



April 25, 2013

Mr. C. Brian Wootton,
Solid Waste Section
Division of Waste Management
NCDENR
1646 Mail Service Center
Raleigh, North Carolina 27699-1646

Subject: **City of Albemarle Landfill
MNA Sampling Schedule
DSWM Permit No. 84-01
Shield Project 1110192**

Dear Mr. Wootton:

Following a review of previous documentation concerning the monitored natural attenuation (MNA) sampling at the City of Albemarle Landfill and recent changes concerning this landfill, the purpose of this letter is to propose a revised MNA sampling schedule based on a rationale presented herein.

Background

As you are aware, two plume areas (i.e., West Plume and the East Plume) have been previously identified in the vicinity of the active C&D and the closed MSWLF site at the City of Albemarle Landfill. There are five monitoring wells (i.e., MW-2, MW-6, MW-7, MW-24, and MW-25: see Figure 1) in the area of the West Plume and three monitoring wells (i.e., MW-3, MW-9, and MW-10: see Figure 1) in the area of the East Plume. The Corrective Action Plan has already been prepared and approved by the Solid Waste Section (SWS). Corrective action was subsequently initiated for the West Plume several years ago. As part of the monitoring for these two plumes natural attenuation was evaluated, and a baseline MNA sampling for the two plume areas was completed in 2011.

These MNA baseline data were submitted to the SWS in a subsequent Corrective Action Effectiveness Report (CAER) dated April 21, 2011. Within this CAER the MNA analytical data



were presented in several tables. Subsequently, within this CAER a proposed long-term MNA sampling schedule was presented to the SWS for each of the two plumes (i.e., East and West Plumes). In response to this proposed long-term MNA sampling schedule, the SWS responded with an alternate sampling schedule for both of these two plumes in a letter dated July 11, 2011.

At this time Shield Engineering, Inc. (Shield) is currently performing the groundwater monitoring for the City of Albemarle Landfill. However, because of the recent purchase of the adjacent property located immediately west of the landfill, Shield revisited the sampling requirements outlined in previous documents. In so doing, we initially reviewed the MNA analytical data submitted to SWS in April 2011.

Review of MNA Baseline Data

In order to present a more complete understanding of the presence of anaerobic biodegradation within the subsurface and how such biodegradation within the subsurface is evolving, Shield prepared a composite evaluation of the MNA parameters using tools presented by the United States Environmental Protection Agency (EPA) in their publication *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water*, dated September 1998 (EPA/600/R-98/128). In Table 2.3 of this report a value weighting system was presented for screening of various anaerobic biodegradation processes within the subsurface. The weighting scores assigned to each parameter are cumulated into a composite score. This weighting system was applied to the four datasets for these MNA analytical baseline data. The results using this weighting system protocol on the baseline MNA data collected at the City of Albemarle Landfill are presented in the attached Table 1. The cumulative MNA weighting scores are presented for each well for each semi-annual sampling event.

Together these MNA weighting scores clearly show that the anaerobic biodegradation processes were becoming more evident within the subsurface environment over the two-year sampling period. The average MNA weighting score for the all of the monitoring wells in the West Plume increased by 39% over the two-year period, and in the East Plume the average MNA weighting score for the all of the monitoring wells increased by 25% over the same period. During the time

frame of the baseline sampling (i.e., July 2009 through January 2011) those wells that exhibited the presence of volatile organic constituents (VOCs) within the West Plume (i.e., MW-2, MW-6, and MW-7) also exhibited an increase in the rate of anaerobic biodegradation within the groundwater. Notably, the two wells (MW-24 and MW-25) that have consistently been showing non-detects for the VOCs, also exhibited limited evidence of anaerobic biodegradation for the West Plume (see Table 1). Hence, the MNA weighting scores shown in Table 1 correlate well with the cumulative analytical VOC data for the West Plume (see Table 2).

Within the East Plume anaerobic biodegradation was stronger at Monitoring Well MW-3, whereas the anaerobic degradation in Monitoring Well MW-10 was limited. Similar to the West Plume, these MNA weighting scores correlate with the presence of organic constituents in these same wells (see Table 2). For example, on average those wells exhibiting “strong evidence of anaerobic degradation” on Table 1 (i.e., shown as red cells, with MNA weighting scores above 20) have an average total VOC concentration of about 11 µg/l, whereas for those dates and wells that exhibit green and yellow cells on Table 1, the average total VOC concentrations are about 3 µg/l. Hence, with the continued sampling and analysis for VOCs in these same wells, and the strong correlation with anaerobic biodegradation processes, the semi-annual sampling event for VOCs is a good indicator of changing subsurface anaerobic conditions.

Current MNA Sampling Schedule

The usefulness of this MNA weighting score system is evident in that with a standardized procedure such as provided by EPA the changes of anaerobic biodegradation rates within the subsurface can be readily evaluated with a consistent documented approach. However, based on the current MNA sampling approach outlined by SWS in the July 11, 2011 letter, which was drafted in response to the CAER, the full set of MNA parameters will be assessed only once every six years. For all of the other preceding and succeeding semi-annual sampling events none of them will include an analysis for the full suite of MNA parameters. As a result it is not possible to fully evaluate the MNA weighting scores for these other sampling events, due to incomplete MNA data sets. These partial sets of analytical data for the MNA parameters do not lend themselves to a full and proper evaluation of anaerobic biodegradation within either of the

two plume areas. Such an evaluation can only be done once every six years. Hence, these partial data sets are of limited value for assessing anaerobic biodegradation within the subsurface. As a result these data will not tell us anything we do not already know.

MNA Sampling Frequency

In reviewing the MNA sampling frequency for both plumes the question has to be asked as to how many times does the City of Albemarle have to prove that anaerobic biodegradation is progressing within the subsurface? The baseline MNA data collected to date conclusively shows that these anaerobic processes are ongoing and are being sustained within the subsurface. Therefore, the MNA sampling frequency should be based on an ongoing reasonable monitoring program that incorporates other factors and recent property additions at the site.

Several factors ought to be incorporated into the process of determining the optimal or appropriate sampling frequency as follows (Refs.: EPA/600/R-98/128 [page 52] and *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, OSWER Directive 9200.4-17P [page 23]):

1. groundwater flow velocities;
2. hydraulic conductivity;
3. observable changes in subsurface geochemical conditions; and
4. VOC sampling schedule.

The first and the second factors are linked, since the hydraulic conductivity is used to calculate the groundwater flow velocity. Therefore these two factors are reviewed together for each of the two plumes below:

West Plume: The calculated groundwater flow velocities in the West Plume range from 1 to 20 feet per year (ft/yr) (see Groundwater Monitoring Reports). The field determined hydraulic conductivities for this area ranged from 3×10^{-6} to 4×10^{-5} centimeters per second (cm/sec). Within the West Plume there are two paired sets of wells (i.e., MW-2 & MW-25; and MW-7 & MW-24). The latter well in each of these pairs is downgradient of the former well. The distances between these two well pairs are 82 and 60 feet, respectively. Based on the average

groundwater flow velocity at each of these two pairs of wells the estimated travel time for groundwater from the upgradient well to the downgradient well ranges from 80 to 10 years. However, due to adsorption, biodegradation, dispersion the actual migration rate of VOCs within the groundwater is impeded to flow velocities less than those for groundwater. Additionally, the other major factor with respect to the West Plume, is that with the recent purchase of the adjacent property there is no likelihood of this plume migrating offsite.

Since the City of Albemarle has purchased the adjacent property and the semi-annual sampling is to be continued for the five monitoring wells in this plume, we recommend that every four years an evaluation should be made of the analytical results from the semi-annual sampling for the West Plume. If no significant changes are evident in these analytical results from the semi-annual sampling, then the semi-annual sampling should continue without any MNA sampling. However, if significant changes are evident from these analytical results there may be justification for conducting a sampling round for the full set of MNA parameters.

East Plume: The calculated groundwater flow velocities in the East Plume range from 50 to 120 feet per year (ft/yr) (see Groundwater Monitoring Reports). The field determined hydraulic conductivities for this area ranged from 7×10^{-5} to 3×10^{-4} cm/sec. Within the East Plume there are no paired sets of wells; that is where one well is downgradient of the other well. However based on the average groundwater flow velocity at each of these wells the estimated travel time for groundwater from the monitoring well to the unnamed tributary of Jacobs Creek ranges from ½ year to 2 years. However, due to adsorption, biodegradation, dispersion the migration of VOCs within the groundwater is impeded to flow velocities less than those for groundwater. The frequency of the sampling for MNA parameters should be of the order of every few years because of the slow migration of any VOCs within the groundwater. Hence, the frequency of the sampling for MNA parameters should be of the order of two years because of the slow migration of any VOCs within the groundwater; to sample for the full suite of MNA parameters any more frequently is redundant. Additionally, the City of Albemarle is planning to continue the semi-annual sampling of all of these wells.

The third and fourth factors presented above are also linked in that any changes of the geochemical conditions within the groundwater can be detected during the semi-annual VOC sampling event. Each of these semi-annual sampling events also includes the field parameters such as the dissolved oxygen, the oxidation reduction potential, specific conductivity, pH, and temperature. These parameters, in conjunction with the laboratory analytical data, provide the basis for determining changes within the subsurface geochemistry. Based on such changes the inclusion of an additional MNA sampling event could be included in the subsequent semi-annual sampling event, if the need was evident from the results of the regular sampling event.

Recommended MNA Sampling Frequency

Based on the above discussion, Shield is recommending the following changes to the MNA sampling frequency:

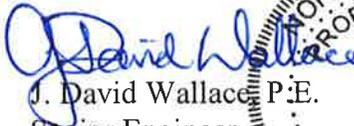
- collect samples and analyze for the full set of MNA parameters once every two years in Monitoring Wells MW-3, MW-9 and MW-10 within the East Plume.
- between the biannual MNA sampling events for the East Plume continue collecting the VOC analytical data at the semi-annual sampling events with field parameters.
- evaluate the analytical results from the semi-annual sampling for any significant changes in the West Plume after four years of sampling for VOCs and determine whether there is a need for the full set of MNA parameters to be collected from Monitoring Wells MW-2, MW-6, MW-7, MW-24, and MW-25 within the West Plume.
- continue to evaluate the subsurface geochemistry for significant changes (based on both the field parameters and the total VOCs) that may predicate the need for an additional sampling for the full set of MNA parameters in either plume.

Both the City of Albemarle and Shield believe the above sampling recommendations are better suited to the estimated groundwater flow velocities in the area of the respective plumes, and will provide more useful and complete data sets that will allow for more frequent full assessments when needed, of the ongoing anaerobic biodegradation within the subsurface in each of these two plume areas. Additionally, this proposed sampling schedule recognizes the impact of the recent property purchase adjacent to the existing site.

We appreciate your consideration of this matter and look forward to receiving a positive response to these proposed recommendations prior to our next sampling event in July 2013.

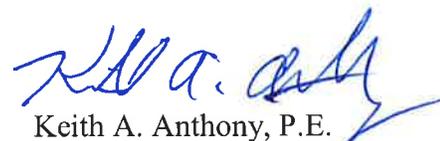
If you should have any questions please do not hesitate to contact David Wallace either by e-mail at dwallace@shieldengineering.com or by phone at 704-394-6913.

Sincerely,
SHIELD ENGINEERING, INC.


J. David Wallace, P.E.
Senior Engineer



The seal is circular with a double-line border. The outer ring contains the text "NORTH CAROLINA" at the top and "ENGINEER" at the bottom. The inner ring contains "PROFESSIONAL" at the top and "J. DAVID WALLACE" at the bottom. In the center, it says "SEAL" and "20055".


Keith A. Anthony, P.E.
Chief Engineer

JDW/KAA

cc: Mr. Ervin Lane, Solid Waste Section, DWM
Mr. Mike E. Lambert, Public Works Director
Ms. Nina Underwood, Assistant Public Works Director
Mr. Darren Preslar, Landfill Superintendent

TABLE 1
SUMMARY OF NATURAL ATTENUATION DATA
CITY OF ALBEMARLE LANDFILL
ALBEMARLE, NORTH CAROLINA

Well Grouping	Well ID	ANAEROBIC BIODEGRADATION SCORES				
		Date	Jul-09	Jan-10	Jul-10	Jan-11
Background Well	MW-1		10	7	15	7
	MW-2		10	17	24	19
WEST PLUME	MW-6		14	10	14	21
	MW-7		19	19	25	24
	MW-24		14	13	12	16
	MW-25		10	17	20	13
EAST PLUME	MW-3		9	15	22	28
	MW-9		19	14	27	17
	MW-10		16	12	19	10

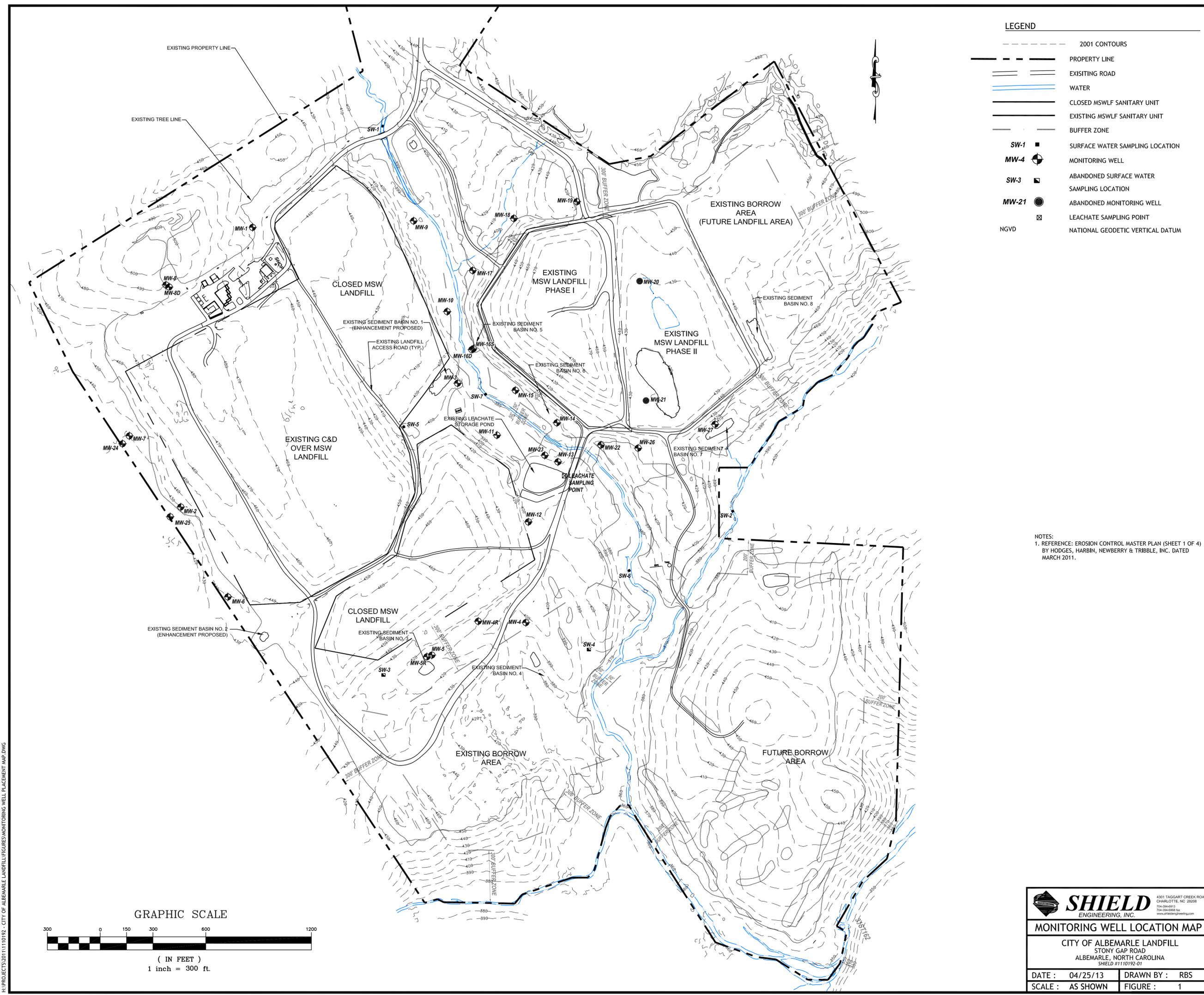
Reference: *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water, September 1998 (EPA/600/R-98/128)*

TOTAL SCORE FOR ASSESSING ANAEROBIC BIODEGRADATION

<6	Inadequate evidence for anaerobic degradation
6 - 14	Limited evidence for anaerobic degradation
15 - 20	Adequate evidence for anaerobic degradation
>20	Strong evidence for anaerobic degradation

TABLE 2
SUMMARY OF TOTAL VOC DATA
CITY OF ALBEMARLE LANDFILL
ALBEMARLE, NORTH CAROLINA

Well Grouping	Well ID	TOTAL VOC CONCENTRATIONS (µg/l)				
		Date	Jul-09	Jan-10	Jul-10	Jan-11
Background Well	MW-1		0	0	8	0
	MW-2		0.72	0	0.59	0.51
WEST PLUME	MW-6		13.32	2.45	27.06	18.99
	MW-7		12.4	16.03	18.34	14.02
	MW-24		0	0	0	0
	MW-25		0	0	0	0
EAST PLUME	MW-3		0.31	0	4.8	5.17
	MW-9		2.96	0	11.95	0
	MW-10		0	0	0	0



LEGEND

	2001 CONTOURS
	PROPERTY LINE
	EXISTING ROAD
	WATER
	CLOSED MSWLF SANITARY UNIT
	EXISTING MSWLF SANITARY UNIT
	BUFFER ZONE
	SW-1 SURFACE WATER SAMPLING LOCATION
	MW-4 MONITORING WELL
	SW-3 ABANDONED SURFACE WATER SAMPLING LOCATION
	MW-21 ABANDONED MONITORING WELL
	LEACHATE SAMPLING POINT
	NGVD NATIONAL GEODETIC VERTICAL DATUM

NOTES:
 1. REFERENCE: EROSION CONTROL MASTER PLAN (SHEET 1 OF 4) BY HODGES, HARBIN, NEWBERRY & TRIBBLE, INC. DATED MARCH 2011.

GRAPHIC SCALE



(IN FEET)
 1 inch = 300 ft.

H:\PROJECTS\2011\110192 - CITY OF ALBEMARLE LANDFILL\FIGURES\MONITORING WELL PLACEMENT MAP.DWG

		4301 TAGGART CREEK ROAD CHARLOTTE, NC 28208 704-384-0913 704-384-0988 fax www.shieldengineering.com	
		MONITORING WELL LOCATION MAP CITY OF ALBEMARLE LANDFILL STONY GAP ROAD ALBEMARLE, NORTH CAROLINA SHIELD #110192-01	
DATE :	04/25/13	DRAWN BY :	RBS
SCALE :	AS SHOWN	FIGURE :	1