not limited to procedures for storage, transport, placement, and seaming/joining.

1.4 QUALIFICATIONS

A. Installer's Qualifications:

1. Refer to Specification Section 313200 "HDPE Geomembrane" or Specification Section 313205 "LLDPE Geomembrane" as applicable for Installer's qualifications.

B. Manufacturer shall have manufactured a minimum of 10,000,000 square feet of geocomposite material during the last five years.

1.5 QUALITY CONTROL

A. Perform work in accordance with these specifications and the CQA Plan.

B. Interface Friction Testing Requirements

1. Refer to Specification Section 313200 "HDPE Geomembrane" or Specification Section 313205 "LLDPE Geomembrane" as applicable for interface friction testing requirements.

C. The Manufacturer shall sample and test the geocomposite material at a minimum frequency as required by this specification.

D. If the Manufacturer's test results do not conform to the requirements of this specification, retesting to determine conformance or rejection shall be done as set forth in the manufacturer's quality manual at no additional cost to the CQA Engineer or Owner.

E. Any geosynthetic sample that does not conform to the requirements of the specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected roll at no cost to the Owner.

1.6 QUALITY ASSURANCE

A. Conformance Testing

1. The performance of conformance testing shall be coordinated by the CQA Engineer.
2. Conformance testing shall be performed on material specifically manufactured for this project and conform to ASTM D4354.
3. Samples shall be taken across the entire width of the roll and shall not include the first three feet. Unless otherwise specified, samples shall be three feet long by the roll width. The machine direction shall be marked on the samples.
4. Conformance testing will be performed by an independent laboratory at a frequency of at least 1 test per 100,000 square feet for the following:
   a. Thickness (ASTM D5199)
   b. Density (ASTM D1505)
   c. Ply Adhesion (ASTM D7005)
   d. Transmissivity (ASTM D4716)

B. If the conformance test results do not conform to the requirements of this specification, retesting to determine conformance or rejection shall be done as set forth in the CQA Plan at no additional cost to the CQA Engineer or Owner.

C. Any geosynthetic sample that does not conform to the requirements of the specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected roll at no cost to the Owner.

PART 2 - PRODUCTS

2.1 GEOCOMPOSITE DRAINAGE LAYER

A. The geocomposite shall consist of an HDPE geonet drainage core with a nonwoven geotextile heat bonded to each side, or small diameter perforated polypropylene pipes at a uniform spacing between two nonwoven geotextiles that are needle punched together.

B. The Supplier shall not furnish products specifically manufactured to meet the Specifications of this project unless authorized by the Owner and Engineer.

C. The geonet core structure shall consist of solid rib extruded high density polyethylene.

D. Geocomposite shall contain no plasticizers, fillers, chemical additives, or extenders.

E. Physical, Mechanical and Chemical Property Requirements

1. Geocomposite shall meet or exceed the values presented in Table 313220A at the end of this specification.

F. In addition to the property values listed in Table 313220A, the geocomposite shall:
1. Retain its structure during handling, placement, and long-term service.
2. Be capable of withstanding outdoor exposure for a minimum of 30 days with no measurable deterioration.
3. Be chemically inert when immersed in the leachate from a typical sanitary landfill.

2.2 ACCESSORIES

A. Geonet Ties: Plastic fasteners recommended by Manufacturer for tying geonet panels together. Metallic ties shall not be used for joining the geonet strips.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Each roll of geocomposite delivered to the Site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, lot number, material thickness, roll number, roll dimensions, and roll weight.

B. Procedures for storage and handling of geocomposite shall conform to ASTM D4873 and the manufacturer instructions, including the following:

1. Geocomposite shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.
2. Rolls shall be stored away from high traffic areas, protected from theft and vandalism.
3. Continuously and uniformly support rolls on a prepared level surface (not on wooden pallets) away from standing water. Rolls shall not be stacked more than two rolls high.

C. Geocomposite shall be observed by the CQA Engineer upon delivery of the product to the Site, and during installation and field seaming. The Contractor shall provide all labor and equipment required to assist CQA Engineer in the observation of the product.

3.2 PREPARATION

A. Ensure acceptance of underlying layers before installing overlying layers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Installation of the geocomposite shall be in compliance with this Specification and with the Manufacturer's standard guidelines and specifications for geocomposite installation, subject to approval by the Engineer.

B. Geocomposite shall be placed only on geomembrane that has been approved by the Geomembrane Installer and accepted by the CQA Engineer.

C. Geocomposite Deployment:

1. The Geosynthetics Installer shall handle all geocomposite in such a manner as to ensure the material is not damaged in any way.
2. The geocomposite roll should be installed at no more than a 30 degree angle to the direction of the slope and in the intended direction of flow unless otherwise specified by the Engineer.
3. The geocomposite machine direction shall be installed in the slope direction. The slope direction is the direction perpendicular to the contour lines indicated on the Drawings.
4. On slopes, secure geocomposite and then roll geocomposite down slope in manner to continually keep geocomposite in tension. If necessary, position geocomposite by hand after unrolling to minimize wrinkles.
5. Weight geocomposite with sandbags or equivalent in presence of wind. Do not remove weight until replaced with cover material. Handle sandbags with care to prevent rupture or damage of sandbag.
6. If the project includes an anchor trench at the top of the slopes, the geocomposite shall be properly anchored to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the geocomposite.
7. Do not weld geocomposite to geomembrane unless otherwise specified in construction plans.
8. Cut geocomposite using cutting tools as specified by the Manufacturer.
9. Do not damage underlying geosynthetic layers during placement of geocomposite.
10. During geocomposite deployment, do not entrap dirt, excessive dust that could cause clogging of drainage system, or stones that could damage adjacent geomembrane. If dirt or excessive dust is entrapped in geocomposite, hose clean prior to placement of next layer of material.

D. Seam and Overlap: Each component of the geocomposite (i.e., geotextile(s) and geonet) will be secured or seamed to the like component at overlaps.

1. Geonet Components

a. Overlap adjacent geonet rolls minimum of 4 in.
b. Geonet roll ends (butt seams) shall be overlapped one foot in areas with less than 10 percent slope.
c. In areas of greater than 10 percent slope, butt seams shall be overlapped two feet. Two staggered rows of ties shall be applied at 12 inch intervals.
d. Tie geonet overlaps with plastic fasteners. Use white or yellow tying devices for easy inspection. Do not use metallic devices.
e. Tie every 5 ft along edges, every 6 in. in anchor trench, and every 12 in. along end-to- end seams.
f. Horizontal seams on side slopes shall be minimized. If horizontal seams on side slopes cannot be avoided, ensure that horizontal seams are staggered between adjacent panel sections.
g. In corners of side slopes of rectangular landfills, where overlaps between perpendicular geonet strips are required, unroll an extra layer of geonet along slope, on top of previously installed geonet, from top to bottom of slope.
h. Stagger joints when more than one layer of geonet is installed.
i. When several layers of geonet are stacked, deploy rolls in same direction to prevent strands of one layer from penetrating channels of adjacent layer.

2. Geotextile Components
   a. The bottom layer of geotextiles shall be overlapped. The top layer of geotextile shall be continuously sewn. Geotextiles shall be overlapped a minimum of 4 inches prior to seaming.
   b. Polymeric thread, with chemical resistance properties equal to or exceeding those of the geotextile component, shall be used for all sewing. The seams shall be sewn to provide a flat (prayer) seam, "J" seam or "butterfly-folded" seam and shall be a two-thread, double-lock stitch or a double row of single-thread, chain stitch.
3. Perforated Pipe Components
   a. Perforated pipes shall be connected using snap coupler fittings supplied by the geocomposite manufacturer.

3.4 FIELD QUALITY CONTROL

A. The Contractor shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the installation schedule.

B. The finished geocomposite shall have good appearance qualities. It shall be free from such defects that would affect the specific properties of the geocomposite, or its proper functioning.

C. Defects and Repairs:
   1. Repair damage to geocomposite as follows, if hole or tear width across roll is less than 50% of width of roll.
      a. Place patch extending 2 ft beyond edges of hole or tear.
      b. Secure patch to original geocomposite by tying every 6 in. Use approved tying devices specified by Manufacturer.
      c. The top geotextile component of the patch shall be heat sealed to the top geotextile of the geocomposite needing repair.
   2. Repair damage to geocomposite as follows, if hole or tear width across roll is greater than 50% of width of roll.
      a. On base of landfill, cut out damaged area and replace with new geocomposite.

b. On side slopes, remove and replace damaged geocomposite panel.
c. Join in the new portions as noted above in this Section.

D. The CQA Engineer shall observe repairs and report noncompliance in writing to Owner and Engineer.

E. Before initial placement of overlying materials, inspect system seams and repaired areas to ensure tight, continuously bonded installation. Repair damaged system and re-inspect repaired work.

3.5 PROTECTION OF FINISHED WORK

A. Protect installed geocomposite according to geocomposite manufacturer's instructions. Repair or replace areas of geocomposite damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.

B. The geotextile component of the geocomposite shall not be left exposed for a period in excess of 20 days unless a longer exposure period is approved by the Engineer based on a formal demonstration from the Contractor that the geotextile is stabilized against U.V. degradation for the proposed period of exposure.

C. The Geosynthetics Installer and Contractor shall use all means necessary to protect all prior Work and all materials and completed work of other Sections included in these Specifications.

D. In the event of damage, the Contractor shall immediately make, or cause to be made, all repairs and replacements necessary, to the satisfaction of the CQA Engineer and at no additional cost to Owner.

Table 313220A - Required Properties for Geocomposite Drainage Layer			
Properties	**Test Method**	**Test Value**	**Minimum Testing Frequency**
Geonet			
Thickness (min. avg.)	D 5199	*(1)*	100,000 ft^2
Density (min. avg.)	D 1505	0.94 g/cc	100,000 ft^2
Carbon Black Content (% range)	D 4218	2.0 - 3.0	100,000 ft^2
Geotextile			
Mass per Unit Area (min. avg.) • landfill cover system • landfill liner (leachate collection and leakage detection)	D 5261	6 oz/sy 8 oz/sy	100,000 ft^2
Grab Tensile (min. avg.) • landfill cover system • landfill liner (leachate collection and leakage detection)	D 4632	160 lb 200 lb	100,000 ft^2
Puncture (min. avg.) • landfill cover system • landfill liner (leachate collection and leakage detection)	D 6241	475 lb 650 lb	100,000 ft^2
Apparent Opening Size, US Sieve	D 4751	70+	500,000 ft^2
Permittivity (min. avg.) *(2)*	D 4491	0.3 /s	500,000 ft^2
Geocomposite			
Ply Adhesion (min. avg.) • landfill liner side slopes and landfill cover system • landfill liner floor	D 7005	1.0 lb/in 0.5 lb/in	100,000 ft^2
Transmissivity (min.) • landfill liner leachate collection system *(3)* • landfill liner leakage detection system *(4)* • landfill cover system *(5)*	D 4716	4.0E-4 m^2/s 4.0E-4 m^2/s 1.0E-3 m^2/s	per lot

NOTES:

(1) Thickness shall be that which is required to achieve the required transmissivity.

(2) If hybrid geotextile is required to achieve acceptable HCR results, then a permittivity of 0.1 / s is acceptable.

(3) Landfill liner leachate collection system geocomposite shall be tested as follows:
- upper material of protective cover compacted to 90 percent of Standard Proctor MDD and within 3% of OMC
- lower material of geomembrane
- seating time = 100 hours
- Hydraulic gradient = 0.1
- normal load = 15,000 psf

(4) Landfill liner leakage detection system geocomposite shall be tested as follows:
- upper material of geomembrane
- lower material of geomembrane
- seating time = 100 hours
- Hydraulic gradient = 0.1
- normal load = 15,000 psf

(5) Landfill cover system geocomposite shall be tested as follows:
- upper material of final soil cover compacted to 95 percent of Standard Proctor MDD and within 3% of OMC
- lower material of geomembrane
- seating time = 24 hours
- Hydraulic gradient = 0.33
- normal load = 1,000 psf

END OF SECTION 313220

SECTION 313240 – NONWOVEN GEOTEXTILE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes nonwoven geotextile.

B. Related Requirements:

1. Section 313520 "Erosion and Sedimentation Control"
2. Section 313700 "Aggregate and Riprap."

1.2 REFERENCES

A. Construction Quality Assurance (CQA) Plan

B. ASTM International:
1. ASTM D4355 Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
2. ASTM D4491 Standard Test Method for Water Permeability of Geotextiles by Permittivity.
3. ASTM D4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile.
4. ASTM D4533 Test Method for Trapezoidal Tearing Strength of Geotextiles.
5. ASTM D4632 Test Method for Grab Breaking Load and Elongation of Geotextiles.
6. ASTM D4873 Guide for Identification, Storage and Handling of Geotextiles.
7. ASTM D5261 Test Method for Measuring Mass per Unit Area of Geotextiles.
8. ASTM D6241 Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

1.3 SUBMITTALS

A. Submit the following to the CQA Engineer with the Contractor's bid:

1. A material properties sheet for the geotextile, including at a minimum all properties, test methods, and test values as required by this specification.

B. Submit the following to the CQA Engineer, for review and approval, no later than 30 calendar days prior to shipment of geotextile to the Site:

1. Manufacturer's quality control program manual, or descriptive documentation.
2. The manufacturer's quality control certifications (including results of source quality control testing of the products as required by this specification) to verify that the materials supplied for the project are in compliance with the product specifications in this Section. The certifications shall be signed by a responsible party employed by the manufacturer,

such as the geotextile QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers, and corresponding shipping information.

3. Manufacturer's instruction manual for geotextiles on-site handling and installation, including but not limited to procedures for storage, transport, placement, and seaming/joining.

1.4 QUALITY CONTROL

A. The Manufacturer shall sample and test the nonwoven geotextile material at a minimum frequency as required by Table 313240A.

B. If the Manufacturer's quality control test results do not conform to the requirements of this specification, retesting to determine conformance or rejection shall be done as set forth in the manufacturer's quality manual at no additional cost to the CQA Engineer or Owner.

1.5 QUALITY ASSURANCE

A. Quality Assurance will be provided by the Owner as described in the CQA Plan.

B. Conformance Testing

1. The performance of conformance testing shall be the responsibility of the CQA Engineer.
2. Conformance testing shall be performed on material specifically manufactured for this project.
3. Samples shall be taken across the entire width of the roll and shall not include the first three feet. Unless otherwise specified, samples shall be three feet long by the roll width. The machine direction shall be marked on the samples.
4. Required test methods and test frequencies are presented in the CQA Plan.

C. If the conformance test results do not conform to the requirements of this specification, retesting to determine conformance or rejection shall be done as set forth in the CQA Plan at no additional cost to the CQA Engineer or Owner.

D. Any geosynthetic sample that does not conform to the requirements of the specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected roll at no cost to the Owner.

PART 2 - PRODUCTS

2.1 NONWOVEN GEOTEXTILE

A. Nonwoven geotextile nominal mass per unit area shall be as indicated on the Drawings.

B. The geotextile shall be:

1. Nonwoven, needle punched, continuous filament polyester material; or
2. Nonwoven, needle punched, continuous filament polypropylene material; or
3. Nonwoven, needle punched, polypropylene staple or continuous fiber material.

C. The geotextile shall be manufactured from first quality virgin polymer.

D. The supplier shall not furnish products specifically manufactured to meet the specifications of this project unless authorized by the Owner and Engineer.

E. Physical, Mechanical and Chemical Property Requirements

1. Nonwoven geotextile shall meet or exceed the values presented in Table 313240A, unless otherwise approved by the Engineer.

2.2 ACCESSORIES

A. Sewing materials: Types recommended by manufacturer for sewing seams in geotextile.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Each roll of geotextile delivered to the Site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, lot number, material thickness, roll number, roll dimensions, and roll weight.

B. Procedures for storage and handling of geotextile shall conform to ASTM D4873 and the manufacturer instructions, including the following:

1. Geotextile shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.
2. Rolls shall be stored away from high traffic areas, protected from theft and vandalism.
3. Supplied in rolls wrapped in relatively impermeable, waterproof, and opaque protective cover that is resistant to photodegradation by ultraviolet (UV) light.
4. Continuously and uniformly support rolls on a prepared level surface (not on wooden pallets) away from standing water. Rolls shall not be stacked more than two rolls high.

3.2 PREPARATION

A. Verify acceptance of underlying layers before installing overlying layers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Installation of the geotextile shall be in compliance with this Specification and with the Manufacturer's standard guidelines and specifications for geotextile installation, subject to approval by the Engineer.

B. After unwrapping the geotextile from its opaque cover, the geotextile shall not be left exposed for a period in excess of 20 days unless a longer exposure period is approved by the Engineer based on a formal demonstration from the Contractor that the geotextile is stabilized against U.V. degradation for the proposed period of exposure.

C. The Contractor shall take care not to entrap stones, excessive dust, or moisture in the geotextile during placement.

D. Nonwoven geotextile shall be overlapped a minimum of 6 inches, or as otherwise specified in the Specifications.

E. Damage Repair

1. Any holes or tears in the geotextile shall be repaired with a patch made from the same geotextile. The patch shall be placed with a minimum of 12 inches overlap in all directions.
2. Care shall be taken to remove any soil or other material, which may have penetrated the torn geotextile.

3.4 FIELD QUALITY CONTROL

A. The Contractor shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the installation schedule.

B. Before placement of overlying materials, inspect seams and repaired areas. Repair damaged geotextiles and reinspect repaired work.

3.5 PROTECTION OF FINISHED WORK

A. The Geosynthetic Installer and Contractor shall use all means necessary to protect all prior Work and all materials and completed work of other Sections of these Specifications.

B. The geotextile shall be covered as soon as possible after installation and approval. The geotextile shall not be exposed to precipitation prior to being installed and shall not be exposed to direct sun light for more than 20 days after installation.

C. Placement of Cover Material:
1. Placement of the cover soil or aggregate shall proceed immediately following placement and inspection of the geotextile
2. The cover material shall be placed on the geotextile in such a manner that ensures that:
   a. The geotextile and underlying materials are not damaged.
   b. Minimal slippage occurs between the geotextile and underlying layers.
   c. Wrinkling of geosynthetics does not occur.

D. In the event of damage, the Installer shall immediately make all repairs and replacements necessary at the expense of the responsible party, to the approval of the Engineer.

Table 313240A - Required Properties for Nonwoven Geotextile

Properties	Test Method	Test Value				Minimum Testing Frequency
		6 oz/sy	8 oz/sy	10 oz/sy	12 oz/sy	
Mass per Unit Area (min. avg.)	D 5261	6 oz/sy	8 oz/sy	10 oz/sy	12 oz/sy	100,000 sf
Grab Tensile Strength (min. avg.)	D 4632	160 lb	200 lb	230 lb	300 lb	100,000 sf
Grab Tensile Elongation (min. avg.)	D 4632	50%	50%	50%	50%	100,000 sf
Trapezoid Tear Strength (min. avg.)	D 4533	65 lb	80 lb	95 lb	115 lb	100,000 sf
CBR Puncture Strength (min. avg.)	D 6241	450 lb	600 lb	725 lb	900 lb	100,000 sf
Apparent Opening Size (AOS, US Sieve)	D 4751	70	80	100	100	per lot
Permeability (min. avg.)	D 4491	0.25 cm/sec	0.30 cm/sec	0.30 cm/sec	0.30 cm/sec	per lot
UV Resistance (1)	D 4355	70%	70%	70%	70%	per lot

NOTES:
(1) Evaluation to be on 2.0 inch strip tensile specimen after 500 hours of exposure

END OF SECTION 313240

SECTION 313520 – EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall implement and maintain best management practices (BMPs) and perform other required activities as indicated on the Drawings.

B. Related Requirements:

1. Section 311000 "Site Clearing."
2. Section 312000 "Earth Moving."
3. Section 313240 "Nonwoven Geotextile."
4. Section 313700 "Aggregate and Riprap."
5. Section 329200 "Seeding."

1.2 REFERENCES

A. North Carolina Department of Environmental Quality (NCDEQ) and North Carolina Sedimentation Control Commission:

1. "Erosion and Sediment Control Planning and Design Manual", latest edition.

B. North Carolina Department of Transportation:

1. "Standard Specifications for Roads and Structures" 2012 Edition (NCDOT Standard Specifications).

1.3 SUBMITTALS

A. Submit product data on proposed erosion and sedimentation control measures.

B. Dust Control Plan: Submit coordination drawing and narrative that indicates the dust control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:

1. Water Tank Capacity.
2. Method of water dispersing.

1.4 QUALITY CONTROL

A. Comply with the requirements of pollution control laws, rules and regulations of governmental authorities having jurisdiction, and applicable permit conditions as presented on the Drawings, including, but not limited to, the following:

1. "Sedimentation Pollution Control Act of 1973" (as amended through latest legislative session), North Carolina General Statutes (NCGS Chapter 113A, Article 4).
2. Chapter 4 of Title 15A of the North Carolina Administrative Code (T15A.04); Sedimentation Control.

PART 2 - PRODUCTS

2.1 EROSION AND SEDIMENTATION CONTROL DEVICES

A. Erosion and sedimentation control (E&SC) devices shall be as shown on the Drawings.

B. Additional E&SC measures may be required during construction to prevent erosion and offsite sedimentation.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify approval of Erosion and Sedimentation Control Plan and completion of all required notifications have been given prior to beginning work.

3.2 EROSION AND SEDIMENTATION CONTROL

A. Provide erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion and sedimentation control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion and sedimentation control measures during construction until permanent vegetation has been established.

3.3 REMOVAL OF TEMPORARY CONTROLS

A. Remove temporary erosion and sedimentation control measures upon stabilization of the tributary area and closure of the E&SC Permit and when approved by the Owner and Engineer.

B. Restore and stabilize areas disturbed during removal.

END OF SECTION 313520

SECTION 313700 – AGGREGATE AND RIPRAP

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Aggregate base course road surfacing material consisting of NCDOT ABC aggregate.
2. Riprap consisting of NCDOT Class A, B, 1, or 2 aggregate.
3. Drainage aggregate consisting of NCDOT 57, 78, or 78M aggregate.
4. Fine aggregate filter consisting of ASTM C33 concrete sand.

B. Related Requirements:

1. Section 313240 "Non-Woven Geotextiles".
2. Section 313520 "Erosion and Sedimentation Control."

1.2 REFERENCES

A. ASTM International:
1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D75 - Standard Practice for Sampling Aggregates

B. North Carolina Department of Transportation (NCDOT):
1. "Standard Specifications for Roads and Structures", 2012 Edition (NCDOT Standard Specifications).

1.3 SUBMITTALS

A. Submit the following to the Engineer, for review and approval, no later than 30 calendar days prior to shipment of aggregate and riprap to the Site:

1. Written documentation and certification (including gradation test results) signed by the material producer, indicating that material meets or exceeds the specified requirements.

B. Submit the following during Work progress and at completion:
1. Copy of truck ticket for every load of aggregate material delivered to the site.

1.4 QUALITY ASSURANCE

A. The CQA Engineer will perform specified tests to determine conformance of the materials and constructed work with the Specifications.

1.5 TESTING OF AGGREGATE

A. If determined necessary by the Engineer and/or Owner, verification testing will be performed by the CQA Engineer upon delivery of aggregate to the Site. Sampling will be at a minimum rate of one for every 1,000 tons of material, and for each visible change in material. Sampling will be in conformance with ASTM D75.

B. The following tests will be performed:
   1. Sieve analysis (using ASTM C136)

PART 2 - PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Proposed materials and source shall be approved by the CQA Engineer as specified prior to delivery and use in the construction.

B. Riprap shall meet specified gradation prior to placement. All processing shall be completed at the source.

C. Aggregate shall meet specified gradation prior to placement. All processing shall be completed at the source. If the aggregate, at any time, deviates from the required gradation, the Contractor shall, at his own expense, correct the inconsistency to the satisfaction of the CQA Engineer.

2.2 AGGREGATE MATERIAL

A. Aggregate base course road surfacing material shall consist of NCDOT ABC aggregate.

B. Riprap shall consist of NCDOT Class A, B, 1, or 2 aggregate as shown on the Drawings.

C. Drainage aggregate shall consist of NCDOT 57, 78 or 78M aggregate as shown on the Drawings.

D. Fine aggregate filter shall consist of ASTM C33 concrete sand

2.3 GEOTEXTILE

A. Specified in Section 313240.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Material shall be delivered and stockpiled on-site only in designated areas approved by the Owner.

B. Stockpile areas shall be maintained to prevent erosion.

3.2 PREPARATION

A. Verify that subgrade gradients and elevations are correct, and that subgrade is ready for placement of aggregate surfacing material.

B. Ensure acceptance of underlying layers before installing overlying layers.

C. Aggregate base course road surfacing material consisting of NCDOT ABC aggregate: Ensure subgrade meets requirements for road surfacing subgrade as specified in Section 312000.

D. Where required, install nonwoven geotextile as specified in Section 313240.

3.3 AGGREGATE PLACEMENT

A. Contractor shall take special care to avoid damaging installed ground stabilization geotextile when placing and compacting the aggregate. Damage to the geotextile shall be repaired at the Contractor's expense, and as approved by the Engineer.

B. Aggregate surfacing shall be constructed to the total depth indicated on the Drawings. Place in uniform horizontal layers, with each layer having a maximum compacted thickness of six inches.

C. Place, spread, shape, and compact the aggregate as continuously as practicable during each day's operations. Place the material in a manner to avoid segregation. Uncontrolled spreading shall not be permitted.

D. Level and contour surfaces to achieve the final grades and cross-sections indicated on the Drawings.

E. The depth of aggregate shall be carefully controlled, with periodic measurements of the loose and compacted depth.

F. At the time aggregate is placed, it shall have a moisture content sufficient to obtain the required compaction. If necessary, uniformly apply water over the aggregate during compaction. Prevent free water from appearing on the surface during, or subsequent to, compaction operations. Compaction shall follow the spreading operation closely to prevent loss of contained moisture and displacement of material.

3.4 FIELD QUALITY ASSURANCE

A. The CQA Engineer shall observe that NCDOT ABC aggregate is well compacted.

3.5 TOLERANCE

A. Aggregate base course road surfacing material consisting of NCDOT ABC aggregate: Acceptable tolerance for depth of aggregate surfacing shall be plus or minus 0.10 feet.

3.6 PROTECTION OF FINISHED WORK

A. The Contractor shall use all means necessary to protect all prior Work, and all materials and completed Work of other Sections of these Specifications.

B. In the event of damage, the Contractor shall immediately make all repairs and replacements necessary to the approval of the CQA Engineer and at no additional cost to the Owner.

END OF SECTION 313700

SECTION 329200 – SEEDING

PART 1 - GENERAL

1.1 SUMMARY

A. The Work covered by this section consists of furnishing all equipment, tools, materials, and labor necessary for establishing temporary and permanent vegetative cover; e.g., seeding, fertilizing, and mulching, on all areas disturbed at the site.

B. Related Requirements:

1. Section 313520 "Erosion and Sedimentation Control."

1.2 REFERENCES

A. North Carolina Department of Environmental Quality (NCDEQ) and North Carolina Sedimentation Control Commission:

1. "Erosion and Sediment Control Planning and Design Manual", latest edition.

1.3 SUBMITTALS

A. Product and certificates of compliance or reports:
1. Seed mix;
2. Fertilizer;
3. Mulch;
4. Agricultural Soil Test Reports; and
5. Other accessories and soil amendments.

B. Soil test results and fertilizer and soil amendment recommendations from the North Carolina Department of Agriculture and Consumer Affairs or a similar soil and nutrient testing laboratory.

C. Qualification Data: For the Installer.

D. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

E. Certification of each seed mixture for grass. Include identification of source and name and telephone number of supplier.

F. Seeding maintenance warranty. The Contractor shall be responsible for the satisfactory establishment and growth of a permanent stand of vegetation as judged by the CQA Engineer for a period of one year following the final seeding. During this period, the Contractor shall be

responsible for the maintenance items described in Paragraph 3.5 (Maintenance) of this Specification.

G. Operation and Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer. Recommended procedures to be established by Owner for maintenance of vegetative cover system and grasses during a calendar year. Submit before expiration of required maintenance periods.

1.4 QUALITY CONTROL

A. Provide seed mixture in containers showing percentage of seed mix, germination percentage, inert matter percentage, weed percentage, year of production, net weight, date of packaging, and location of packaging.

B. Perform Work in accordance with North Carolina Erosion and Sediment Control Planning and Design Manual.

C. Installer Qualifications: A qualified landscape installer whose work has resulted in successful vegetation establishment of a similar species to that utilized for this project.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

PART 2 - PRODUCTS

2.1 SEED

A. Temporary Seed Mixture: As specified on the Drawings.

B. Permanent Seed Mixture: As specified on the Drawings.

2.2 ACCESSORIES

A. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry and as described in the North Carolina Erosion and Sediment Control Planning and Design Manual.

B. Fertilizer: Commercial grade; recommended for grass; of proportion necessary to eliminate deficiencies of topsoil as described in the North Carolina Erosion and Sediment Control Planning and Design Manual and as indicated on Drawings.

C. Water: Clean, fresh and free of substances or matter capable of inhibiting vigorous growth of grass.

D. Limestone (if required by soil analysis): Agricultural grade limestone ground to pass an 8-mesh with 25 percent passing a 100-mesh sieve shall be furnished. In addition, calcareous limestone shall contain not less than 50 percent calcium oxide, and dolomitic limestone shall contain not less than 40 percent magnesium oxide. Coarser materials will be acceptable provided the specified rates of application are increased proportionately, on the basis of quantities passing the 8- and 100- mesh sieves, but no additional payment will be made for the increased quantity.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. During delivery, seed shall be protected from any drying or contamination by detrimental material.
2. Seeding material shall be inspected upon arrival at the site; unacceptable material shall be immediately removed from the site by the Contractor.
3. Fertilizer shall be delivered to the site in the original, unopened containers bearing the manufacturer's guaranteed chemical analysis, name, trade name, trademark, and conformance with State of North Carolina.
4. Pesticides and herbicides shall not be delivered to the site without written approval from the Owner.

B. Storage:

1. Seed and fertilizer shall be stored in cool, dry locations away from contaminants.
2. Materials shall be stored in areas designated or approved by the Engineer or Owner.
3. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

3.2 PREPARATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint

thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by CQA Engineer and Owner and replace with new planting soil.

3.3 SEEDING

A. Apply seed at rate as indicated on Drawings evenly in two intersecting directions and in accordance with the North Carolina Erosion and Sediment Control Planning and Design Manual. Rake in lightly.

B. Do not seed areas in excess of that which can be mulched on same day.

C. Planting Season: As indicated on Drawings and in accordance with the North Carolina Erosion and Sediment Control Planning and Design Manual.

D. Do not sow immediately following rain, when ground is too dry, or when winds are over 12 mph.

E. Immediately following seeding, apply mulch to thickness as specified on Drawings and in accordance with the North Carolina Erosion and Sediment Control Planning and Design Manual.

F. Apply water with fine spray immediately after each area has been mulched.

G. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h).

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.

3.4 HYDROSEEDING

A. Apply fertilizer, mulch and seeded slurry with hydraulic seeder at rate of 2000 lbs per acres evenly in one pass.

B. After application, apply water with fine spray immediately after each area has been hydroseeded.

C. Hydroseeding: Mix specified seed and commercial fertilizer using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

3.5 MAINTENANCE

A. The Contractor shall be responsible for maintaining all seeded areas through the end of the one year warranty period. The Contractor shall provide, at his expense, protection of all seeded areas against damage at all times until acceptance of the work following completion of the one year warranty period. Maintenance shall include, but not be limited to, the following items:
   1. Regrade and revegetate all eroded areas until adequately stabilized by grass.
   2. Remulch with new mulch in areas where mulch has been disturbed by wind or maintenance operations sufficiently to nullify its purpose. Anchor as required to prevent displacement.
   3. Replant bare areas using same materials specified.

END OF SECTION 329200

Construction Quality Assurance Plan

Closed Pine Hall Road Ash Landfill - Cover System Modifications

Duke Energy– Belews Creek Steam Station

Belews Creek, Stokes County, North Carolina

Amec Foster Wheeler Project No. 7810150512

NORTH CAROLINA PROFESSIONAL SEAL 031203 ENGINEER MARTIN A. SHUMPERT

1/22/16

Prepared For:	Duke Energy Carolinas, LLC 526 S. Church St., Charlotte, NC 28202
Date	January 22, 2016
Prepared By:	Amec Foster Wheeler 2801 Yorkmont Rd., Charlotte, NC 28208

Table of Contents

1 INTRODUCTION 1

2 PROJECT TEAM AND RESPONSIBILITIES 1
2.1 Owner 1
2.2 CQA Project Team 1
2.2.1 Design Engineer of Record 1
2.2.2 Construction Quality Assurance Engineer 1
2.2.3 Engineering Technicians 1
2.3 Contractor 1
2.4 Pre-Construction Meeting 2
2.5 Progress Meetings 2
2.6 Pre-Installation Meeting 2
2.7 Troubleshooting Meetings 2

3 COMPACTED FILL 2
3.1 Material 2
3.2 Observations 2
3.3 Testing 2
3.3.1 Laboratory Testing (Conformance Testing) 2
3.3.2 In-Place Testing (Record Testing) 3

4 GEOMEMBRANE 3
4.1 Material 3
4.2 Geosynthetic Manufacturer and Construction 3
4.2.1 Manufacturer Submittals 3
4.2.2 Interface Friction Testing 4
4.3 Geomembrane Material Testing 4
4.3.1 Manufacturer Quality Control Testing 4
4.3.2 Conformance Testing 4
4.4 Geomembrane Installation 4
4.4.1 Meetings 4
4.4.2 Field Panel Identification 5
4.4.3 Field Seaming 5
4.4.4 Test Seams 5
4.4.5 Seam Monitoring 5
4.4.6 Non-Destructive Testing 6
4.4.7 Field Destructive Testing 6
4.4.8 Laboratory Destructive Testing 6
4.4.9 Repair Procedures and Verification 6
4.4.10 Daily Field Installation Reports 6
4.4.11 Acceptance and Closeout Procedures 7

5 GEOCOMPOSITE DRAINAGE LAYER 7
5.1 Materials 7
5.2 Geocomposite Manufacturer and Contractor 7
5.2.1 Manufacturer Submittals 7
5.2.2 Interface Friction Testing 7
5.3 Geocomposite Material Testing 7
5.3.1 Manufacturer Quality Control Testing 7
5.3.2 Conformance Testing 7
5.4 Geocomposite Installation 8
5.5 Acceptance and Closeout Procedures 8

6 NONWOVEN GEOTEXTILE 8
6.1 Materials 8

6.2 Geosynthetic Manufacturer and Contractor 8
6.2.1 Manufacturer Submittals 9
6.2.2 Interface Friction Testing 9
6.3 Geotextile Material Testing 9
6.3.1 Manufacturer Quality Control Testing 9
6.3.2 Conformance Testing 9
6.4 Geotextile Installation 10
7 FINAL COVER SOIL AND VEGETATIVE COVER 10
7.1 Construction 10
7.2 Testing 10
7.2.1 Laboratory Testing (Conformance Testing) 10
7.2.2 In-Place Testing 10
8 RECORD DRAWINGS AND FINAL SUBMITTALS 11
9 CERTIFICATION REPORT 11

1 Introduction

This Construction Quality Assurance (CQA) Plan was prepared for the Closed Pine Hall Road Ash Landfill in accordance with Title 15A Subchapter 13B of the North Carolina Administrative Code (NCAC) to meet the requirements of 0.0503(2) and 0.0504(2) and 0.0505 for industrial landfills. This CQA Plan is applicable to landfill construction and closure projects at the Closed Pine Hall Road Ash Landfill.

2 Project Team and Responsibilities

2.1 Owner

Duke Energy Carolinas, Inc. (Duke Energy) is the project Owner. The Owner has overall responsibility for the project and will maintain the contractual relationships with the Design Engineer of Record (Engineer) and the Contractor(s).

2.2 CQA Project Team

The CQA Project Team will oversee construction of the landfill and will provide certification of landfill construction.

2.2.1 Design Engineer of Record

The Design Engineer of Record (Engineer) is responsible for defining quality assurance requirements compatible with the project objectives, reviewing and approving shop drawings, reviewing and approving submittals, outlining procedures for the analysis of test data, and preparing quality assurance memorandums and quality assurance reports. The Engineer is responsible for design changes (as approved by the State Solid Waste Section), clarifications, and specification addenda. The Engineer also has the ultimate responsibility for approving or disapproving design elements of the project. The responsibility to stop work is held by the Owner. The Engineer will be a registered Professional Engineer in the State of North Carolina and will report to Duke Energy.

2.2.2 Construction Quality Assurance Engineer

The Construction Quality Assurance Engineer (CQA Engineer) will be experienced in quality assurance testing and monitoring. The CQA Engineer will report to the Owner and, at the Owner's discretion, can be employed by the same entity as the Engineer or may be the Engineer. The CQA Engineer, along with the engineering technicians, serves as the on-site representative of the Owner and is responsible for the field implementation and documentation of the approved quality assurance program and for certifying that construction was completed in general accordance with the permit to construct, the construction drawings and specifications, acceptable engineering practices, and applicable waste management rules. The CQA Engineer will inform the Engineer of quality assurance activities and non-conformance to the approved CQA program, if any. The CQA Engineer will maintain an awareness of the overall field testing operations to identify conditions that may jeopardize the quality of testing. The CQA Engineer is responsible for supervising the engineering technicians, who are considered representatives of the CQA Engineer. Actions required of the CQA Engineer by this plan may be carried out by the CQA Engineer or his/her representative, where appropriate.

2.2.3 Engineering Technicians

The engineering technicians (technicians) are responsible for field observations and field testing at the direction of the CQA Engineer. Technicians will be assigned to the project as deemed necessary by the CQA Engineer. The CQA Engineer may perform and conduct field observations and testing personally. Technicians will be under the direct supervision of the CQA Engineer.

2.3 Contractor

The Contractor is the organization with whom the Owner has entered into a contractual agreement to complete the project construction. The Contractor and his subcontractors will be responsible for providing materials, labor, and equipment to complete the scope of work as defined in the contract documents. The Contractor may subcontract the geosynthetics work to a specialized contractor referred to herein as the

Geosynthetics Installer. Actions required of the Geosynthetics Installer are ultimately the responsibility of the Contractor.

2.4 Pre-Construction Meeting

A pre-construction meeting will be conducted prior to the start of construction. The meeting will include, but not be limited to, discussion of:

- Health and safety;
- Construction quality assurance organization;
- Respective duties of the Engineer, CQA Engineer and the Contractor(s);
- Proposed construction schedule;
- Testing requirements and procedures; and
- Periodic reporting requirements for test results and construction activities.

2.5 Progress Meetings

Progress meetings will be held on a regular basis, and as needed, between the Owner, Engineer, CQA Engineer, Contractor, and representatives of other involved parties. The status of the project, scheduled activities, and construction related subjects will be discussed.

2.6 Pre-Installation Meeting

A pre-installation meeting will be scheduled prior to geosynthetics installation. The Contractor, the Geosynthetics Installer, and the CQA Engineer will attend the meeting.

2.7 Troubleshooting Meetings

If problems develop or should deficiencies arise during construction, troubleshooting meetings will be held between the Owner, Engineer, the CQA Engineer, the Contractor, and representatives of other involved parties. The problem(s) will be defined and a resolution will be discussed.

3 Compacted Fill

3.1 Material

Compacted fill is soil material placed to achieve proposed liner system subgrade elevations, establish berms, and access roads. Compacted fill may consist of off-site and on-site soils that meet the project specifications. The compacted fill will be constructed and compacted to meet the requirements outlined in Section 312000 of the Technical Specifications. Each compacted fill material source will be approved in advance by the Engineer; however, the Contractor will not be responsible for obtaining off-site borrow soil.

3.2 Observations

Prior to fill placement, the base surface or surface of the previous lift will be observed. Soils will be monitored to evaluate that the materials are free of deleterious materials and meet the specification requirements. During fill placement, observations of lift thickness and uniform mixing of soils will be performed.

3.3 Testing

Testing of subgrade fill will consist of both in-place and laboratory testing described as follows.

3.3.1 Laboratory Testing (Conformance Testing)

For laboratory testing, a bulk sample of the fill soils will be obtained for each 10,000 cubic yards of soil placed. The CQA Engineer may modify the number of bulk samples needed for laboratory testing depending on the variability of the soils being placed. Laboratory testing will include, but not be limited to, the following tests:

Table 3.3.1 - Laboratory Testing Requirements of Subgrade Fill

TEST	METHOD	FREQUENCY
Water (Moisture) Content	ASTM D2216	One (1) test per 10,000 cubic yards
Particle Size	ASTM D422	
Liquid Limit, Plastic Limit, and Plasticity Index	ASTM D4318	
Standard Proctor Compaction Characteristics	ASTM D698	

3.3.2 In-Place Testing (Record Testing)

In-place field density and moisture content tests will be performed as shown in Table 3.3.2. Where multiple test methods are listed, only one test method need be used.

Table 3.3.2 - In-Place Field Density Testing Requirements of Subgrade Fill

TEST	METHOD	FREQUENCY
Field Density	Sand Cone (ASTM D1556)	One (1) test per acre per lift. Trenches: One (1) test per 200 LF per lift
	Drive Cylinder (ASTM D2937)	
	Nuclear Gauge (ASTM D6938)	
Moisture Content	Nuclear Gauge (ASTM D6938) Direct Heating Moisture (ASTM D4959) Oven Moisture (ASTM D2216)	

Required field density and moisture content tests will be completed before the overlying lift of soil is placed.

4 Geomembrane

4.1 Material

The geomembrane material will meet the requirements contained in the Technical Specifications.

4.2 Geosynthetic Manufacturer and Construction

The Geosynthetics Installer is the party that performs installation of the geomembrane. The manufacturer is the party that supplies the geosynthetic products.

4.2.1 Manufacturer Submittals

The Contractor will submit the following as obtained from the geosynthetic manufacturer to the CQA Engineer:

- Test data for material and resin for each liner type. The results of these tests must meet the minimum required physical properties for HDPE geomembrane specified in tables 313205-A, and 313205-B of the Technical Specifications
- MQC Material Certification for liner rolls and resin used in manufacturing them
- Description of spark testing and Manufacturer Quality Control (MQC) Program for testing the geomembrane material and resin. These tests are discussed in the Technical Specification 313205.
- Manufacturer's installation instructions

- Proposed geomembrane panel layout

4.2.2 Interface Friction Testing

The Contractor will submit representative samples of the proposed geomembrane to the CQA Engineer or a geosynthetic testing laboratory as directed by the CQA Engineer. The CQA Engineer will coordinate interface friction testing to evaluate the interface shear strength between the geomembrane and the overlying and underlying materials, as specified in the Technical Specifications.

4.3 Geomembrane Material Testing

Testing of geomembrane will consist of both MQC and conformance testing, described as follows.

4.3.1 Manufacturer Quality Control Testing

The manufacturer will sample and test the geomembrane material prior to shipment to the site, at minimum frequencies specified in the Technical Specifications. The CQA Engineer will verify that the requirements of the Technical Specifications are met.

4.3.2 Conformance Testing

The CQA Engineer will obtain samples for conformance testing. Samples may be obtained prior to shipment at the manufacturing facility. The minimum number of samples will be one per 100,000 ft^2. The samples must be representative of the materials supplied and exclude the outer wrap of geomembrane if evidence of scuffing or other damage is observed. Samples should extend across the full roll width, not include the first 3 feet, and be at least 3 feet long.

Representative samples will be sent to a geosynthetics laboratory approved by the Engineer for conformance testing. The laboratory testing program will be coordinated by the CQA Engineer and include the following tests:

Table 4.3.2 - Conformance Testing Requirements of Geomembrane.

TEST	METHOD	FREQUENCY
Thickness	ASTM D5199 and/or ASTM D5994	One (1) test per 100,000 square feet
Asperity height	ASTM D7466	
Density	ASTM D1505 and/or ASTM D792	
Carbon black content	ASTM D1603	
Tensile Properties	ASTM D6693	
Tear Resistance	ASTM D1004	

If a representative sample does not comply with the requirements of the Technical Specifications, the roll of geomembrane that is in non-conformance will be replaced at no additional cost to the Owner. Additional conformance testing will be performed on the closest numerical roll on both sides of the failed roll. Sampling and testing of rolls will continue until acceptable results are established.

The CQA Engineer will inventory the rolls upon delivery to the site and report observed deviations from the requirements of the Technical Specifications to the Contractor. At the Engineer's discretion, the CQA Engineer may sample rolls from each shipment of geomembrane delivered to the site.

4.4 Geomembrane Installation

4.4.1 Meetings

A geosynthetics pre-installation meeting will be held prior to beginning geosynthetic installation. At a minimum, the Contractor, Geosynthetics Installer, CQA Engineer, and a representative of the Owner will be in attendance. The Technical Specifications, quality assurance, and quality control procedures will be reviewed and discussed.

4.4.2 Field Panel Identification

The Geosynthetics Installer will number each panel with an identification code using the format P1, P2, etc. Panels in the field must be numbered in the order in which the panels are actually laid regardless of pre-construction numbering. The CQA Engineer will record the location and date of installation of each panel using the identification code.

Panels shall be observed by the CQA Engineer when the panels are initially deployed. Observation shall be for identification of defects, holes, and any sign of contamination by foreign matter. Defects in seam and non-seam areas shall be repaired as required by this specification.

4.4.3 Field Seaming

Field seaming will be in accordance with the US EPA. Technical Guidance document: "The Fabrication of Polyethylene FML Field Seams" EPA/530/SW-89/069 and/or according to the Technical Specifications. Seaming may be extrusion or fusion welding or a combination of these methods. The Engineer reserves the right to reject any proposed seaming method believed to be unacceptable. Additional concepts and requirements of proper field seaming are found in the Technical Specifications.

Adjoining liner panels will be overlapped as recommended by the manufacturer, but not less than 4 inches, by adequately lapping the edges of the sheets. The overlap will not exceed 6 inches for double-wedge fusion welds.

The Technical Specifications provide more in depth details on the general requirements for geomembrane handling, placement, field seaming, and installation. The CQA Engineer will monitor geomembrane installation for conformance with the Technical Specifications.

4.4.4 Test Seams

The Geosynthetics Installer will perform test seams at the beginning of each seaming period, after any interruption in power, after any prolonged idle period during the day, when changes in storing equipment occur, and at the request of the CQA Engineer if a potential change of seam quality is observed. A test seam will be made for each texture contact type to be seamed by that welder during the working increment (i.e. smooth/smooth for edge seams, texture/texture for butt seams, etc.)

The CQA Engineer may request additional test seams according the Technical Specifications. The test seam should be approximately 6 feet long. The CQA Engineer will sample the test seam from the center 3 feet of the test sample.

The welder, date, time and equipment, as well as liner temperature, welding temperature, and seaming parameters will be recorded in the Geomembrane Trial Seam Log by the CQA Engineer for each test seam.

A minimum of six specimens from each sample will be tested with three in peel and three in shear. Film Tear Bond (FTB) type failures will be the criterion for qualification of the test seam. Testing will be performed in the field by the Geosynthetics Installer under full-time observation by the CQA Engineer.

Untested portions of the test seam will be retained by the CQA Engineer at his or her discretion for the project records and future testing, as required.

All test seams must pass the field testing requirements presented in the Technical Specifications before production seaming is performed by the Geosynthetics Installer.

4.4.5 Seam Monitoring

During seaming, the CQA Engineer will observe the seams for the proper preparation, grinding technique and for evidence of overheating. Where observations indicate that repairs are needed, the method of repair will be evaluated in the field by the CQA Engineer. The repairs will be logged in the Geomembrane Repair Testing Log by the CQA Engineer.

At the discretion of the CQA Engineer, coupons may be cut from the end of the extrusion seams and the bottom side of the seam will be observed for visible warping or deformation.

The CQA Engineer will observe the geomembrane during the cooler parts of the day to check for slack. Any areas where insufficient contact between the subgrade and geomembrane occurs will be marked and logged in the Geomembrane Defect Log by the Engineer for repair by the Geosynthetics Installer.

All repair locations will be patched and tested in accordance with the Technical Specifications prior to acceptance. All patches will extend a minimum of 6 inches beyond the repair location. All repairs will be logged in the Geomembrane Repair Testing Log by the CQA Engineer.

4.4.6 Non-Destructive Testing

The Geosynthetics Installer is responsible for non-destructive testing of the entire length of field seams. The testing will be vacuum, air pressure and/or spark testing as outlined in the Technical Specifications.

Non-destructive testing will be monitored by the CQA Engineer on a full-time basis.

4.4.7 Field Destructive Testing

Field destructive testing (FDT) will be conducted periodically at the discretion of the CQA Engineer or Engineer. The Geosynthetics Installer will obtain 12-inch wide by 42-inch long samples of field seams for testing. The name of the sample (e.g. FDT-1), date, time, equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA Engineer in the Geomembrane Defect Log.

Samples retained will be tested in the field by the Geosynthetics Installer. A minimum of three specimens with dimensions of 12 inches wide by 1 inch long from each sample will be tested in peel (ASTM D6392). FTB type failures will be the criterion for qualification of the production seam.

4.4.8 Laboratory Destructive Testing

Destructive seam samples will be shipped by the CQA Engineer to a laboratory approved by the Engineer. Testing frequency is at least one sample per 500 cumulative linear feet of field seam at locations specified by the CQA Engineer. The name of the sample (e.g. LDT-1), date, time, equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA Engineer in the Geomembrane Defect Log. Test samples will be at least 54 inches long and 12 inches wide.

A minimum of five peel specimens will be tested for each sample in accordance with ASTM D6392. At least five specimens from each sample will be tested for bonded shear strength in accordance with ASTM D6392. Peel tests will be performed on both sides of a double-wedge fusion seam.

4.4.9 Repair Procedures and Verification

The Geosynthetics Installer will visually inspect the geomembrane surface for defects. Portions of the geomembrane exhibiting defects, or failing a destructive or nondestructive test, must be repaired by the Geosynthetics Installer. Repairs will be made in accordance with the Technical Specifications.

Each liner repair will be recorded by the CQA Engineer in the Geomembrane Repair Testing Log including the date of repair, liner panel identification number, repair location, type of defect, cause of defect, and details of repairs made. Each repaired area will be required to pass non-destructive testing. Large repair areas may require destructive test sampling.

4.4.10 Daily Field Installation Reports

At the beginning of each day's work, the CQA Engineer shall provide the Engineer with Daily Field Installation Reports for all work accomplished on the previous work day. Reports shall include the following:

- Total amount and location of geomembrane placed;

- Total amount and location of seams and repairs completed, names of individuals doing seaming and repairing, and units used;
- Drawings of the previous day's installed geomembrane showing panel numbers and seam numbers;
- Results of pre-qualification test seams; and
- Results of non-destructive testing and field destructive testing.

4.4.11 Acceptance and Closeout Procedures

The CQA Engineer will communicate in writing to the Contractor and Owner when the requirements for geomembrane acceptance contained in the Technical Specifications have been completed.

Upon completion of cover system construction, the Contractor will submit a Letter of Acceptance from the Geosynthetics Installer to the Owner that the installation conforms to the requirements of the Manufacturer. The CQA Engineer will include this letter in the certification report.

5 Geocomposite Drainage Layer

5.1 Materials

The geocomposite drainage layer will consist of an HDPE geonet drainage core with nonwoven geotextiles heat bonded to each side, and will meet the requirements of Section 313220 of the Technical Specifications.

5.2 Geocomposite Manufacturer and Contractor

The Geosynthetics Installer is the party that performs installation of the geocomposite. The manufacturer is the party that supplies the geosynthetic products.

5.2.1 Manufacturer Submittals

The Contractor will submit the following as obtained from the geosynthetic manufacturer to the CQA Engineer:

- Manufacturer's product information and manufacturer quality control test results. The results of these tests must meet the minimum required physical properties for geocomposite specified in Table 313220-A of the Technical Specifications
- Manufacturer's installation instructions

5.2.2 Interface Friction Testing

The Contractor will submit representative samples of the proposed geocomposite to the CQA Engineer or a geosynthetic testing laboratory as directed by the CQA Engineer. The CQA Engineer will coordinate interface friction testing to evaluate the interface shear strength between the geocomposite and the overlying and underlying materials, as specified in the Technical Specifications.

5.3 Geocomposite Material Testing

Testing of geocomposite will consist of both MQC and conformance testing, described as follows.

5.3.1 Manufacturer Quality Control Testing

The manufacturer will sample and test the geocomposite material prior to shipment to the site, at minimum frequencies specified in the Technical Specifications. The CQA Engineer will verify that the requirements of the Technical Specifications are met.

5.3.2 Conformance Testing

The CQA Engineer will obtain samples for conformance testing. Samples may be obtained prior to shipment at the manufacturing facility. The minimum number of samples will be one per 100,000 ft^2 or 1 per lot, whichever provides the larger number of tests. Samples should extend across the full roll width and be at least 3 feet long.

The CQA Engineer will obtain representative samples of protective cover material for liner system construction or final cover soil for cover system construction to perform conformance testing of the soil/geotextile system.

Representative samples of the geocomposite and final cover material will be sent to a geosynthetics laboratory approved by the Engineer for conformance testing. The laboratory testing program will be coordinated by the CQA Engineer and include the following tests:

Table 5.3.2 - Conformance Testing Requirements of Geocomposite

TEST	METHOD	FREQUENCY
Thickness	ASTM D5199	One (1) test per 100,000 square feet
Density	ASTM D1505	
Ply Adhesion	ASTM D7005	
Transmissivity	ASTM D4716	
Hydraulic Conductivity Ratio (HCR) Testing of Soil/Geotextile Systems	ASTM D5567	Minimum of three (3) tests

If a representative sample does not comply with the requirements of Section 313220 of the Technical Specifications, the roll of geocomposite material that is in nonconformance will be replaced at no additional cost to the Owner. Additional conformance testing will be performed on the closest numerical roll on both sides of the failed roll. Sampling and testing of rolls will continue until a pattern of acceptable results is established.

The CQA Engineer will inventory the geocomposite rolls upon delivery to the site and report observed deviations from the requirements found in the Technical Specifications to the Contractor. At the CQA Engineer's discretion, the CQA Engineer will sample rolls from each shipment of geocomposite delivered to the site.

5.4 Geocomposite Installation

Each component of the geocomposite will be secured or seamed to the like component at overlaps. The geocomposite will be joined and repaired according to Section 313220 of the Technical Specifications. The CQA Engineer will observe geocomposite installation and repairs.

5.5 Acceptance and Closeout Procedures

The Geosynthetics Installer will observe and check all phases of the geocomposite installation. Upon completion of cover system construction, the Contractor will submit a Letter of Acceptance from the Geosynthetics Installer to the Owner that the installation conforms to the requirements of the Manufacturer. The CQA Engineer will include this letter in the certification report.

6 Nonwoven Geotextile

6.1 Materials

Nonwoven geotextile will meet the requirements of the Technical Specifications.

6.2 Geosynthetic Manufacturer and Contractor

The Geosynthetics Installer is the party that performs installation of the non-woven geotextile. The manufacturer is the party that supplies the geosynthetic products.

6.2.1 Manufacturer Submittals

The Contractor will submit manufacturer quality control test data to the CQA Engineer. The results of these tests must meet the minimum required physical and hydraulic properties for geotextile specified in Section 313240 of the Technical Specifications.

6.2.2 Interface Friction Testing

If required, the Contractor will submit representative samples of the proposed nonwoven geotextile to the CQA Engineer or a geosynthetic testing laboratory as directed by the CQA Engineer. The CQA Engineer will coordinate interface friction testing to evaluate the interface shear strength between the nonwoven geotextile and the overlying and underlying materials, as specified in the Technical Specifications.

6.3 Geotextile Material Testing

Geotextile will consist of both manufacturer quality control and conformance testing, described as follows.

6.3.1 Manufacturer Quality Control Testing

The manufacturer will sample and test the geotextile material prior to shipment to the site, at minimum frequencies specified in Section 313240 of the Technical Specifications.

6.3.2 Conformance Testing

The need for conformance testing will be as specified by the Engineer. If geotextiles testing is deemed necessary, it will be tested as described below.

The CQA Engineer will obtain samples for conformance testing. Samples may be obtained prior to shipment at the manufacturing facility. The minimum number of samples will be one per 100,000 ft^2 or 1 per lot, whichever provides the larger number of tests. Samples should extend across the full roll width and be at least 3 feet long.

Representative samples of the geotextile will be sent to a geosynthetics laboratory approved by the Engineer for conformance testing. The laboratory testing program will be coordinated by the CQA Engineer and include the tests in Table 8.3.2 below.

Table 6.3.2 - Laboratory Testing Requirements for Geotextiles

TEST	METHOD	FREQUENCY
Grab Tensile Strength	ASTM D4632	One (1) test per 100,000 square feet
Puncture Resistance	ASTM D4833	
Trapezodial Tear Strength	ASTM D4533	
Apparent Opening Size (AOS)	ASTM D4751	
Hydraulic Conductivity Ratio (HCR) Testing of Soil/Geotextile Systems	ASTM D5567	One per Combination of Materials

If a representative sample does not comply with the requirements of Section 313240 of the Technical Specifications, the roll of geotextile that is in nonconformance will be replaced at no additional cost to the Owner. Additional conformance testing will be performed on the closest numerical roll on both sides of

the failed roll. Sampling and testing of rolls will continue until a pattern of acceptable results is established.

The CQA Engineer will inventory the geotextile rolls upon delivery to the site and report observed deviations from the requirements found in the Technical Specifications to the Contractor. At the CQA Engineer's discretion, the CQA Engineer will sample rolls from each shipment of geotextile delivered to the site.

6.4 Geotextile Installation

The non-woven geotextile will be continuously sewn at the seams. Geotextiles will be overlapped a minimum of 6 inches overlap. Any holes or tears in the geotextile will be repaired with a patch made from the same geotextile. The CQA Engineer will monitor repairs.

7 Final Cover Soil and Vegetative Cover

The final cover soil and vegetative cover will be placed in accordance with Section 312000 of the Technical Specifications and this CQA Plan.

7.1 Construction

Final cover will be placed in accordance with a method to be approved by the Engineer. The CQA Engineer will monitor final cover placement.

Wrinkles in the geosynthetics resulting from final cover placement will be "walked out" prior to additional material placement. Excessive wrinkles will be observed by the CQA Engineer for possible repair by the Geosynthetics Installer.

When placing final cover, do not drive directly on the geosynthetic materials. Only use equipment to place, spread, and compact soil fill that produces ground pressures compliant with the following for minimum thickness over geosynthetic materials or as required by the Technical Specifications: less than 5 psi for overlying thickness of 12 inches and less than 10 psi for overlying thickness of 18 inches.

7.2 Testing

The final cover soil testing will consist of in-place and laboratory testing described as follows.

7.2.1 Laboratory Testing (Conformance Testing)

Bulk samples of the final cover will be obtained for each 10,000 cubic yards of soil placed. The CQA Engineer may reduce or increase the number of bulk samples needed depending on the variability of the soil being used. Laboratory testing will include but not be limited to the following properties:

Table 7.2.1 - Laboratory Testing Requirements of Final Cover Soil

TEST	METHOD	FREQUENCY
Moisture Content	ASTM D2216	One (1) test per 10,000 cubic yards
Particle Size	ASTM D422	
Liquid Limit, Plastic Limit, and Plasticity Index	ASTM D4318	

7.2.2 In-Place Testing

The thickness of the final cover soil will be randomly tested by the CQA Engineer to verify adequate coverage.

8 Record Drawings and Final Submittals

The Contractor will retain a third-party surveyor registered in the state that the work is performed. The Contractor will be responsible for submitting to the Engineer the following (as applicable):

- Existing Conditions Survey
- Final Conditions Survey
- Geomembrane Survey
- Material certification and warranty information for installed material and equipment

The existing and final conditions topographic surveys will be performed on a 50-foot grid with channels and breaks-in-slope also surveyed. Topographic surveys will be performed on the same grid such that survey point locations are consistent with the survey points of the underlying layer. Surveys will also include a table summarizing northings, eastings, and elevations for each grid point to provide a comparison for thickness verification. Surveys will also show contours of the completed surface at one-foot contour intervals.

The geomembrane as-built drawing will include panel corners, transitions in panel geometry, repair locations (including locations of samples taken for destructive seam testing), and other significant features. Survey timing should be coordinated with the Geosynthetics Installer and the CQA Engineer so as not to impact the construction schedule of the geosynthetics. This does not replace the required Panel Layout Shop Drawing to be submitted by the Contractor.

9 Certification Report

The CQA Engineer will prepare a certification report upon work completion. The certification report will contain test results and monitoring documentation performed for construction including:

- Compacted fill for all modifications
- Cover system geosynthetics installation including:
  - MQC data and test results
  - CQA data, test results, and documentation
- Geocomposite Drainage Layers
- Final cover soil

Record drawings and a narrative of the construction process and CQA activities will be included with the certification report. Color photographs of key elements for landfill construction will also be included in the certification report.