David Garrett & Associates
Engineering and Geology

July 13, 2009

Mr. Ed Mussler, P.E., Permitting Branch Head
NC DENR Division of Waste Management
Solid Waste Section
401 Oberlin Road
Raleigh, North Carolina, 27611

APPROVED
DIVISION OF WASTE MANAGEMENT
SOLID WASTE SECTION
DATE 7/15/09 BY Brian Wootton Hydrogeologist
Tracking # 7998

RE: **Supplement to Design Hydrogeologic Report**
Landfill Gas Monitoring Plan
CMS-V MSWLF Facility Phase 3 (PTC Application)
Concord (Cabarrus County), North Carolina
NC DENR Solid Waste Permit #13-04

Dear Mr. Mussler:

On behalf of BFI Waste Systems of North America, Inc. (a subsidiary of Republic Services), I am pleased to present the following amendment to the referenced application. This document was prepared in response to the Solid Waste Section's review comments and is presented in conjunction with the May 2009 update of the Water Quality Monitoring Plan (already submitted). It should be pointed out that the Solid Waste Rules, 15A NCAC 13B .1626, i.e., the Operational Requirements for MSWLF facilities, prescribe the maximum thresholds for explosive gas limits around the facility but do not address the requirements *per se* for landfill gas monitoring locations, monitoring well (i.e., gas probe) depths, methodologies, and sampling procedures.

I understand new SWS guidelines are pending, however in anticipation of those guidelines, this document is presented as a standalone supplement to the facility monitoring program (described in the May 2009 Water Quality Monitoring Plan, Rev. 4.1) and, thus, I have shown relevant gas monitoring locations on the enclosed update of Drawing MP-1. **This amendment does not modify the previously submitted ground water monitoring plan at this facility.** This plan is a work in progress and may require adjustment during or after construction of Phase 3. Further plan modifications, if needed, may warrant a future revision of the WQMP.

Please contact me if I can provide any needed clarification or if you have comments.

Sincerely,

G. David Garrett, P.G., P.E.
Consulting Engineer

cc: Mr. Mike Gurley – Environmental Manager, BFI Waste Systems of North America
Mr. Brian Wootton – NCDENR Division of Waste Management, Solid Waste Section

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Landfill Gas Management and Monitoring

Landfill gas is a by-product from the decomposition of organic waste in a sanitary landfill, which typically includes methane, carbon dioxide, hydrogen sulfide, water, and other constituents. Methane can be explosive under certain conditions, and landfill gas migration has been known to transfer certain contaminants into ground water. The Solid Waste Rules typically focus on the explosive properties of landfill gas from a public safety standpoint. Subsurface gas normally migrates above the ground water table and is restricted laterally by streams. Pipelines or trenches (which exist nearby) can serve as potential conduits for off-site landfill gas migration; although the on-site soils existing just above the bedrock are very porous and can potentially serve as gas migration pathways. No occupied structures exist off-site that appear to be at risk for gas migration.

Active gas recovery is the primary means of controlling gas at this facility. A network of recovery wells installed through the cap of inactive portions of the landfill is connected to two blower stations equipped with flares and dewatering units, which feed an on-site waste-to-energy facility (designed by others). In addition, monitoring of subsurface soil-gas adjacent to the landfill is accomplished at pre-determined locations via either bar-hole punch tests or gas monitoring probes, the latter of which are identified in the facility drawings as "MMW" for methane monitoring wells (see **Drawing MP-1**). It should be noted that the piping for the gas recovery system surrounds the landfill and is a likely source of gas introduced to the subsurface, rather than suspecting a leak in the cell liner.

The methane monitoring wells (landfill gas probes) are installed above the water table using construction techniques that are otherwise similar to ground water monitoring wells (see Figure 2 in the May 2009 WQMP Update). Components of the active gas recovery system (shown in construction drawings by others) are not to be monitored. Landfill gas monitoring will be performed during the active life of the landfill and throughout the post-closure care period. **Quarterly monitoring will be conducted** at all subsurface gas detection locations and in all occupied structures located on the landfill property. Alternatively, the buildings may be equipped with continuous explosive gas detection devices. Depending on the sampling data, future additional monitoring and/or remedial measures may be required.

Regulatory Requirements

NCAC 15A 13B .1646 (4) (a) requires monitoring for the following explosive gas limits:

- 25% of the Lower Explosive Limit (LEL, defined as 5% methane in standard atmosphere) within occupied structures – excluding the gas recovery systems
- 100% LEL at the facility boundary
- No detectable concentration at off-site occupied structures.

The rules require monitoring but they do not specify what devices or procedures are to be used – typically repetitive monitoring of the same locations is performed.

Monitoring Location Criteria

Gas migration is a process of diffusion through porous media, affected by porosity and permeability, similar to ground water within an unconfined or partly confined soil aquifer. For gas, pressures and concentrations are higher near the source and gradually decrease with distance – unless a distinct conduit is present – thus a "halo effect" is often discernable. The gas can be confined in the soil by lower permeability clay layers and saturated layers – impermeable to gas – that can occur either above or below the porous layer. At the project site, horizontal permeability for ground water flow appears to exceed vertical permeability, due in part to the shape of the saprolite (PWR) aquifer as it conforms to the topography and upper bedrock surface, ostensibly this relationship holds true for gas. The unsaturated saprolite is the likely gas conveyance – along with known pipelines contained in this layer – and is the target of the gas monitoring plan.

Placement of well screens for gas monitoring above the water table is standard practice. The required horizontal placement for gas monitoring appurtenances (either wells or bar-hole punch locations) is not defined. Considering the similarities of gas migration to ground water, with a compliance boundary established at property lines, a sensible criteria for test locations is outside the perimeter of any gas conveyances (such as recovery system pipelines) and approximately half the distance from the source to the compliance boundary – or no more than 150 feet if the property line is more than 300 feet from the source – thus establishing a review boundary. Gas monitoring locations for Phase 3, shown on **Drawing MP-1** (**Attachment 1**), adhere to these criteria.

Monitoring Devices and Procedures

Equipment: A portable gas monitoring device, e.g., an Organic Vapor Analyzer (OVA) or Photo-Ion Detector (PID) – or gas-specific monitoring meters (recommended), which can be calibrated to methane using the manufacturer's calibration kit and procedures – shall be used to measure the concentration of combustible gases at the sampling locations. Concentrations shall be reported in units of percent methane or percent of the lower explosive limit (LEL), i.e., the lowest percent by volume of a mixture of combustible gas in air that will propagate a flame at 25 degrees Celsius and atmospheric pressure. The LEL for methane is approximately 5%. General sampling procedures are discussed below, relative to different types of monitoring appurtenances and locations, but the instructions for the specific monitoring device should be followed.

Occupied Buildings: Gas monitoring in on-site structures will be conducted during regular quarterly monitoring events at the earliest possible time after the structure has been unused (e.g., early morning). The monitoring locations will be in corners along floors and ceilings, at cracks in the floor, and at other areas likely to accumulate gas. Alternatively, the buildings may be equipped with continuous explosive gas detection devices. Gas monitoring will also be conducted in any confined space requiring the entry of personnel for maintenance or inspection. The monitoring will take place prior to entry by personnel in accordance with OSHA regulations.

Bar-Hole Punch Locations: Gas monitoring in bar-hole punches will consist of punching a hole with a 3-foot probe. Tubing that is open-ended and perforated on the bottom should be placed in the bottom of the hole, taking care not to plug the bottom of the tubing with soil. The peak methane reading should then be recorded for each bar-hole probe location. Due to the required monitoring depths, the use of bar-hole punch tests is not recommended for this site.

Gas Monitoring Wells: Also called "landfill gas probes" or "methane monitoring wells", appropriate monitoring depths for this site have been established as 15 feet, or the water table, whichever is encountered first, which implies the need for permanent gas monitoring wells. Each gas monitoring well will be constructed with a 10-foot screen interval sealed below a bentonite plug, similar to ground water monitoring well construction, with appropriate stickups for visibility and locking covers. During gas sampling, each well shall be "sniffed" with a gas meter (calibrated for methane) equipped with a probe or open-ended tube that can inserted beneath the well cap that is opened just slightly (to prevent accumulated gas from escaping). Readings should be taken over a five-minute period (or as recommended by the equipment manufacturer) and the peak methane reading should then be recorded, either as percent methane or percent LEL, depending on the meter output.

Monitoring Well Head-Space: The well heads of ground water monitoring wells should be sampled for gas, using similar procedures described above, during routine ground water monitoring events.

Record Keeping: The sampling technician shall record the date, time, location, sampling personnel, atmospheric temperature, reported barometric pressure, and general weather conditions at the time of sampling, in addition to the concentration of combustible gases – see example **Landfill Gas Monitoring Field Log** (**Attachment 2**). The records will be maintained in the landfill operating record.

Contingency Plan

NCAC 15A 13B .1646 (4) (c) specifies that, upon detection of methane exceeding the threshold values (described above), the facility management must perform the following:

- Immediately take all steps required to protect human health and notify the Division

- Within seven days place in the operating record a report of the methane gas levels (and the location of the detection), along with a description of the response to protect human health

- Within 60 days implement a remediation plan for the methane gas release, place a copy of the plan in the Operating Record and notify the Division that the plan has been implemented – the plan shall describe the nature and extent of the problem and the proposed remedy.

Monitoring Locations

Refer to **Table 1** following this test and **Drawing MP-1**.

Monitoring Schedule

Gas detection monitoring at the approved monitoring locations shall commence within the first quarter following the opening of a cell and shall be conducted quarterly thereafter. An alternative monitoring schedule may be required by the Division in response to a detection (see **Contingency Plan**), after initial measures have been taken to safeguard human health and implement a remedy.

Certification

This landfill gas monitoring plan has been prepared by a qualified geologist who is licensed to practice in the State of North Carolina. The monitoring plan has been prepared based on knowledge of site conditions and familiarity with North Carolina solid waste rules and industry standard protocol. This monitoring plan should provide early detection of explosive gas migration into the soils around the landfill, so as to be protective of public health and the environment. No other warranties, expressed or implied, are made.

Signed_____

Printed G. DAVID GARRETT

Date July 13, 2009

NORTH CAROLINA LICENSED SEAL 983 GEOLOGIST G. DAVID GARRETT

Not valid unless this document bears the seal of the above-named licensed professional.

Revisions

This document amends the following revision of the Water Quality Monitoring Plan:

4.1 Sampling and Analysis Plan with
Location and Methods Amendments
CMS Landfill V – Phase 3 (Cells 2I – 2M)
May 18, 2008 (Updated PTC Submittal)

Table 1
Summary of Gas Monitoring Locations

See Drawing MP-1

Existing Methane Monitoring Wells

MMW-1	Near Cell 1A
MMW-2	Near Cell 1B
MMW-3	Near Cell 2A
MMW-4	Near Cell 2C
MMW-5	Near Cell 2E
MMW-6	Near Cell 2F

Proposed Methane Monitoring Wells

MMW-7	Near Cell 2G
MMW-8	Near Cell 2H
MMW-9	Near Cell 2I
MMW-10	Near Cell 2J
MMW-11	Near Cell 2K
MMW-12	Near Cell 2H

Existing or Proposed Methane Monitoring Wells*

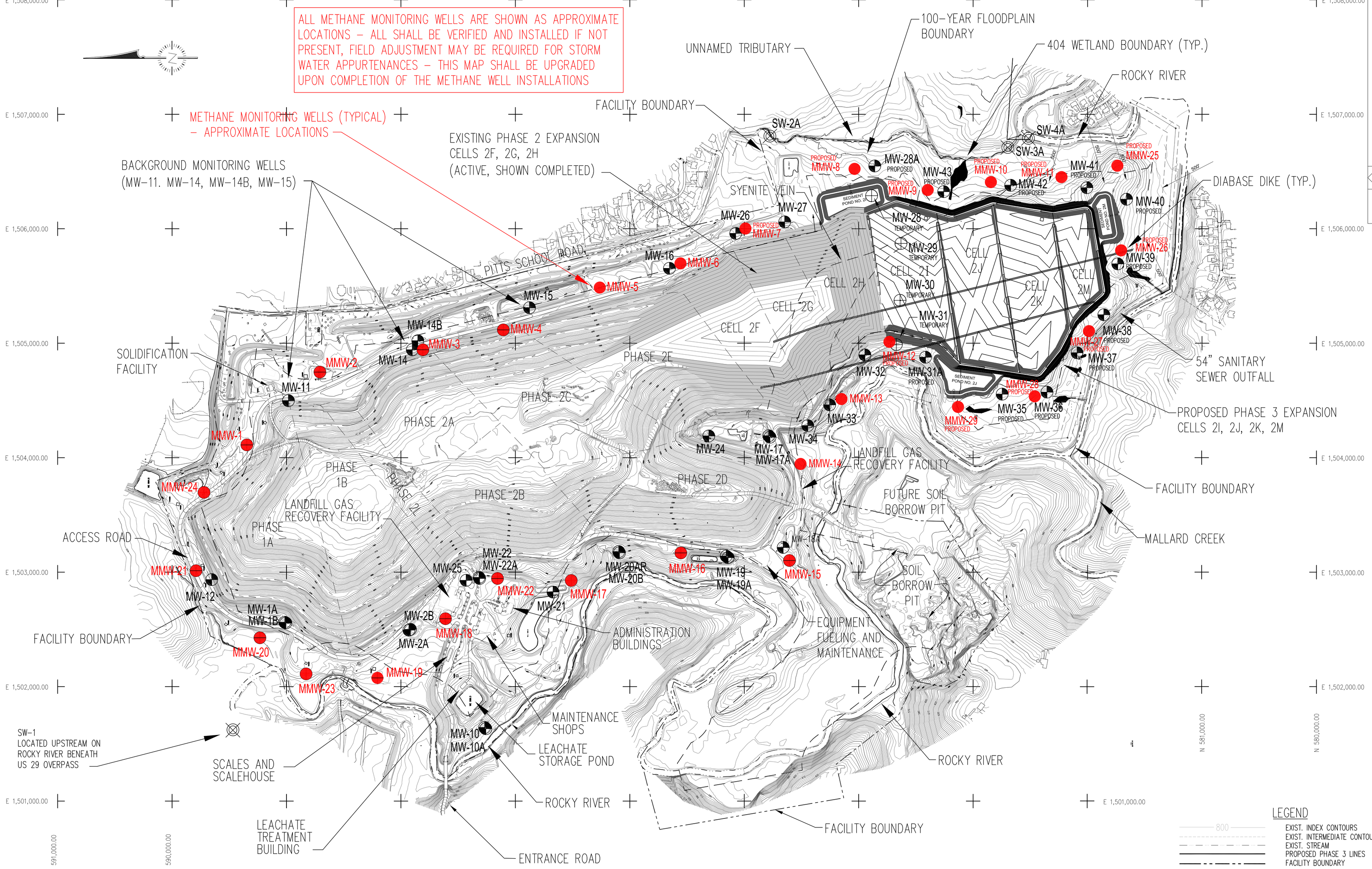
MMW-13	Near Cell 2G
MMW-14	Near Cell 2E and new gas works
MMW-15	Near Cell 2D
MMW-16	Near Cell 2D
MMW-17	Near Cell 2B
MMW-18	Near Cell 1B and old gas works
MMW-19	Near Cell 1B
MMW-20	Near Cell 1A
MMW-21	Near Cell 1A
MMW-22	Near Cell 2B
MMW-23	Near Cell 1A
MMW-24	Near Cell 1A

Proposed Methane Monitoring Wells

MMW-25	Near Cell 2M
MMW-26	Near Cell 2M
MMW-27	Near Cell 2K
MMW-28	Near Cell 2K
MMW-29	Near Cell 2J

*These show as proposed on older facility plan maps – to be verified or installed as needed; all well depths will be gauged and recorded concurrent with opening Phase 3

ALL METHANE MONITORING WELLS ARE SHOWN AS APPROXIMATE LOCATIONS – ALL SHALL BE VERIFIED AND INSTALLED IF NOT PRESENT, FIELD ADJUSTMENT MAY BE REQUIRED FOR STORM WATER APPURTENANCES – THIS MAP SHALL BE UPGRADED UPON COMPLETION OF THE METHANE WELL INSTALLATIONS



GENERAL NOTES:

1. TOPOGRAPHIC INFORMATION PROVIDED BY IMC, DATE OF PHOTOGRAPHY FEBRUARY 3, 2009.
2. SITE BOUNDARY INFORMATION PROVIDED BY ESP ASSOCIATES, P.A., SURVEY DATED JUNE 11, 2003.
3. FLOODPLAIN DATA OBTAINED FROM F.E.M.A. F.I.R.M. MAP # 37025C0115 D, DATED NOVEMBER 2, 1994.

LEGEND

800	EXIST. INDEX CONTOURS
	EXIST. INTERMEDIATE CONTOURS
	EXIST. STREAM
	PROPOSED PHASE 3 LINES
	FACILITY BOUNDARY
MW-40	MONITORING WELL (PROPOSED AS NOTED)
MMW-12	METHANE MONITORING WELL (PROPOSED AS NOTED)
SW-4A	SURFACE WATER SAMPLING LOCATION

0 400' 800' 1200'
1" = 400'

NO.	DATE	REVISION
2	6-30-09	ADDED LANDFILL GAS MONITORING WELL LOCATIONS
1	5-6-09	ADJUSTED PHASE 3 MONITORING WELLS PER HHNT PLANS

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SEAL: NORTH CAROLINA REGISTERED PROFESSIONAL ENGINEER DAVID GARRETT 6-20-2009

SEAL: NORTH CAROLINA REGISTERED PROFESSIONAL GEOLOGIST DAVID GARRETT 6-30-2009

PROJECT TITLE: CMS V MSWLF PHASE 3 DESIGN HYDROGEOLOGIC REPORT PERMIT #13-04 CABARRUS COUNTY, NORTH CAROLINA

DRAWING TITLE: FACILITY MONITORING PLAN GROUND WATER AND GAS SAMPLING LOCATIONS

DESIGNED BY: G.D.G.	DRAWN BY: A.W.H.
CHECKED BY: G.D.G.	PROJECT NO.: CMS-3
SCALE: AS SHOWN	DATE: FEBRUARY 2008
FILE NAME: CMS-3 MONITORING PLAN	
SHEET NO. 9	DRAWING NO. MP1

E:\H&H-CAD\DGARRETT\CMS-3\SHEETS\CMS-3 MONITORING PLAN.dwg DATE: JUN 20, 2008 TIME: 2:34 PM

DATE: _____

BOUNDARY PROBE MONITORING LOG

Project Name: _____ **Project Number:** _____

Site Contact: _____ **Technician(s):** _____

Starting Temperature: _____ **End Temperature:** _____

Starting Barometric Pressure: _____ **End Barometric Pressure:** _____

Monitoring Equipment: _____

Probe No.	% Methane (CH_4)	% Carbon Dioxide (CO_2)	% Oxygen (O_2)	% Balance Gas	Static Pressure (inches of water)	Comments

Completed by: _____