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April 28, 2016

Christine Ritter, P.G., Hydrogeologist
Division of Waste Management- Solid Waste Section
NC Department of Environmental Quality
1646 Mail Service Center
Raleigh, NC 27699-1646

**RE: Coastal Regional Solid Waste Management Authority's Tuscarora Landfill
Phase 4 Expansion Drilling Program
JOYCE Project No. 618.1602.12, Task No. 01**

Dear Christine:

On behalf of the Coastal Regional Solid Waste Management Authority (CRSWMA) Joyce Engineering (JOYCE) is submitting this drilling and sampling plan for the proposed Phase 4 MSW landfill expansion. This plan is prepared to address the requirements of the Rule .1623 for geologic and hydrogeologic investigations for MSW landfills.

The hydrogeologic field investigations will provide the data needed to complete the Design Hydrogeologic Report for the 17.7-acre Phase 4 expansion. This will include the installation of 11 piezometers within the proposed footprint of Phase 4 and six monitoring wells in the compliance area outside of the footprint for future monitoring of Phase 4. Most of the piezometers and wells will be constructed as nested pairs (one shallow and one deep in close proximity). The shallow wells/piezometers are expected to average 15 feet deep and will be screened in the upper-most aquifer, while the deeper wells/piezometers are expected to average 40 feet deep and will be screened in the deeper aquifer. Actual depths may vary based on conditions encountered during drilling. The attached drawing shows the approximate proposed locations of the wells and piezometers and the attached table summarizes the proposed drilling plan.

There are currently five existing monitoring wells inside the Phase 4 footprint and two more that are less than 20 feet outside of the footprint. The proposed new wells and piezometers will bring the total number of borings in (or very near) the footprint to 18, or 24 if the compliance area is included.

The proposed drilling plan is designed for a Geoprobe drill rig that can perform both direct-push and auger drilling. In lieu of continuous split-spoon sampling, we propose first collecting continuous Geoprobe soil cores to the desired total depth (typically 40 feet) at each drilling location, and then going back with hollow-stem augers to install the wells or piezometers. This will provide a more accurate determination of the stratigraphy, including identifying the clay

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aquitard which separates the upper and lower aquifers at this site. For locations with a nested pair, both the shallow and deep wells/piezometers will be drilled to a target depth and screened based on the stratigraphy observed in the soil core. During the auger drilling, we will collect one or two targeted split-spoon samples with Standard Penetration Test (STP) to confirm the characteristics of the soil. Shelby-tube samples will be collected for geotechnical testing from selected borings based on the soil core data.

Lithological and geotechnical data will be collected from the borings during drilling, including collection of approximately eight Shelby-tube samples for geotechnical laboratory testing. The Shelby-tube samples will be tested for the following parameters:

- Particle Size / Hydrometer Analysis (ASTM D 422);
- Water Content (ASTM D 2216);
- Unified Soil Classification (ASTM 2487);
- Atterberg Limits (ASTM D 4318);
- Flex Wall Permeameter (ASTM D 5084) (2-3 tests); and
- Consolidated Triaxial Shear (ASTM D 4767) (1 test).

One comprehensive set of groundwater level measurements will be obtained after the wells/piezometers are installed. These water level data, in conjunction with the historical water level data from the site, will be used to create a seasonal high water table and a long-term high water table map. Slug tests will be performed on selected wells/piezometers to determine the hydraulic conductivity of the shallow and deep aquifers.

These data will be used to demonstrate compliance with vertical separation requirements, establish foundation characteristics, and provide more detailed understanding of the hydrogeologic regime beneath the Phase 4 footprint. This information is needed for landfill design requirements and to aide in the design of an effective water quality monitoring system.

If you have any questions during your review of the proposed drilling plan, please contact either me or Van Burbach at (336) 323-0092.

Sincerely,
JOYCE ENGINEERING, INC.



Hannu Kemppinen, P.G.
Senior Project Consultant

Attachments: Table - Proposed Phase 4 Drilling Program
Drawing - Proposed Phase 4 Boring Locations

cc: Bobby Darden, CRSWMA
Alex Everhart, Joyce Engineering

CRSWMA Phase 4 - Proposed Drilling Program

Drilling Location	MW/PZ ID	Total Depth (Feet)	Screen (Feet)	Stick-up (Feet)	Geoprobe Cores	Split-spoons w SPTs	Shelby Tubes	Surface Completion
1	PZ-40 S	15	10	3		1-2		No
	PZ-40 D	40	10	3	60' continuous		2	No
2	PZ-41 S	15	10	3		1-2		No
	PZ-41 D	40	10	3	40' continuous		2	No
3	PZ-42 S	15	10	3		1-2		No
	PZ-42 D	40	10	3	60' continuous		2	No
4	PZ-43 S	15	10	3		1-2		No
	PZ-43 D	40	10	3	40' continuous		2	No
5	PZ-44 S	15	10	3		1-2		No
	PZ-44 D	40	10	3	40' continuous			No
6	PZ-45	15	10	3	20' continuous	1-2		No
7	MW-20 S	15	10	3	20' continuous			Yes
	MW-20 D	40	10	3	40' continuous			Yes
8	MW-21	15	10	3	20' continuous			Yes
9	MW-22 S	15	10	3	20' continuous			Yes
	MW-22 D	40	10	3	40' continuous			Yes
10	MW-23	15	10	3	20' continuous			Yes

TOTALS:	430	170	51	420	7-14	8	6
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Continuous Geoprobe cores in all deep borings and in three single shallow borings, followed by hollow-stem auger installation of wells/piezometers at each drilling location. One or two optional split-spoon samples with SPTs in selected auger borings. Shelby-tube samples in selected borings.
 (Note that two of the PZ and four shallow MW geoprobe cores will extend deeper than the PZ/Well will be installed.)

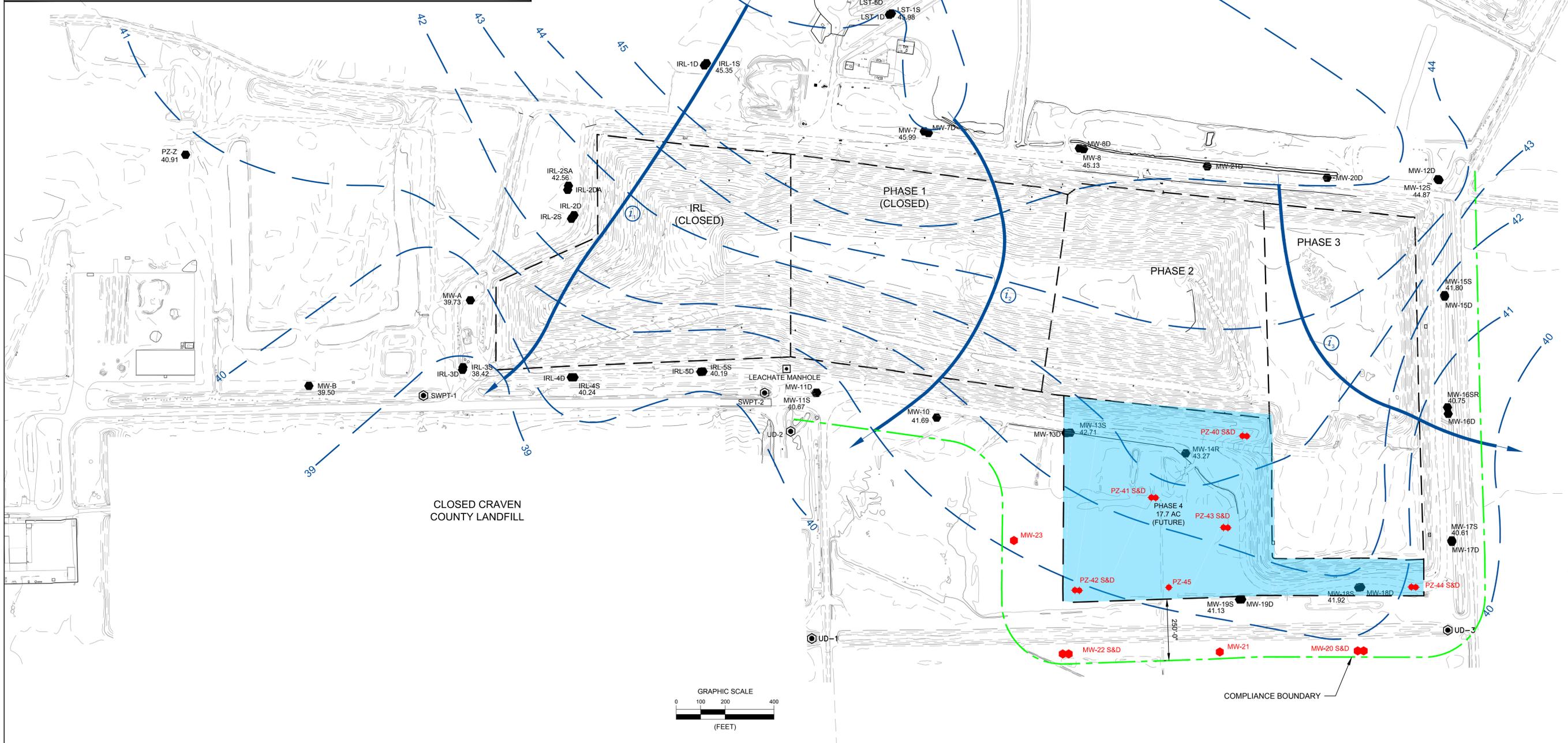
Total Geoprobe cores:	420	feet
Total HSA drilling with 1-2 split-spoons per boring:	90	feet
Total HSA drilling with geoprobe cores:	355	feet
Estimated total PVC pipe (screen & riser, including 3' stick-up):	496	feet

MW/PZ construction must be done inside of augers to avoid boring collapse.
 Surface completions for MWs include an above-ground steel cover and a 2'x2'x6" well pad.
 PZs will be left as PVC stick-up.

LEGEND

- POINT IN TIME GROUNDWATER CONTOUR (APPROXIMATE) 1 FT. CONTOUR INTERVAL
- GROUNDWATER FLOW PATHWAY USED TO CALCULATE HYDRAULIC GRADIENT
- SEGMENT USED FOR GRADIENT CALCULATION
- GROUNDWATER MONITORING WELL LOCATION, IDENTIFICATION, AND GROUNDWATER ELEVATION
- SURFACE WATER MONITORING LOCATIONS AND IDENTIFICATIONS
- LEACHATE MONITORING LOCATION AND IDENTIFICATION
- NOT MONITORED
- SEGMENT LENGTH
- NOTES

- EXISTING 10 FT CONTOUR
- EXISTING 2 FT CONTOUR
- GRAVEL ROAD
- PAVED ROAD
- EDGE OF LINER
- MW-10 41.69
- SWPT-1
- LEACHATE MANHOLE
- NM
- MW-21 PROPOSED MONITORING WELL LOCATION AND IDENTIFICATION
- PZ-45 PROPOSED PIEZOMETER LOCATION AND IDENTIFICATION
- $i_1 = 1,826$ LF
- $i_2 = 1,527$ LF
- $i_3 = 1,543$ LF
- 1. PIEZOMETERS AND MONITORING WELLS SCREENED IN THE DEEP AQUIFER DO NOT HAVE WATER LEVEL ELEVATION LABELS.
- 2. STATIC WATER LEVELS MEASURED ON OCTOBER 20 AND 21, 2015.
- 3. GROUNDWATER CONTOURS BASED ON LINEAR INTERPOLATION BETWEEN AND EXTRAPOLATION FROM KNOWN DATA, TOPOGRAPHIC CONTOURS, AND KNOWN FIELD CONDITIONS. THEREFORE, GROUNDWATER CONTOURS MUST BE ASSUMED TO BE APPROXIMATE.
- 4. GROUNDWATER ELEVATIONS ARE MEASURED IN FEET AND REFERENCED TO MEAN SEA LEVEL.



	NO. BY: CK APP
	REVISIONS AND RECORD OF ISSUE
	DATE
	DESIGNED: VB
	DRAWN: RWH
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<p>CRSWMMA: TUSCARORA LANDFILL TUSCARORA, NORTH CAROLINA</p> <p>PROPOSED MONITORING WELL AND PIEZOMETER LOCATION</p>	
<p>PROJECT NO. 618</p>	
<p>SCALE AS NOTED</p>	
<p>DRAWING NO. 1</p>	