BLE INC.
BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL, ENVIRONMENTAL AND CONSTRUCTION MATERIALS CONSULTANTS

October 20, 2008

Macon County Solid Waste Management Department
C/O McGill Associates, P.A.
55 Broad Street
Asheville, North Carolina 28801

Attention: Mr. Jeffrey R. Bishop, P.E.

Subject: **Assessment of Corrective Measures**
Macon County Landfill, Permit #57-03
Franklin, North Carolina
BLE Project Number J08-1101-04

Mr. Bishop:

Bunnell-Lammons Engineering, Inc. (BLE) has completed the Assessment of Corrective Measures for the Macon County Landfill in response to the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Waste Management (NCDWM) letter dated March 13, 2008. This report addresses the relevant requirements as outlined in the NCDENR Solid Waste Management Rules, Title 15A Section 13B .1635. The attached report describes the work performed and presents the results obtained. This report should be submitted to the NCDENR as required.

We appreciate the opportunity to serve as your geological and hydrogeological consultant on this project and look forward to continuing to work with you at the Macon County Landfill. If you have any questions, please contact us at (864) 288-1265.

Sincerely,

BUNNELL-LAMMONS ENGINEERING, INC.

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1.0 INTRODUCTION

1.1 Site Information

Macon County owns and operates an active recycling center and solid waste disposal facility at 1448 Lakeside Drive in Franklin, North Carolina (Figure 1). The Macon County Landfill consists of a completed inactive waste area (Phase 1 cell) in the southwestern portion of the property, and an active cell (Phase 2 cell) situated northeast of the inactive area. The Little Tennessee River is located to the north-northwest of the site. The facility includes a network of groundwater monitoring wells (Figures 2 and 3) which are sampled semi-annually in accordance with the facility permit. Groundwater sampling and reporting is currently performed by REI Consultants, Inc (REIC) under contract with Macon County. In addition to the groundwater monitoring wells, the site includes 14 landfill gas monitoring wells located at strategic points within the landfill facility boundary which are monitored quarterly.

Based on the continued detection of volatile organic compounds in two monitoring wells (MW-1A and MW-1B) which exceed North Carolina groundwater standards promulgated under NCAC Title 15A 02L .0202 (2L Standards), the NCDENR required the facility to initiate an assessment monitoring program. The county was notified of the requirement in a NCDENR letter dated August 24, 2007. The county was required to submit a groundwater assessment plan to the NCDENR within 30 days of the receipt of the letter. BLE was retained by Macon County to prepare the work plan which was submitted to the NCDENR on September 13, 2007 (*Groundwater Contamination Assessment Plan,* BLE Project No. J07-1101-02). The work plan was approved by NCDENR on September 14, 2007 in a letter to Mr. Chris Stahl of Macon County. BLE was retained by Macon County to perform the required assessment defined in the approved work plan.

BLE installed three (3) groundwater monitoring wells (MW-23, MW-1D, and MW-5D) from September 12, 2007 through September 20, 2007 (Table 1 & Figure 3). REIC collected groundwater samples from each of the newly installed wells and previously existing wells on October 16, 2007. Laboratory analysis results indicated that low levels of Appendix I VOCs were detected above the Solid Waste Section Limits (SWSL) in monitoring wells MW-1A, MW-1B, MW-1D, and MW-5D (Table 2). Appendix I VOCs were not detected above the SWSL in the remaining wells including the downgradient well, MW-23.

We concluded that a release of VOCs into the groundwater had occurred at the site and impacted a localized area west-northwest of the Phase 1/Phase 2 cell overlap. The horizontal and vertical extent of the release appeared to be defined with the data collected from the new assessment wells MW-5D, MW-1D, and MW-23. Areas southwest (MW-2 & MW-3A), northeast (MW-22 & MW-22A), and southeast (MW-17 background) had not been affected. Since areas downgradient of the release (MW-23) had not been affected we concluded that it was unlikely that the Little Tennessee River (potential receptor) had been impacted.

As a result of these findings, we recommended that the water quality monitoring plan for the landfill be amended to include substitution of the MW-5D for MW-5 which is often dry. We also recommended that MW-1D and MW-23 be added to the semi-annual monitoring plan for assessment

purposes only and that Appendix II sampling be discontinued since no evidence of a release of Appendix II compounds from the landfill had been confirmed.

We also recommended that no further assessment be performed since the affected groundwater is limited in extent, appeared to be confined to the landfill property, and no receptors appeared to be affected. Furthermore we did not recommend implementation of corrective action for this release beyond the changes to the groundwater quality monitoring plan recommended above.

The NCDENR responded to the assessment report in two letters to Macon County dated March 13, 2008 and June 13, 2008. The letters stated that the NCDENR agreed with some of BLE's recommendations with notable exception being the requirement for the performance of an Assessment of Corrective Measures (ACM) report and subsequent implementation of an approved remedial remedy (corrective action). The NCDENR established a September 15, 2008 deadline for submittal of an ACM report, which was later revised to October 31, 2008.

Macon County retained BLE to prepare the ACM report. The ACM is presented below.

ACM PURPOSE AND PROPOSED REMEDY

The purpose of this ACM is to document the extent and environmental impact of a release of contaminants in groundwater and to select an appropriate remedy (corrective measure) to return the site to compliance. As outlined in the NCDENR Solid Waste Management Rules, Title 15A Section 13B .1635(c)(1-4), the ACM is required to include data and analysis of many factors which may influence the selection and implementation of potential remedies. These factors include (but are not limited to): estimations of performance, reliability, ease of implementation, and possible impacts of potential remedies; time required to begin and complete the remedy; the costs of remedy implementation; environmental or public health impact; and state and local permit requirements. The extent and environmental impact of the release has been evaluated, however, an appropriate remedy must be selected and evaluated for feasibility.

Once prepared and submitted, the ACM must be approved by the NCDENR in conjunction with the public (via public notice and meeting). Once approved, an application describing the selected remedy should be submitted to the NCDENR for evaluation and approval.

2.0 ASSESSMENT OF CORRECTIVE MEASURES

The NCDENR Solid Waste Management has requested that an assessment of corrective measures be performed on the subject site according to Title 15A Section 13B .1635. Title 15A Section 13B .1635(c)(1-4) specifies the requirements for selecting a remedial solution to the site's contamination. The information provided below addresses the aforementioned NCDENR Solid Waste Management Rules and provides recommendations for selection for of a remedial remedy.

2.1 Evaluation of Remedial Alternatives

Several remedial alternatives were evaluated based on site-specific information, including the geologic and hydrogeologic properties of the site and the nature and extent of contamination. The remedial alternatives evaluated included soil and landfill gas remediation and groundwater remediation.

2.1.1 Soil and Landfill Gas Remediation

Numerous soil and soil gas treatment alternatives have been used at contaminated sites, as shown below.

In-situ Technologies:
- Volatilization (soil vapor extraction and /or two-phase vacuum extraction)
- Bioremediation
- Passive Gas Venting
- Soil Leaching (flushing)
- Isolation/Containment
- Vitrification
- Monitored Natural Attenuation

Ex-situ Technologies:
- Excavation and Off-Site Disposal
- Surface Bioremediation
- Enhanced Bioremediation
- Low Temperature Thermal
- High Temperature Thermal
- Beneficial Reuse
- Chemical Extraction
- Solidification/Stabilization
- Isolation/Containment

All of these remedial approaches may not be applicable to the Macon County Landfill site. Options common to similar sites are described below.

2.1.1.1 Bioventing and Soil Vapor Extraction

"In-situ" volatilization and subsequent air stripping can remove VOCs in the unsaturated soil zone. Two types of processes can be utilized for this purpose. One method forces air into the soil by an infiltrating vent and pressure pump (bioventing). The other method removes vapors by creating a vacuum in the vadose zone through extraction wells (soil vapor extraction).

The limitations of soil venting are associated with soil characteristics that impede free movement of vapors to the extraction well (low permeability soil such as clay), emissions of volatiles, and explosion hazards. Low permeability soils can be vented utilizing closely spaced venting wells.

Once removed from the subsurface soil pore spaces, the VOCs are emitted to the atmosphere. In some cases, such as those performed within close proximity to populated areas, off-gas treatment is required prior to discharge. Explosion hazards can be overcome by using intrinsically safe equipment and insuring that adequate volumes of air are moved through the system to keep vapor concentrations below the lower explosive limit (LEL).

This remedial alternative is effective for the removal of VOCs such as those detected on site. However, because of the low concentrations of constituents in the affected area and the uncertainty of source locations in the vadose zone, the use of the technology is not recommended at the Macon County Landfill site.

2.1.1.2 Bioremediation

Bioremediation involves artificial measures to enhance the bacteriological activity that naturally degrades organic compounds in soil. The enhancement activities may include supplementing the existing natural bacteria, providing nutrients and/or oxygen needed for the bacterial action and/or controlling the soil pH or moisture content. Usually in-situ bioremediation requires simultaneous collection of groundwater to control the migration of bacteria and nutrients which are added to the system.

This remedial approach is effective for removal of petroleum-based and chlorinated hydrocarbons. However, biodegradation technologies do not affect inorganic compounds such as metals. Again, without clear definition of a source location and low constituent concentration levels, this approach is not recommended. Although technically feasible, the cost-to-benefit ratio for this approach would preclude its use on the site.

2.1.1.3 Passive Landfill Gas Venting

Passive gas venting allows for the removal of landfill gas from the subsurface, therefore preventing or reducing the transfer of contaminants present within the gas to groundwater. This remedial approach is effective for removal of petroleum-based and chlorinated hydrocarbons, but does not affect inorganic compounds, such as metals.

Historical methane monitoring records for Macon County Landfill were provided to BLE dating from March 2002 to June 2008 (Table 3). Please note that historical methane monitoring records predating 2002 are considered to be unreliable, and were therefore not included in this report. Records show consistent detections of methane above LEL concentrations in methane monitoring wells GP-1a, GP-1b, GP-1c and GP-10a. Please note that these monitoring wells are non-compliance wells and were installed voluntarily by Macon County Landfill.

Wells GP-1a, GP-1b, and GP-1C are located along the western boundary of the Phase 1 cell and show historically significant methane levels ranging from 0 to 53.1% since March 2002. In 2003, NCDENR expressed concerns that methane above the LEL may be reaching the toe of the slope along the western boundary of the Phase 1 cell. Macon County responded with a series of punch wells and the installation of gas probe monitoring wells GP-1 and GP-2 along the Phase 1 Landfill dike. Results indicated that methane concentrations above the LEL had not reached the toe of the slope, therefore no further action was necessary.

Methane monitoring well GP-10a, which consistently exhibits the highest methane concentrations, is located upgradient of contaminated groundwater monitoring wells MW-1A and MW-1B near the location where the contaminant plume is believed to have originated (Figure 3). The occurrence of methane levels in GP-10a above the LEL seem to coincide with increased levels of contaminants in groundwater monitoring wells MW-1A and MW-1B (Table 2 & 3), suggesting that increased methane production may be a contributing source of groundwater contaminants.

The implementation of a passive gas vent system could serve to reduce the transfer of contaminants from the gas to the groundwater. We recommend that a passive gas vent system be installed in the vicinity of the Phase 1 and Phase 2 cell overlap, upgradient of monitoring wells MW-1A and MW-1B. A gas vent trench approximately 10 feet deep should be installed parallel to the western boundary of the Phase 1 and 2 cell overlap, spanning a distance of approximately 550 feet (Appendix A). Passive landfill vent pipes should be installed at approximately 100 feet intervals along the length of the trench.

An opinion of cost for this technology was prepared by McGill Associates and is included in Appendix B. The cost for installation of a landfill gas cut-off trench is estimated to range from $35,000 to $40,000. BLE recommends the use of passive gas venting as a corrective measure for this site.

2.1.1.4 Removal of Source Materials

Removal of contaminant source materials through excavation is a corrective measure employed at some contaminated sites. This particular remediation technique involves the removal and transportation of material to a permitted treatment and/or disposal facility. Pretreatment of contaminated media may be required in order to meet landfill disposal restrictions.

In the case of Macon County Landfill, excavation and removal of waste from the inactive Phase 1 cell to the active Phase 2 cell would involve the mobilization of nearly 290,000 cubic yards of material. In addition, the removal and disposal of the contaminated media, which may contain F-listed wastes (chlorinated solvents), may require off site disposal as hazardous waste. Typical cost estimates for excavation, transportation, and disposal of wastes range from $70 per ton for uncontaminated material to $550 per ton for hazardous waste disposal. Opinions of cost for removal of all material from the Phase 1 cell range from $17,000,000 to $19,000,000 (Appendix B). Therefore, due to extreme costs, removal of source materials is not recommended.

2.1.1.5 Soil and Landfill Gas Remediation Summary

Typically, the locations of contaminants buried in landfills can not be accurately predicted from operational records nor can they be economically ascertained. As such, the treatment of contaminated media (soil) cannot be accomplished if the locations and position of these subsurface contaminants are not known. Thus, in most cases, landfill site remediation focuses on the groundwater regime where contaminants can be transported to environmental receptors. Since the vertical and horizontal extent of the contaminant plume at the site has been defined and areas downgradient of the release (MW-23) have not been affected, it is unlikely that the Little Tennessee River (potential receptor) has been impacted. Therefore, BLE recommends passive gas venting as a corrective measure to facilitate groundwater remediation at the Macon County Landfill.

2.1.2 Groundwater Remediation

For the purpose of this evaluation, groundwater treatment technologies are divided into two categories, as follows:

- Groundwater extraction (pumping) and treatment (GWPT)
- In-situ groundwater remediation

2.1.2.1 Groundwater Extraction/Recovery

Various documented technologies can remove VOCs from groundwater that has been extracted from the subsurface. Ex-situ groundwater treatment programs contain three major elements and are called "pump and treat" systems:

- Groundwater extraction/removal system;
- Groundwater treatment system or treatment train; and
- Treated water discharge, disposal or permitted groundwater re-infiltration/re-injection systems.

The following technologies are used for groundwater extraction/recovery:

- Extraction/recovery wells;
- Recovery trenches; and
- Vacuum dewatering (two-phase extraction) systems.

Traditional pump-and-treat systems are primarily used to prevent plume migration and reduce contaminant concentrations in the source areas. Unfortunately, subsurface heterogeneities limit the ability to move water through many contaminated zones, and thereby limit the ability of a pump-and-treat system to cleanse a site. However, when used in conjunction with other remediation techniques, pump-and-treat systems may prevent the exacerbation of groundwater

problems by capturing, substantially containing and removing aqueous-phase contaminants. In addition, where control of groundwater flow direction is necessary to prevent impacts to environmental receptors, GWPT approaches can be useful.

Often, when low concentrations of VOCs are present, extracted groundwater can be directly discharged to streams or publicly owned treatment works. However, if groundwater treatment is necessary, the best demonstrated available technology should be selected to achieve the respective State treatment standards. The most common groundwater treatment technologies for removal of VOCs, are: 1) aeration (air stripping), and 2) granular activated carbon (GAC).

Groundwater Recovery Wells

The installation of groundwater recovery wells or pumping wells is a common method used to bring contaminated groundwater to the surface for treatment and disposal. A line of recovery wells installed at a predetermined spacing with overlapping cones of depression may restrict or limit the flow of contaminated groundwater from an affected area to an unaffected area.

A pump and treat system using multiple recovery wells and an ex-situ groundwater treatment system could act as a viable treatment technology for the site. An opinion of cost for this technology is included in Appendix B. The estimated cost for the design and installation of a pump and treat system at the Macon County Landfill ranges from $237,000 to $285,000. Because the extent of the plume is limited and due to the high startup cost and long-term operation and maintenance cost of the technology, it is not recommended for the site.

Two Phase Vacuum Extraction (TPVE)

TPVE is a method of extracting both vapor and liquid from the subsurface at sites impacted by VOCs. The remediation process is initiated by applying a vacuum to a well or trench in the region where the contaminants are present and inducing two-phase flow out of the well or trench using a liquid ring vacuum pump. The flow of vapor out of the ground causes the in-situ volatilization of some substances that may be present in the vadose zone and increases oxygen availability to accelerate the natural biodegradation of others. The technology induces the flow of contaminants in both dissolved and free phase form, and will control or reverse the spread of a groundwater plume.

In TPVE applications, two-phase flow is established by controlling the flow of air and vapors into the trench conduit or well casing so that they enter at the appropriate point and at the rate necessary to pneumatically carry the liquids to the point of removal. Air/vapor flow is controlled by the selective placement of screening, taking into account the hydrology and the pneumatic permeability of the site, and/or using the priming method described in U.S. Patent No. 5,076,360 (Morrow). The priming method makes use of a tube that can admit air from the surface to any desired depth in the extraction well. The priming tube is provided with a valve so that the rate of admission of air can be controlled.

The priming method overcomes difficulties that could hinder TPVE if:

1. The length of the well rise pipe and the aquifer yield are so great than an applied vacuum causes a column of water to be drawn up to static height above the screening so that no soil gas can enter the riser pipe; or

2. The zone of entry (screened internally or open borehole) of fluids from the subsurface into the well is so deep or in such a low permeability formation that sufficient soil gas velocity cannot be established to lift the water out of the well.

The introduction of atmospheric air (priming) during the startup of a two-phase vacuum extraction operation results in rapid liquid removal even in adverse conditions. In cases where liquid recharge to the well is constant, some atmospheric air may be continually bled into the system to maintain pneumatic lift. In cases where liquid recharge is slow or intermittent, priming air is introduced only as necessary to maintain the well clear of water. In the latter cases, priming air is decreased or eliminated so that only soil gases are extracted in the manner of conventional single-phase vacuum extraction.

Since liquid is transported pneumatically, no mechanical pumps or ejectors are required in the subsurface and therefore equipment and maintenance requirements are simplified in comparison with other technologies for the remediation of soil and groundwater.

TPVE induces liquid extraction at rates that can be increased over that of conventional pumping. The high vacuum applied to a well or trench, causes liquids to flow in the subsurface hydraulic system. Typically by increasing the yield of a groundwater extraction point a greater capture zone can be established so fewer extraction points are needed to achieve hydraulic control of a plume. In addition, as a result of the rapid removal of liquids, TPVE effectively lowers the groundwater table. Lowering the water table exposes a greater volume of contaminated soil to the flow of air, greatly increasing the rate of contaminant removal.

TPVE technology has been proven to be an effective remedial technology at many sites, but because of the prohibitively high costs of the technology and the limited extent of the plume, this technology is not recommended for use at the subject site.

2.1.2.2 Groundwater Treatment

2.1.2.2.1 Ex-situ Groundwater Treatment

Air Stripping

Used in pump and treat systems, air-stripping removes dissolved VOCs from a water stream by aeration. Air stripping is a proven technology that may utilize diffused aeration, tray aeration, spray basins, or packed towers to continually replenish fresh air to the contaminated water stream.

The possibility of producing air pollution impacts from the gaseous effluent is a concern in some areas. By performing air dispersion screen models, the impacts from these emissions can be estimated. Local or regional air permitting agencies are responsible for issuing air emission permits prior to approving a treatment system start up.

Limitations for this remedial process include the types of chemicals to be removed; possible air pollution impacts; high natural iron and manganese in groundwater, and high suspended solids in the influent water. Air stripping is only applicable to the removal of volatile compounds.

Since most constituents detected at the Macon County Landfill site are volatile, this technology could be used to treat contaminated groundwater extracted to the surface. However, BLE does not recommend this technology due to the high startup and long-term operational costs.

Activated Carbon Adsorption
Also used in pump and treat systems, granulated activated carbon (GAC) adsorbs organic and non-organic constituents by a surface attraction phenomenon in which molecules are attracted to the carbon granule matrix. Adsorption depends on the strength of the molecular attraction between adsorbent and adsorbate, molecular weight, type and characteristic of adsorbent, electrokinetic charge, pH and available surface area of the carbon matrix.

When the micropore surfaces become saturated with contaminants, the carbon is "spent" and must either be replaced with clean carbon or be thermally regenerated and returned to service. The time it takes to reach "breakthrough" or exhaustion is the single-most critical operating parameter. Limitations for this remedial process include the absorbability of the various organic compounds, high iron and manganese content of the water, and disposal of the exhausted carbon.

GAC is not the technology of choice at the Macon County Landfill site due to cost limitations of disposing spent GAC containing chlorinated organics.

2.1.2.2.2 In-Situ Groundwater Treatment

In-situ groundwater treatment can be significantly less expensive than pump-and-treat and more effective for certain VOCs that naturally biodegrade. In-situ physical/chemical treatment options amenable to removal of VOCs include air sparging, vapor extraction and permeable reaction walls. In addition, biological treatment options have been used at similar sites to remediate VOCs in groundwater. Technologies applicable to the removal of VOCs include bioslurping, intrinsic bioremediation, monitored natural attenuation, injection of oxygen or hydrogen release compounds, ozone, or other bioremediation enhancers, and phytoremediation.

2.1.2.2.3 Physical/Chemical Treatment

Air Sparging
Volatilization of some organic compounds in saturated zones can be accomplished by sparging air under pressure through soils below the water table. The injected air will travel both horizontally and vertically through the soil column creating transient air filled regimes in the saturated zone. VOCs exposed to the sparged air are carried to the vadose zone where they can be captured by a soil vapor extraction system. Combining air sparging and soil venting with or without groundwater pumping and treating is an effective means of treating VOCs both above and below the water table.

Air sparging will also enhance the natural degradation of many VOCs if amenable under aerobic conditions. The indigenous soil microbial populations can utilize many organic compounds as an energy and carbon source if sufficient oxygen is present to support increased respiration rates. The

sparged air maintains a high dissolved oxygen concentration in the aquifer to support this microbial activity.

However, there are technical concerns with the use of air sparging. One is the potential loss of hydraulic control and the subsequent spread of dissolved organic compounds in the aquifer. Therefore, sparging activity could mobilize the contaminant plume, possibly off site. Because the possibility of remobilization of the contaminant plume exists, BLE does not recommend air sparging for implementation at the site.

Permeable Reactive Barriers/Walls

These technologies encompass passive barriers, passive treatment walls, treatment walls, or trenches. An in-ground trench is backfilled with reactive media to provide passive treatment of contaminated groundwater passing through the trench. The treatment wall is placed at a strategic location to intercept the contaminant plume and is backfilled with media such as zero-valent iron, microorganisms, zeolite, activated carbon, peat, bentonite, limestone, or saw dust. The treatment processes that occur within the treatment wall are typically contaminant degradation, sorption or precipitation. Treatment walls are applicable to a wide range of organic and inorganic contaminants. The choice of media for treatment walls is based on a specific contaminant. Hydrogeologic setting is critical to application; geologic materials must be relatively conductive and a relatively shallow aquitard must be present to provide a "basement" to the system. Groundwater flow should have a high degree of preference, and groundwater quality must support the desired reaction without imposing additional loading of the reactive media or creating undesirable by-products.

BLE has solicited comments on feasibility and opinion of cost for installation of a permeable reactive wall (PRW) for similar landfill sites from an internationally-known engineering design and installation firm. An opinion of cost for this technology is included in Appendix B. Assuming that a PRW system could be installed, the cost is estimated at $1,748,000. BLE does not recommend PRW technology for the site due to high capital cost considerations.

2.1.2.2.4 Biological Treatment

Bioslurping

Bioslurping utilizes vacuum-enhanced pumping to recover light, non-aqueous phase liquid (LNAPL) and initiate vadose zone remediation through bioventing. In bioventing, air is drawn through the impacted vadose zone via extraction wells equipped with low vacuums to promote biodegradation of organic compounds. This approach is not applicable to the Macon County Landfill site.

Phytoremediation

The general use of plants to remediate environmental media in situ is known as phytoremediation. It includes rhizofiltration (absorption, concentration, and precipitation of heavy metals by plant roots), phytoextraction (extraction and accumulation of contaminants in harvestable plant tissues such as roots and shoots), phytotransformation (degradation of complex organic molecules to simple molecules which are incorporated into plant tissues), phytostimulation or plant-assisted bioremediation (stimulation of microbial and fungal degradation by release of exudates/enzymes

into the root zone), and phytostabilization (absorption and precipitation of contaminants, principally metals, by plants). These processes may or may not involve periodic harvesting of plants, depending upon the particular method utilized. The approach is applicable to a wide range of organic and inorganic contaminants and is most appropriate for sites where large volumes of groundwater with relatively low concentrations of contaminants must be remediated to strict standards. These technologies are most effective where groundwater is within ten feet of the ground surface, and soil contamination is within three feet of the ground surface.

Because the extent of the plume has been identified and the threat of affecting off site receptors is unlikely, the incorporation of phytoremediation technology is not recommended at this time. However, phytoremediation may be considered for future implementation.

Intrinsic Bioremediation and Monitored Natural Attenuation

Intrinsic bioremediation is the natural, non-enhanced microbial degradation of organic constituents by which complex organic compounds are broken down to simpler, usually less toxic compounds through aerobic or anaerobic processes. For environmental application, documentation that current biodegradation rates are sufficient to control or degrade a contaminant plume or zone without creation of unacceptable risk to human health or the environment must be demonstrated. The processes of bioremediation are described in the following references:

- U.S. Environmental Protection Agency, 1998, *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater,* EPA/600/R98/128, September 1998.

- Aziz, Carol E., et al., *BIOCHLOR Natural Attenuation Decision Support System,* Draft Version 1.0, July, 1999, User's Manual and Computer Model, Subsurface Protection and Remediation Division, National Risk Management Research Laboratory, Ada, Oklahoma.

Both petroleum hydrocarbons and chlorinated solvents have been detected at the site, however since the concentrations of petroleum hydrocarbons were minor and less pervasive than those of the chlorinated solvents, this report focuses on the fate of the chlorinated solvents.

It is noted in the literature that the natural attenuation of chlorinated solvents is most often accomplished by biotrasformational degradation processes known as reductive dechlorination. This process in its most basic form involves the replacement of the chlorine atoms on a molecule of a chlorinated solvent with a hydrogen atom under anaerobic conditions. These processes require the presence of both electron donors (e.g. hydrogen) and acceptors (e.g. chlorinated solvents). These reactions occur as a first order decay process where a parent compound (e.g. perchloroethene) is sequentially degraded to various daughter compounds until the process terminates in the creation of non-toxic compounds (e.g., water, carbon dioxide, chloride, etc). Flow diagrams showing the conceptualized first-order decay process have been presented in the references above. These processes require; 1) parent solvents, 2) electron donating mater, 3) the establishment of population of compound specific microbes, and 4) the proper geochemical conditions for the reaction to occur.

Monitored Natural Attenuation

MNA is physical, chemical, or biological processes that act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants. These include biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization or destruction of contaminants. The EPA prefers those processes that degrade contaminants and expects that MNA will be most appropriate where plumes are stable.

MNA is appropriate as a remedial approach only where it can be demonstrated to achieve remedial objectives within reasonable time frame, and meets the applicable remedy selection criteria for the particular regulatory program. MNA can be used in conjunction with active remediation measures (e.g., source control) or as follow-up to such measures. MNA should be used where such an approach would not result in significant contamination migration or unacceptable impacts to receptors. Time frame should not be excessive compared to that required for other remedies.

Some factors that impact "reasonableness" of time frame include:

- Current and potential future uses of affected groundwater,
- Relative time frame in which aquifer may be needed,
- Public acceptance of extended time for remediation,
- Reliability of monitoring and institutional controls,
- Adequate funding over time required to reach cleanup objectives,
- Regional resource issues.

In the case of the Macon County Landfill, risk of significant contamination migration and unacceptable impacts on receptors is small. Additionally, a history of parent and daughter product concentrations has not been established. Therefore, MNA may be a viable approach for remediation after a concentration trend history has been established.

2.1.3 Grading Alterations/ Stormwater Infiltration and Leaching

Often times, settlement occurs in portions of a landfill causing water to be impounded. The infiltration of this water through the subsurface may facilitate the transfer of contaminants present within the landfill to the groundwater. We understand that depressions have formed on the landfill cover of the Phase 1 area and a portion of the Phase 2 cell as a result of settlement, causing water to be impounded upgradient of the affected groundwater. We also understand that drainage problems caused by several berms located along the slope face have exacerbated the problem by impeding proper overland flow.

BLE recommends alterations to the grading of the Phase I cell to prohibit the further impoundment of any rainwater. Design engineers at McGill Associates have developed a grading plan suitable for sheeting overland flow and preventing the impoundment of rainwater. The proposed plan for grading activities is included in Appendix A. An opinion of cost for the grading alterations ranges from $35,000 to $40,000 and is included in Appendix B.

2.2 Opinion of Costs for Corrective Action

We have prepared an opinion of cost for the proposed and alternate remedies as required. Please note that an opinion of cost is not a cost estimate or a proposal. Opinions of cost are prepared to provide a realistic cost for remediation based on BLE's best efforts and experience on similar projects. The data used to develop an opinion of cost is most times speculative and conservative in nature and therefore the costs provided are not intended for firm budgeting.

Each of the remedies included in the opinion of cost were discussed in the ACM report. More detailed cost worksheets are presented in Appendix B for a few select remedial technologies. Please note that several of the remedies were deemed inappropriate for the site in the ACM report, however, we have presented an opinion of cost for each of these technologies as requested.

Technology / Remedy	Capital Costs	Yearly O&M Costs	Estimated Time Frame (years)
Soil – Bioventing and SVE	$400,000	$45,000	15
Soil – Bioremediation	$500,000	$75,000	20
Soil – Source Removal	$19,000,000	$20,000	20
Soil – Landfill Gas Cut-Off Trench	$40,000	$750	22
GW – Pump and Treat	$285,000	$49,000	30
GW – Two-Phase Vapor Extraction	$2,000,000	$125,000	20
GW – Air Sparging	$2,000,000	$80,000	15
GW – Reactive Barrier	$1,748,000	$19,000	Life of Landfill
GW – Bioslurping	$350,000	$45,000	Unknown
Grading Alterations	$40,000	$4,000	2*

Legend:
Soil – Soil Remediation Technology
GW – Groundwater Remediation Technology
SVE – Soil Vapor Extraction
* – Estimated time to complete grading

2.3 Recommendation and Rationale for Corrective Action

The corrective action recommended for remediation of groundwater on site is based on the desire to protect human health and the environment, the likelihood of achieving clean-up endpoints, logistical considerations, approval from the NCDENR Division of Waste Management, and financial feasibility. BLE recommends the following remedial actions as corrective measures for the site:

1) Alterations to the grading of the Phase I cell to prohibit or reduce the impoundment and infiltration of stormwater,
2) Installation of supplemental landfill gas cut-off trench and passive landfill gas vents within the limits of the Phase I Cell to reduce groundwater impact from VOCs which may be present in the landfill gas,
3) Continued semi-annual monitoring of selected sentinel monitoring wells for VOCs to determine fate and transport of contaminants.

3.0 CONCLUSIONS

We conclude that the laboratory analysis results of samples from groundwater monitoring wells indicate that a release of VOC's into the groundwater has impacted a localized area west-northwest of the Phase 1/Phase 2 cell overlap. However, the horizontal and vertical extent of the release appears to be defined and areas downgradient of the release have not been affected. Based on the results of the previous assessments, the three part approach of 1) grading alterations, 2) landfill gas mitigation, and 3) continued monitoring of sentinel wells is an acceptable remedy under the ACM and is supported by the information presented herein.

TABLES

Table 1
Monitoring Well and Groundwater Elevation Data
Macon County MSW Landfill
Franklin, North Carolina
BLE Project Number J08-1101-04

Monitoring Point	Northing[1]	Westing[1]	Northing[2]	Easting[2]	TOC[3]	DTW[4]	Elevation	(below TOC)	Depth	Comments
MW-1A	3068.8	-20.7	NA	NA	**2012.25**	9.58	2002.67	31.10	19.5 - 29.5	Prior survey TOC=2010.20
MW-1B	3050.1	-5.6	NA	NA	**2012.19**	9.54	2002.65	17.45	5 - 15	Prior survey TOC=2010.15
MW-1D	NA	NA	557540.8	691268.4	**2013.65**	50.70	1962.95	63.05	NA - NA	New well
MW-2	2790.0	273.5	NA	NA	2014.78	13.82	2000.96	20.15	8 - 18	
MW-3A	2283.1	177.4	NA	NA	2070.55	60.65	2009.90	67.62	52 - 65	
MW-3B	2311.2	186.2	NA	NA	NA	NA	NA	NA	NA - NA	Not sampled
MW-4	2503.9	-512.1	NA	NA	NA	NA	NA	NA	NA - NA	Not sampled
MW-5	2651.1	-8.7	NA	NA	**2072.92**	NA	<2017.72	55.20	38 - 53	Dry; prior survey TOC=2070.88
MW-5D	NA	NA	557151.2	691279.4	**2075.67**	60.50	2015.17	69.82	NA - NA	New well
MW-10	2859.7	-1083.9	NA	NA	2115.08	58.98	2056.10	67.60	55 - 65	
MW-14	3708.3	-1370.3	NA	NA	2049.54	35.39	2014.15	42.57	29 - 39	
MW-15	3344.5	-1483.6	NA	NA	2029.19	13.91	2015.28	17.97	7 - 17	
MW-17	2496.6	-802.7	NA	NA	2133.30	71.47	2061.83	83.30	66 - 81	
MW-18	2710.2	-1023.1	NA	NA	2115.40	53.44	2061.96	62.08	48 - 63	
MW-19	3750.6	-756.4	NA	NA	2021.00	20.20	2000.80	25.80	7 - 22	
MW-19A	3763.6	-744.0	NA	NA	2020.80	19.62	2001.18	57.09	51.5 - 54	
MW-20	3552.6	-538.7	NA	NA	2015.40	13.64	2001.76	23.03	6 - 21	
MW-21	3341.1	-366.7	NA	NA	2020.90	18.21	2002.69	26.93	8.5 - 23.5	
MW-22	3191.2	-169.2	NA	NA	**2020.92**	18.48	2002.44	25.10	8 - 23	Prior survey TOC=2020.60
MW-22A	3200.8	-151.0	NA	NA	**2017.94**	15.15	2002.79	42.30	36.5 - 39.5	Prior survey TOC=2017.60
MW-23	NA	NA	557666.4	691140.8	**2007.08**	6.20	2000.88	30.95	NA - NA	New well
SW-1	2898.1	455.5	NA	NA	NA	NA	NA	NA	NA - NA	
SW-2	3952.3	-533.7	NA	NA	NA	NA	NA	NA	NA - NA	
SW-3	2578.0	-1899.0	NA	NA	NA	NA	NA	NA	NA - NA	
SW-4	4016.5	-1716.5	NA	NA	NA	NA	NA	NA	NA - NA	

[1] - Coordinates from "Monitoring Well, Surface Water, and Leachate Pond Sample Location Map", Altamont Environmental, Inc., May 14, 2003
[2] - Coordinates from McGill 10/3/07 survey
[3] - Bold, shaded values from McGill 10/3/07 survey, all others from prior survey, date unknown
[4] - Water level measurements taken on 10/16/07 and 10/17/07
TOC - Top Of Casing
All elevation values indicated above mean sea level
bgs - Below Ground Surface
MW - Groundwater Monitoring Well
SW- Surface Water Location
All depth measurments in feet
NA - Data Not Available
DTW - Depth To Groundwater

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Table 2
Summary of Analytical Results
Second Semi-Annual 2007 Water Quality Monitoring Event
Macon County MSW Landfill
Franklin, North Carolina
BLE Project Number J08-1101-04

Analyte	Units	SWSL	MW-1A	DUP	MW-1B	MW-1D	MW-2	MW-3A	MW-5D	DUP	MW-10	MW-14	MW-15	MW-17	MW-18	DUP	MW-19	MW-19A	MW-20	MW-21	MW-22	MW-22A	MW-23	SW-1	SW-2	SW-3	SW-4
Arsenic	µg/L	10	ND	ND	ND	ND	**27.9**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	µg/L	100	ND	ND	ND	**317**	**261**	ND	**1410**	**1100**	**226**	**119**	**359**	**125**	**146**	**139**	**965**	ND	ND	ND	**371**	ND	**128**	ND	ND	ND	ND
Cobalt	µg/L	10	**12.5**	**12.3**	ND	**12.4**	**30.4**	ND	**17.1**	**18.0**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	µg/L	10	ND	ND	ND	ND	ND	ND	**13.2**	**12.0**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead	µg/L	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**13.8**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	µg/L	10	**29.8**	**12.7**	**18.7**	**19.4**	ND	**14.1**	**37.2**	**29.7**	ND	ND	**18.0**	**23.0**	**29.4**	**15.5**	**21.8**	**10.6**	**13.7**	**12.3**	**29.5**	ND	**26.4**	**21.9**	ND	**17.6**	ND
Benzene	µg/L	1.0	**2.2**	**2.3**	**2.3**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	µg/L	3.0	**5.1**	**5.3**	**5.0**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	1.0	**5.9**	**6.6**	**5.7**	**1.3**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	µg/L	1.0	ND	ND	ND	ND	ND	ND	**1.2**	**1.2**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	µg/L	1.0	**2.2**	**1.8**	**2.3**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	µg/L	3.0	ND	ND	ND	ND	ND	ND	**5.8**	**4.7**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	µg/L	12	**22**	**18**	**30**	NA	NA	NA	NA	NA	NA	NA	NA	**18**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sampled on October 16, 2007
SWSL - Solid Waste Section Limit (µg/L)
ND - Not Detected Above SWSL
NA - Not Analyzed
Only parameters detected above SWSLs are listed
Bold, shaded values exceed SWSL values
Samples MW-1A, MW-1A DUP, MW-1B, and MW-17 were analyzed for NCDENR Appendix II parameters; all others were analyzed for NCDENR Appendix I parameters

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Table 3
Landfill Gas Probe Measurements
Macon County Landfill
Franklin, North Carolina
BLE Project Number J08-1101-04

Gas Probe ID	3/2002	6/2002	9/2002	12/2002	3/2003	6/2003	9/2003	12/2003	3/2004	6/2004	9/2004	12/2004	3/2005	6/2005	9/2005	12/2005	3/2006	6/2006	9/2006	12/2006	3/2007	6/2007	9/2007	12/2007	3/2008	6/2008
GP-1	NA	NA	NA	NA	1.5	1.1	0	0	0	0	0.5	1.3	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
GP-1a	**32.2**	0	0	**7.5**	**11**	**6.4**	0	**24.2**	**35.5**	0	**23.6**	**18.1**	**20.1**	**16.2**	3.5	**8.9**	**17.6**	0	0	**5.7**	3.2	0	0	0	0	0
GP-1b	**48.4**	1.4	**20.6**	**21.5**	**13**	3.9	**23.5**	**48.1**	**53.1**	**20.6**	**5.2**	**38.8**	**43.6**	**42.5**	**16.2**	**11.4**	**26.2**	1.4	**7.4**	**30.6**	1.2	0	0	**5.2**	0.5	0
GP-1c	**27.3**	**37.5**	0	**17.4**	**33.9**	**43.6**	**26.6**	**10.3**	3.8	**6.2**	1.6	**34.4**	**55.1**	**16.4**	0.6	**10.1**	**16.2**	**5.8**	**17.3**	**34.8**	**39.2**	**10.8**	**23.5**	**18.9**	**12.2**	**10.2**
GP-2	NA	NA	NA	NA	0	0	0	0	0	0	0.8	0.7	0	0	0	0	0	0	NA	0	0	0	0	0	0	0
GP-3	3.1	0	0	2.4	0.1	0	0	0.5	0.1	0	0.1	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0
GP-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GP-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GP-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GP-7	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GP-8	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GP-9	NA	0	**12.5**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GP-10	NA	0	**6.3**	0	0	0	0	0	0	1.1	8.4	0	0	0	0	0	0	0	2.8	0	0	0	0	0	0	0
GP-10a	**48.4**	**18.2**	**53.7**	**59.7**	**42.3**	**59.9**	**54.4**	**68.6**	**61.9**	**46.7**	**62.3**	**64.8**	**65.7**	**60.5**	**46.1**	**66.2**	**65.0**	**23.4**	**58.8**	**63.7**	**65.9**	**25.6**	**33.2**	**58.1**	**45.1**	**20.1**

NOTES:

Units in % methane

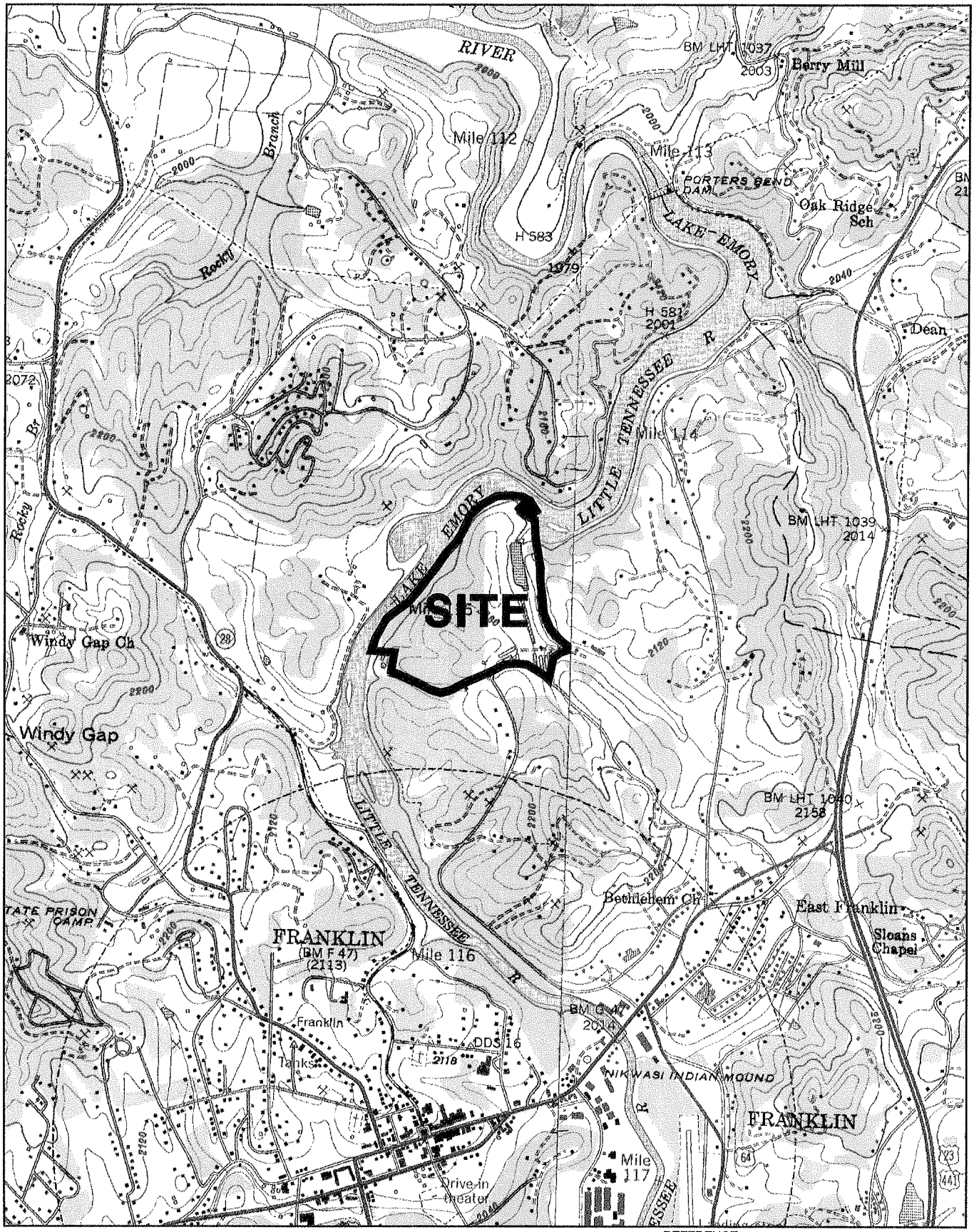
NA = Data Not Available

LEL - Lower Explosive Limit = 5% methane

Bold, shaded values exceed 5% methane

Prepared By: TZS
Checked By: IAI

FIGURES



2000 1000 0 2000 4000

APPROXIMATE SCALE IN FEET

REFERENCE:
USGS TOPOGRAPHIC MAP, 7.5 MINUTE SERIES, CORBIN KNOB AND FRANKLIN, N.C. QUADRANGLES, PHOTOREVISED 1978.

DRAWN: AEH	DATE: 9-11-08	BLE INC. BUNNELL-LAMMONS ENGINEERING, INC. 6004 PONDERS COURT GREENVILLE, SOUTH CAROLINA 29615 PHONE: (864)288-1265 FAX: (864)288-4430	SITE LOCATION MAP MACON COUNTY LANDFILL FRANKLIN, NORTH CAROLINA	FIGURE
CHECKED: TZS	CAD: MACONCOLF-04SLM			1
APPROVED:	JOB NO: J08-1101-04			

APPENDICES

APPENDIX A

SITE PLAN FOR PROPOSED GAS VENT LOCATIONS/ GRADING

APPENDIX B

OPINION OF COSTS FOR CORRECTIVE MEASURES

Macon County Site Opinion of Cost
Installation of Landfill Gas Cut-Off Trench

Landfill Gas Cut-Off Trench System Capital, Installation and Permits:

Landfill Gas Cut-Off Trench Installation, Design & Permits:	$23,650
As-Built and Final Engineering Report	$8,500
Total	$32,150
With 20% Contingency	$38,580
Cost Range	**$35,000 to $40,000**

Annual Operation & Maintenance (O&M)

General Site Maintenance	$600
Total Per Year	$600
With 20% Contingency	$720
Cost Range	**$600 to $750**

Assumptions:

Install approximately 550 LF of Cut-Off Trench along western side of Phase 1, Cell 1
Trench depth – approximately 10 feet deep
Install vent pipes at approximately 100 foot intervals
Removed waste to be disposed of in active cell area of Phase 2
No air permit required
This Opinion of Cost has been prepared with input from McGill Associates and is not a cost estimate

Macon County Site Opinion of Cost
Removal of Waste from Within Phase 1, Cell 1 Area

Remove Waste Material From Within Phase 1, Cell 1 Area
System Capital, Installation, and Permits:

Engineering, Permitting, Construction Observation, and Final Report	$420,000
Waste Removal and On-Site Disposal in Phase 2	$4,985,000
Sub-Total	$5,405,000
With 20% Contingency	$6,486,000
Value of Airspace Consumed in Phase 2 Cell Area to Dispose of Waste from Phase 1, Cell 1 Area	$8,550,000
Permit and Construct a New Cell:	$3,000,000
Total	$18,036,000
Cost Range	**$17,000,000 to $19,000,000**

Annual Operation & Maintenance (O&M)

General Site Maintenance	$16,800
Total Per Year	$16,800
With 20% Contingency	$20,160
Cost Range	**$16,000 to $20,000**

Assumptions:

Approximately 290,000 cubic yards of waste and soil cover to be removed.
No hazardous or unacceptable waste encountered requiring special handling.
All waste and soil material removed and disposed of in Phase 2 Cell area.
No air permit required.
Excavation performed using readily available construction equipment.
Remaining site graded to drain, erosion control measures installed and area grassed.
Assume the County will be required to permit and construct a new phase/cell in order to continue to receive waste generated from within the service area.
This Opinion of Cost has been prepared with input from McGill Associates and is not a cost estimate

Macon County Site Opinion of Cost
Pump and Treat System

Pump and Treat System Capital, Installation, and Permits

Recovery Well Installation and Permits	$33,000
System Engineering Design and Permits	$35,000
Capital Equipment	$81,000
System Installation and Startup with Permits	$79,500
As-Built and Final Engineering Report	$9,000
Total	$237,500
With 20% Contingency	$285,000
Cost Range	**$237,000 to $285,000**

Annual Operation and Maintenance (O&M)

Electric Power	$6,900
System Checks	$6,000
Monitoring and Sampling	$8,000
Reporting	$8,000
Repairs with Parts	$12,000
TOTAL per year	$40,900
With 20% Contingency	$49,080
Cost Range	**$40,000 to $49,000**

Assumptions:
Depth to water 60 feet bgs
Recovery wells along single 600 foot long boundary
6 Recovery Wells, 6-inch ID, 90 feet deep each
100 foot on center spacing yields sufficient capture zone
60 GPM total production
1,200 linear feet of utility trench
2,000 feet OHP
Discharge to surface water (NPDES permit)
Air-stripping only treatment technology required
No air permit needed
O&M services 100% outsourced
NPDES discharge requires quarterly monitoring
This Opinion of Cost is not a cost estimate

Macon County Site Opinion of Cost
Permeable Reaction Wall

PRW System Capital, Installation, and Permits

PRW Installation and Permits (Geo Solutions)	$480,000
System Engineering Design and Permits	$35,000
Capital Equipment (Iron Materials)	$945,000
Bench Study with Field Sampling	$30,000
As-Built and Final Engineering Report	$30,000
Total	$1,520,000
With 15% Patent License	$1,748,000
Cost	**$1,748,000**

Annual Operation and Maintenance (O&M)

Electric Power	$0
System Checks	$0
Monitoring and Sampling	$8,000
Reporting	$8,000
Repairs with Parts	$0
TOTAL per year	$16,000
With 20% Contingency	$19,200
Cost Range	**$16,000 to $19,200**

Assumptions:
Depth to water 60 feet bgs
PRW along single 600 foot long boundary
PRW 90 feet deep and is technically feasible
PRW depth and width sufficient to capture flow
PRW 2.5 feet wide
Sampling and analysis services 100% outsourced
This Opinion of Cost is not a cost estimate

Macon County Site Opinion of Cost
Partial Site Re-grading to Repair Settlement and Enhance Drainage

Re-grade Portions of Cell to Enhance Drainage - System Capital, Installation and Permits:

Re-grade top and Install Diversion Dikes to Include Grading Plans & Permits	$24,000
As-Built and Final Engineering Report	$8,500
Total	$32,500
With 20% Contingency	$39,000
Cost Range	**$35,000 to $40,000**

Annual Operation & Maintenance (O&M)

General Site Maintenance	$3,300
Total Per Year	$3,300
With 20% Contingency	$3,960
Cost Range	**$3,000 to $4,000**

Assumptions:

Re-grade top of Phase 1, Cell 1 to promote positive drainage.
Re-grade portions of side slope to repair settlement and promote positive drainage.
Install drainage diversion berm – middle of west side slope to divert run-off away from the site.
Install down-slope pipe in the southwest corner to divert run-off.
Re-grade existing diversion dikes.
Re-grass disturbed areas.
This Opinion of Cost was prepared with input from McGill Associates and is not a cost estimate