CIVIL/SANITARY/ENVIRONMENTAL ENGINEERS
SOLID WASTE MANAGEMENT

Municipal Services Engineering Company, P.A.

SITE PLANNING/SUBDIVISIONS
SUBSURFACE UTILITY ENGINEERING (SUE)

April 30, 2009

Mr. Zinith Barbee, Permitting Branch
Solid Waste Section
Division of Waste Management
North Carolina Department of Environmental and Natural Resources
401 Oberlin Road, Suite 150
Raleigh, NC 27605

Re: Revised Corrective Action Plan
Lenoir County C&D Permit #54-03

Dear Mr. Barbee:

Please find enclosed the revised Corrective Action Plan for the Lenoir County C&D Landfill, permit #54-03. The CAP has been revised as per your comments dated March 31, 2009. Our response to the specific comments follows. The numbers correspond to the numbered sections of the CAP.

Comment 1 *1.3 Include cobalt on the list of COC's.*

Cobalt has been added to the list of COC's presented in Section 1.3.

Comment 2 *1.4 Expand the table to include cobalt as a COC.*

The table presented in Section 1.4 has been expanded to include cobalt as a COC.

Comment 3 *2.0 Add bulleted point for cobalt.*

A bulleted point for cobalt has been added to the list of COCs..

Comment 4 *2.3 Clarify whether the existing gas system will be discontinued or continued as a "source control measure". Operation and maintenance costs for it are not listed in the estimate submitted for financial assurrance.*

The existing *passive* gas extraction system will continue to be use as a source control measure, as it prevents the buildup of landfill gas within the closed landfill. Operation and maintenance costs are included in the facility's annual operating budget..

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Comment 5 *5.11 Clarify what is meant by "various remedial/mechanisms/processes that are ocurring at the site." Unclear is which, if any, of the technologies referenced in the subsequent sentence are already in use or intended for a contingency plan.*

This paragraph is a non-specific, generic paragraph meant to illustrate how qualitative/quantitiative methods would be applied to assess the progress of *any* form of remediation, including those not listed in the subject CAP (or related ACM) report. This paragraph also occurs in the CAP reports that have been recently submitted by MESCO for Alexander Co. (Permit #02-01, approved by SWS 02/19/09) and the City of Albemarle, Stanly County (Permit #84-01, approved by SWS 03/02/09). The specific remedial approach is addressed in the appropriate sections of the report text.

Comment 6 *6.1 Hydrogen Release Compound (HRC) had not been listed among alternative remediation technologies presented in the ACM. A cost of installing, operating, and maintaining this corrective action measure should be submitted for evaluation byt the SWS, as had cost estimates for other remediation technologies listed in the ACM.*

The ACM report, as approved by the SWS on November 1, 2007, did not list many applicable, alternative remedial technologies that are currently available, and that should probably have been included in the relevant table. Although HRC injection is a proven remedial technology, and is conducive to use in high permeability aquifers, its use as a contingency plan has been supplanted by phytoremediation, another form of remediation listed in the ACM.

Comment 7 *6.2 Include more data about the existing "passive horizontal gas venting system". On Table 15 in the ACM, an "active" system is described as "currently in operation" at an annual operating cost of $50,000 or "total turn key expense" of $750,000. Whereas, in the CAP a "passive" system is mentioned whose design and installation cost is estimated at $75,000 in the ACM. Also, because uncertainty about the system's effectiveness is expressed in Section 2.3, unclear is whether utilization of the system will continue and what its value is as a "safeguard measure" or "source control measure".*

As stated in Section 3.4 of the ACM, the gas extraction and collection system (aka *methane extraction system, horizontal gas venting system,* etc.) operates passively. This system allows for the venting of landfill gas, a potential contaminant transport medium that allows dissolved-phase contaminants to partition into the vapor phase, thereby providing limited control over contaminant migration. The system also prevents buildup of explosive levels of methane within the waste limits. The costs associated with annual maintenance are included as part of the Lenoir Co. landfill's operating budget, and cover periodic measuring of gas levels by county employees. Since this system has been implented since 1994, O&M costs were excluded from the corrective action cost estimates. As stated above, the system will continue to be used as a source control measure.

Comment 8 *8.0 Submit more information about financial assurance. Pursuant to Regulation .1628(d)(1) a "detailed" estimate should be submitted in lieu of a lump sum cost estimate. Also, the cost estimate does not appear to reflect operation of the existing gas venting system mentioned mentioned in Section 2.3...*

The estimated costs of MNA implementation over a 5-year period have been divided into labor and consulting charges, since MESCO will be responsible for reporting duties while an independently-contracted environmental company will be responsible for sampling and

monitoring activities. Costs for operation and maintenance of the passive gas collection system are not included in the estimated cost of corrective action since these are included as part of facility's annual operating expenses, and are minimal.

Attached is the draft of the revised report text for your review. Upon approval a complete hard copy will be sent to your attention. Please contact us by phone at (919) 772-5393, should you have any questions or comments regarding this report.

Sincerely yours,
MUNICIPAL ENGINEERING SERVICES CO., P.A.

Sean K. Patrick, P.G.
Professional Geologist

Attachments

Cc: Tom Miller, Lenoir Co., NC

Corrective Action Plan

Prepared for

Lenoir County Landfill - Permit #54-03
La Grange, Lenoir County, North Carolina

MESCO Project Number: G07062.0

Completed on 2/13/2009
Revised on 4/30/2009

Municipal Services Garner, NC
Engineering Company, P.A. Boone, NC

Municipal Engineering Services Company, P.A.
Garner, Boone and Morehead City, North Carolina

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1 INTRODUCTION

1.1 Site Background

The Lenoir County Sanitary landfill is located on Hodges Farm Road (SR 1524), La Grange, Lenoir County, North Carolina. Lenoir County landfill operates under permit #54-03. Prior to operation as a C&D landfill the site operated as a Municipal Solid Waste (MSW) unlined sanitary landfill. A small area of the MSW, located in the southern portion of the facility stopped receiving waste prior to October 1994 and was closed with a 24 inch soil cover. The remainder of the sanitary landfill was closed prior to October 1998. This unit was closed with an 18-inch cohesive soil cap with a permeability of 1 x 10^{-5} cm/sec, and 18 inches of erosive layer, as part of the *Lenoir Conuty Transition Plan.*[4] The C&D landfill was constructed and is operating on top of the MSW unit. In 1980 S&ME completed a geotechnical investigation of the soils per the City of Kinston's request. Adjacent to the C&D landfill and utilizing the same scale house is the existing Subtitle D MSW landfill, which also operates under permit #54-09. The site is monitored under 15A NCAC 13B.1630. A topographic map showing the location of the site is included as **Plate 1**. A site map showing the layout of the permitted facility is included as **Plate 2**.

1.2 Aquifer Characteristics

The site lies within the Atlantic Coastal Plain physiographic province [2], a region that is characterized by flat or gently undulating topography dissected by drainage features with narrow to moderately sloped sides. Surface drainage flows northwest towards Fredricks Branch*, which flows northeast into Falling Creek and subsequently into the Neuse River. The site is generally bounded by NCSR 1524 on the west, Falling Creek on the east and Fredricks Branch on the north. The existing Subtitle D MSW landfill is adjacent to C&D area.

The lithology below the site consists of a unit of unnamed surficial sediments overlying the Cretaceous-age Peedee Formation. The surficial deposits consist of clayey sand, sandy clay, silty sand, and sand. The Peedee Formation consists of an overlying confining unit of clay, silty clay, and sandy clay approximately 25 feet thick, underlain by a unit of fine to medium sand interbedded with clay and silt. The estimated depth of the Peedee confining layer at the site is 36 feet below ground surface (bgs), based upon boring logs from previous subsurface investigations. Monitoring well MW-11 was completed on top of the Peedee confining layer at an approximate elevation of 39.4 feet above mean sea level (amsl). Assuming a slight dip of the confining layer, monitoring wells MW-9 and MW-12 were also completed close to the confining layer.

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* The name of the creek was referenced as Fredricks Branch in the *Transition Plan*. The creek is not named on USGS topographic quadrangle maps.

Regionally, Lenoir County is located in the Coastal Plain groundwater region of the United States.[3] The unconfined aquifer at the site consists of unconsolidated silty and clayey sands that are underlain by the Peedee Confining Unit. Groundwater typically occurs at depths of <10 to over 20 feet (bgs), with the shallowest depths occurring in draws and near drainage features. Groundwater depths in the monitoring wells have been generally consistent over time, and have been reported in the following approximate depth ranges:

- ≤ 10 ft. bgs: *MW-3, MW-4, MW-6, MW-9*
- 10 to 20 ft. bgs: *MW-1, MW-6, MW-8, MW-10, MW-11, MW-12*
- > 20 ft. bgs: *MW-8, MW-10*

Historical groundwater elevations are provided in **Table 2**. Groundwater flow dynamics are primarily controlled by the topographical high and local drainage features of Fredricks Branch and Falling Creek. Groundwater flow at the site is in a general east-northeasterly direction. A single-day potentiometric map depicting groundwater flow conditions on July 15, 2008 is provided as **Plate 4.**

Hydraulic conductivity (K) values are summarized in **Table 3**. K values, as determined from slug testing, ranged from 6.55 x 10^{-6} cm/sec (MW-12) to 5.40 x 10^{-4} cm/sec (MW-4), with a geometric mean of 1.32 x 10^{-4} cm/sec. Hydraulic gradient in the area of the closed landfill is relatively and shallow and consistent, with a typical value of 0.009 ft/ft. Average linear groundwater velocities (v_x), also known as *seepage velocities*, were calculated in the *Assessment of Corrective Measures* (ACM) report using the following equation:

$$v_x = \frac{K * i}{n_e}$$

where

v_x is the average linear groundwater velocity ([length/time]

K is the hydraulic conductivity [length/time]

n_e is the effective porosity [unitless]

i is the horizontal hydraulic gradient in the direction of groundwater flow, taken as the difference in head elevation between two points divided by the distance between those points [unitless, or length/length]

The calculated average linear groundwater velocities were found to have a median value of 13.7 ft/yr. [5]

1.3 Contaminant Distribution

Groundwater contamination at the site consists of dissolved-phase volatile organic compounds (VOCs) and inorganic compounds in concentrations exceeding established 15A NCAC 2L groundwater standards (2L Standards). Groundwater contaminants-of-concern (COCs), as identified in the *ACM* and subsequent semi-annual groundwater monitoring reports are 1,1-dichloroethane (1,1-DCA; a VOC), mercury (a toxic heavy metal), and cobalt (a naturally-occurring metal). Historic organic and inorganic results of detected constituents are shown in **Tables 4A & 4B**, respectively. The extent of VOCs at the site is depicted in **Plate 6**. VOC concentrations are greatest in the area near monitoring wells MW-8 and MW-10. Groundwater impact is limited to the unconfined aquifer.

1.4 Site Conceptual Models

Site conceptual and analytical models were developed in the *ACM.* The models consisted of conceptual cross sections and analytical modeling using MODFLOW with MT3D^{96}. The conceptual cross sections from the *ACM* are provided as **Plate 5**.

Physical Process

As dissolved-phase constituents in groundwater, all COCs are subject to the physical processes of advection and dispersion. The primary physical mechanism of plume movement is through advection. Advective flow with applied sorption (retardation) typically slows plume migration. The retardation coefficient (R) used to calculate the expected migration rates for the constituents can be calculated from the following equation [7]:

$$R = 1 + \frac{\rho_d}{n} K_d$$

where

- R is the retardation coefficient
- ρ_d is the dry bulk density of the soil (g/cm^3)
- n is the porosity (unitless)
- K_d is the distribution coefficient (mL/g)

The average dry bulk density (ρ_d) presented in the *ACM* report, as calculated from laboratory dry weights determined during the *Phase 1 Design Hydrogeological Study*, was reported as 1.78 g/cm^3. The distribution coefficient (K_d) can be estimated as the constituent-specific soil–water partitioning coefficient (K_{oc}) times the fraction of organic carbon (f_{oc}) in the soil.[1] A conservative value of 1% (0.01) was chosen for soil organic carbon, based on boring logs and field observations An average total porosity value of 37% (0.37) was used based upon the range of 32%-43% determined for laboratory soil samples that was reported in the *ACM* report. Values for the three COCs are presented in the following table.

Table of Retardation Coefficients		
Constituent of Concern	**Distribution Coefficient (K_d)**	**Retardation Coefficient (R)**
1,1-Dichloroethane (1,1-DCA)	0.40 (K_{oc} = 40) [7]	2.92
Mercury	6,310 [8]	30,400
Cobalt	126 [8]	601
Note - values have been re-calculated for this CAP report.		

Since contaminant velocity in groundwater (v_c) is equal to the seepage velocity divided by the retardation coefficient[7], the above table of retardation coefficients suggests that 1,1-DCA has the potential to travel at approximately one-third that of the seepage velocities calculated in the *ACM.* Cobalt is expected to be less mobile, with a travel rate approximately 1/600th that of the calculated seepage velocities. Mercury is expected to be relatively immobile in groundwater.

Chemical/Biochemical Process

The identified COCs consist of chlorinated aliphatic hydrocarbons and metals dissolved in groundwater. Natural bidegradation of chlorinated solvents such as 1,1-DCA occurs primarily through the biochemical process of reductive dechlorination.[7] Reductive dechlorination occurs as the result of microbial activity which progressively removes chlorine atoms from chlorinated hydrocarbons through various oxidation-reduction reactions. Under anaerobic conditions, reductive dechlorination occurs through electron acceptor reactions, with the chlorinated hydrocarbons acting as electron donors rather than as a carbon source for microbial activity. Under aerobic and some anaerobic conditions, reductive dechlorination can occur as a result of electron donor reactions, during which chlorinated hydrocarbons act as both carbon and energy sources for microbial actitivity.

1.5 Regulatory Status

The Lenoir County Landfill operates as a C&D landfill over a MSWLF landfill under permit #54-03. Assessment monitoring is currently performed on a semi-annual basis at the site.

2 CONTAMINANT CHARACTERIZATION

2.1 Contaminants of Concern

The following chemical compounds were identified in the *ACM* as being COCs:

- 1,1-dichloroethane (1,1-DCA) – *chlorinated aliphatic hydrocarbon*
- mercury – *toxic metal*
- cobalt –*heavy metal*

Additionally, the naturally-occurring metal cobalt has been detected in concentrations up to and exceeding the established NCDENR Solid Waste Section Limit (SWSL) of 10 μg/L. Increases in cobalt concentrations were identified as statistically significant during the semi-annual groundwater monitoring events conducted in July 2002, January 2003, July 2003, and January 2004. At the request of the NCDENR Solid Waste Section (SWS), cobalt has been added to the list of COCs.

2.2 Contaminant Source Confirmation

The groundwater contaminant source appears to be the former MSW landfill cell. The mechanism for the presence of this contamination is precipitation that has percolated through the landfill waste, allowing VOCs to partition from solid/liquid phases into a dissolved phase, and that has subsequently migrated downwards to mix with groundwater. To limit water percolation, the MSW unit was closed with an 18 inch cohesive soil cap with a permeability of 1 x 10^{-5} cm/sec, and 18 inches of erosive layer.

2.3 Source Control Measures

The first unit of the landfill stopped receiving MSW by October 1994 and was closed with a 24-inch thick final soil cover. The second unit was closed with an 18-inch cohesive soil cap with a permeability of 1 x 10^{-5} cm/sec, and 18 inches of erosive layer. Lenoir County owns and controls an extensive buffer around the waste limit. Northeast of the waste is a borrow site and the facility transfer station. North of the waste limit is a flood plain consisting of unused property owned by Lenoir County. East of the property is the borrow site for the Subtitle D landfill. South of the property, across Hodges Road and upgradient, is private property that is being used for the storage of construction trailers.

A passive gas venting system for methane extraction/collection was installed as part of the *Transition Plan*. The permanent probes were installed in October 1994 and are monitored quarterly. Since landfill gas is a potential contaminant transport mechanism. The existing methane extraction system will continue to be used to passively vent vapor-phase hydrocarbons from the subsurface. Information regarding the methane extraction system, as presented in the *Transition Plan*, is presented in **Appendix C**.

Several institutional control measures have been implemented to restrict and control access to the site and possible contact with contamination. Public access to the site is limited during operation hours. A chain link fence controls vehicle access off Hodges Farm Road. Heavy vegetation and the floodplain limit access from other areas. Access to groundwater at the facility is controlled by locked monitoring wells. Lenoir County owns the majority of the property surrounding the facility.

A receptor survey performed as part of the *Transition Plan* identified three (3) potable water supply wells and one (1) non-potable water supply well located within 2,000 feet of the facility. An updated receptor survey was performed in 2007. Lenoir County has since purchased two of those properties. Connections to the potable water supply wells located on those properties have been removed, and the properties have been demolished or are in the process of being demolished. Municipal water is available to the surrounding area.

The non-potable water supply well is located at the facility, and is used for equipment washing. The well is constructed of 1-inch dia. PVC encased in 3-inch PVC. The depth of the well was reported to be 155 feet bgs with a screened interval from 75-100 feet bgs. These construction details indicate that the on-site non-potable water supply well is screened below the Peedee confining layer, and is cased off from the surficial aquifer. This fact, combined with the low flow rates achievable from wells of this type, indicate that the on-site water supply well would be unable to significantly affect downward migration of groundwater contaminants. There is, therefore, no need to abandon this well as part of any corrective action at the facility.

2.4 Risk Assessment

Risk assessment was performed as part of the *ACM* and assumed direct contact with the identified contamination. Risk assessments were performed assuming children would consume 1 liter of water each day with an exposure duration of 8 years. Dermal exposure risks assumed contact through bathing based on one 15 minute bath per day. Inhalation exposure assumed 12 cubic meters of air per day. Risk assessment is based on worst-case scenario, where exposure is to the maximum observed concentrations and the current concentrations for the COCs. Exposure tables from the *ACM* report are presented as **Tables 7A – 7C**.

2.5 Contaminant Concentrations

2.5.1 Background Concentrations

Groundwater sampling and monitoring has been conducted at the site since 1994. Background water quality data has historically been collected from monitoring well MW-1. Background sampling has detected concentrations of arsenic, beryllium, chromium, cobalt, manganese, lead, and zinc, with only manganese and lead exceeding 2L Standards. A 2L Standard for cobalt has not been established, although the Solid Waste Section has adopted a Groundwater Protection Standard (GWP) of 70 µg/L in lieu of a 2L Standard. The presence of metals occurring in the background samples, surface water samples, Subtitle D landfill samples, and NURE sediment samples[5, 9] indicate that these metals are naturally occurring and may not represent contamination associated with the landfill. Historical results are shown in **Tables 4A, 4B, & 5**. Current groundwater results (July 2008) are shown in **Table 6**.

2.5.2 Exceedances of Groundwater Quality Standards

Groundwater contaminants that have been found to exceed 2L Standards are 1,1-DCA, 1,2-dichloropropane, benzene, vinyl chloride (chloroethene), *cis*-1,2-dichloroethene, ethylene dichloride, methylene chloride, *p*-dichlorobenzene, tetrachloroethene, and trichloroethene. Mercury was detected in monitoring wells MW-3, MW-4, MW-5, MW-8, MW-10 and MW-12 from the period of 1995 through 2007. Since the presence of mercury cannot be attributed to either natural sources or laboratory error, its presence in groundwater is likely due to the waste stored in the closed landfill. Manganese and lead concentrations in some samples were also found to exceed 2L Standards, and were identified in the *ACM* as occurring naturally. Cobalt has been found to exceed the currently accepted SWSL.

2.5.3 Exceedances of Surfacewater Quality Standards

Laboratory analysis of surfacewater samples have not detected contaminant concentrations in excess of established NCAC 2B surfacewater quality standards (2B Standards). Appendix I VOCs and metal concentrations were not detected above method detection limits during the July 2008 semi-annual sampling event.

2.6 Media of Concern

Groundwater is the primary media of concern at the site since it acts as the primary mechanism of transport for environmental contaminants emanating from the landfill. Dissolved-phase contaminants can potentially be transported via groundwater and discharged to surfacewater.

Landfill gas is a secondary media of concern since it can transport VOCs that have partitioned into the vapor phase, allowing them to re-partition into the dissolved phase into groundwater. A passive horizontal gas venting system for methane extraction/collection was installed as part of the *Transition Plan*.

3 SELECTED AND APPROVED REMEDY / TECHNICAL APPROACH

A number of factors influenced selection of remediation alternatives.

- Groundwater contamination exists within the surficial (unconfined) aquifer.
- Groundwater contamination exists within the relevant zone of compliance.
- Groundwater contamination exists at relatively low levels (ppb range).
- Groundwater contamination is below risk exposure levels.
- Mercury, one identified COC, was determined in the *ACM* to be relatively immobile in groundwater.
- No active potable wells have been identified within 2,000 feet of the waste limit.
- The on-site non-potable water supply well is screened below the Peedee confining layer and cased off from the surficial aquifer.

The relatively low levels of groundwater contamination, the biodegradability of 1,1-DCA, and the relative immobility of mercury and cobalt indicate that aggressive remedial technologies discussed in the *ACM* (e.g. air sparging, vapor extraction, pump-and-treat), although effective for VOC remediation, are ineffective for metals remediation, and would therefore be unsuitable for implementation.

3.1 Technical Approach – Monitored Natural Attenuation

Groundwater contamination exists within the unconfined, shallow aquifer. Natural attenuation mechanisms are actively controlling groundwater contaminant movement in this area. Since contaminant modeling results indicate limited plume movement over a 50-year period, monitored natural attenuation (MNA) has been chosen as a cost-effective remedial strategy. Modeling results from the *ACM* report are presented in **Appendix A**.

Groundwater sampling will continue to be performed semi-annually on all monitoring wells currently included in the sampling schedule. Additionally, baseline sampling for the full suite of MNA performance parameters listed in **Section 4** and **Appendix B** shall be performed for two years following initiation of the remedial strategy. Monitoring of stream quality in the adjacent surface waters will be achieved through sampling at sampling points SW-1 and SW-2 (see **Plate 3**, and **Appendix B, Plate B**). Surfacewater sampling parameters will include Appendix I VOCs and metals.

4 GROUNDWATER AND SURFACEWATER MONITORING PLAN

4.1 Groundwater Sampling and Monitoring

Data with which to monitor and evaluate the performance of remediation shall be obtained through a groundwater sampling and monitoring program. Semi-annual groundwater sampling will continue to be performed on the following wells: MW-1, MW-3, MW-4, MW-6, MW-9, MW-11, and MW-12. All groundwater samples collected from the monitoring wells will be analyzed for Appendix I VOC concentrations by EPA method 8260, and EPA method 6010 (or 7040) for mercury, and compared with the existing 2L Standards. Additionally, the following MNA performance parameters will be analyzed for an initial two-year period for following initiation of corrective action:

MNA Performance Parameters

Parameter	Analysis Type	Analytical Method
Dissolved Oxygen (DO)	Field Reading	Multi-parameter Field Instrument w/ flow-through cell
pH	Field Reading	
Oxidation-Reduction Potential (ORP)	Field Reading	
Turbidity	Field Reading	
Conductivity	Field Reading	
Temperature	Field Reading	
Dissolved CO_2	Field Reading	Field Instrument / Hach Kit
Alkalinity (Total as $CaCO_3$)*	Laboratory/Field*	EPA 310.2
Chloride*	Laboratory/Field*	SM 4500-CLB
Iron	Laboratory	SM3111B
Nitrate*	Laboratory/Field*	EPA 353.2 / SM 2320B
Sulfate*	Laboratory/Field*	EPA 375.4 / SM 4500-SO4E
Sulfide*	Laboratory/Field*	EPA 376.1 or SM 4500SE
TOC/BOD/COD	Laboratory	EPA 415.1 / EPA 405.1 / EPA 410.1
Methane	Laboratory	RSK 175
Ethane, Ethene	Laboratory	RSK 175
Hydrogen	Laboratory	AM19GA
Volatile Fatty Acids	Laboratory	AM23G

*For budgetary considerations these analyses may be performed in the field using Hach® brand color wheel test kits. Historical iron concentrations have exceeded Hach kit quantitation limits.

4.2 Surfacewater Sampling and Monitoring

Surfacewater sampling will be conducted to monitor COC concentrations in the adjacent stream areas. To date (January 2009) COC concentrations have been below NCAC 2B standards. Surfacewater sampling point locations are depicted in **Plate 2**. Surfacewater sampling point SW-1 is located downstream of the landfill, and sampling point SW-2 is located upstream of the landfill, along Fredericks Branch. All surfacewater samples will be analyzed for Appendix I VOC and metals concentrations by EPA methods 8260 and 6010, respectively, and compared with the existing 2B Standards. The complete *Ground and Surfacewater Sampling and Analysis Plan* is presented as **Appendix B**.

5 EVALUATION OF EFFECTIVENESS AND REPORT SUBMITTALS

5.1 Evaluation of Effectiveness

As remediation progresses at the site certain changes in the physical and chemical characteristics of the contaminant plumes should occur. In all areas contaminant concentrations are expected to decrease over the period of remediation, thus resulting in a decrease in the physical extent of the plume. The various methods for evaluating the effectiveness are discussed in the sections below.

5.1.1 Qualitative and Quantitative Evaluation

Qualitative Evaluation

Qualitative methods include graphical analysis of groundwater analytical data over time to visualize changing trends in groundwater chemistry that are expected to occur over time as a result of the various remedial mechanisms/processes occurring at the site (e.g. biodegradation, phytoremediation, HRC injection, etc.). Examples of graphical analyses that will be used include, but are not be limited to, time-series graphs of contaminant concentrations and groundwater levels, distance-concentration graphs of analytical data, and mapping of the contaminant plumes over time. Specific biodegradation plume parameters (e.g. point attenuation rate, bulk attenuation rate, biodegradation rate) will be determined for the individual plume areas.

Quantitative Evaluation

Quantitative evaluation will be conducted through revised MODFLOW modeling and through analysis of groundwater analytical data using statistical tests for significance. Statistical significance tests can be grouped into two types, *inter-well* and *intra-well. Inter-well* methods determine statistical significance by examining trends in contaminant concentrations from performance wells with respect to those from background wells, which are used as a control group. As remediation progresses, the performance well data is expected to exhibit decreases in contaminant concentrations, while contaminant concentrations in the background wells are expected to remain relatively stable. Background wells are selected on the basis of location (typically upgradient) and analytical history (non-impacted wells are best). *Intra-well* methods determine statistical significance within individual performance wells by examining historical analytical results (time series) for a given well, thus indicating if changing contaminant concentrations at a given well location result from either remedial activity or natural fluctuation. Comparisons of background well data with sentinel and compliance well data will also be performed to monitor groundwater contaminant movement over time.

Various types of significance tests have been developed to analyze differing types of data populations based upon characteristics such as distribution type (normal vs. non-normal), trend type (changing vs. non-changing), percentage of "non-detect" results for a given population, and the sample population size. This allows for the selection of particular methods that are appropriate for a given situation. For the remedial activity at the subject facility the following statistical tests are proposed for use, although others may be used as the course of remediation progresses:

- Wilcoxon Rank-Sum (Inter-well) - *normal or non-normal data, invariant trends, < 90% non-detects, >3 samples/per well.*
- Parametric Prediction Limit (Inter-well) – *normal data, varying trends,< 15% non-detects.*
- Parametric Prediction Limit (Intra-well) – *normal data, varying trends,≥ 4 samples/well, < 15% non-detects.*
- Non-Parametric Prediction Limit (Inter-Well & Intra-Well) – *normal or non-normal data, can tolerate high percentage of non-detects, compares recent to historical data.*

As indicated by the above list, it is important to note that prior to conducting any test of statistical significance a baseline of analytical data must first be established. For the MNA parameters listed in **Section 4.0** this baseline will consist of the four (4) semi-annual sampling events mentioned previously. *Since some plume areas do not have upgradient wells that are suitable for use as background wells, non-impacted compliance wells may be used if necessary for inter-well statistical analyses.*

5.1.2 Evaluation of MNA

Monitoring well MW-1 will continue to be used as a background well for inter-well statistical analysis of MNA data. The remaining monitoring wells will be used as performance and compliance wells.

5.2 Refining the Site Conceptual Model

Over the course of corrective action the site conceptual model may be refined, if necessary, in order to determine the appropriate course of remediation. New and/or additional information on groundwater chemistry, site lithology, plume characteristics, etc. will be used to further improve understanding of contaminant fate and transport at the site, and to determine any changes to the approved remedial measures if necessary.

5.3 Report Submittals

Remediation Status Reports will be submitted on a semi-annual basis, within 30 days of receiving all complete laboratory analytical reports. An *Initial Status Report* will be submitted upon implementation of the selected remedial approach, and will detail all activities performed to initiate corrective action. All reports submitted shall include complete laboratory analytical reports, data tables, contaminant concentration trend graphs, groundwater flow maps, contaminant plume maps, and cross-sections, as per NCDENR-SWS guidelines.

6 CONTINGENCY PLAN

6.1 Contingency Plan

Should the selected remedial approach not perform as expected and/or the constituent concentrations do not decrease, a contingency plan will be needed. One remedial technology that could potentially supplement MNA of VOC and metals concentrations is phytoremediation. Phytoremediation occurs through several processes including the release of enzymes from the root system that break down hydrocarbons (phytodegradation), increasing evapotranspiration to limit plume migration (phytostabilization), and uptake of hydrocarbons and metals (phytoextraction). To accelerate the natural evapotranspiration process and to allow for hydraulic containment (plume control), the proposed area would be planted with hybrid willows of the genus *Salix*. Hybrid willows have been recognized as being phreatophytic (water-loving) trees with root systems that can extend up to 40 feet bgs. Available literature (e.g. Schnoor, 1997 [6]) indicates an initial planting density of 1,000-2,000 trees/acre (~43 ft^2/tree). As the trees become established over time (1-2 years) competition between plants will reduce this density to ~600-800 trees/acre. The plume area over which phytoremediation would be implemented comprises approximately 1.4 acres. At the aforementioned planting density a minimum of 1,400 hybrid willow seedlings would need to be planted at the onset of corrective action. Planting of seedlings would likely be performed by mechanical methods to reduce installation costs, and would occur during the spring. Protective fencing to prevent damage to the seedlings by wildlife (e.g. deer) would be constructed around the area of planting. *It must be noted that the proposed contingency plan is subject to change depending on future site and environmental conditions. The proposed phytoremediation area would be determined after the decision to implement the contingency plan is made, and would roughly correspond to the footprint of the dissolved-phase plume as determined through subsequent groundwater sampling and monitoring events.*

6.2 Safeguard Measures and Site Security

Exposure pathways are limited to onsite contact with groundwater. Monitoring wells are cased and secured with locking well caps. Access to the site is limited during operational hours. Heavy vegetation limits access from other areas. Lenoir County owns the majority of the property surrounding the facility. Public water is available to the surrounding area. A passive horizontal gas venting system for methane extraction/collection was installed as part of the *Transition Plan.* [4]

Prior to the facility becoming a C&D landfill, the western unit of the sanitary landfill was closed with a 24-inch cohesive soil cap and vegetative cover. The vegetative cover acts as an erosion control measure and also aides in the evapotranspiration process to reduce infiltration. As with the western unit, side slopes of the eastern unit were closed with a 24 inch soil cap and vegetative cover. The top of the eastern unit was closed with an 18-inch thick cohesive soil cap with a permeability of 1×10^{-5} cm/sec, and 18 inches of erosive layer. Surfacewater is diverted from the landfill and is not impounded on the landfill property.

6.3 Revisions

Requests for modification of the approved corrective action and implementation schedule will be submitted in writing to the Solid Waste Section. No actions regarding modification will be implemented until written approval is received from the Division of Waste Management.

7 SCHEDULE AND MAINTENANCE

7.1 Operations & Maintenance

Apart from semi-annual sampling, monitoring, and reporting, the implementation of MNA will not require additional operation or maintenance procedures. Lenoir County landfill personnel will continue to oversee the operation, maintenance, and monitoring of the gas extraction and collection system. The Lenoir Department of Solid Waste can be contacted at (252) 566-4194 regarding daily activities.

7.2 Timeline

Implementation of corrective action will begin within 30 days of CAP approval. The MNA performance parameter baseline will be established during the July 2009 semi-annual sampling event. A timeline estimate for sampling events and performance evaluation is presented in **Table 8**.

8 FINANCIAL ASSURANCE REQUIREMENTS

In general accordance with 15A NCAC 13B .0546, demonstration of financial assurance was achieved through the local government financial test. Semi-annual sampling and monitoring activities, analysis, data interpretation, and semi-annual compliance reporting will be performed by MESCO. A breakdown of estimated costs for the implementation of MNA over a 5-year period, is as follows:

Laboratory Analyses –
Est. cost of MNA groundwater sample = $750/sample
Total annual est. MNA sample costs = 14 (7 monitoring wells sampled twice yearly) = $10,500/year
Est. cost of surfacewater sample = $230/sample
Total annual surfacewater sample costs = 4 (2 sampling points sampled twice yearly) = $920/year

Labor-
Est. cost per semi-annual event = $2,000
Total annual est. cost of labor = $4,000/year

Compliance Reporting-
Est. semi-annual monitoring report preparation & review - $2,500
Total annual est. cost of reporting = $5,000/year

Estimated Annual Costs - $20,420
Estimated Total Costs (5 years) – $102,100

9 COMPLETENESS OF CORRECTIVE ACTION

Results indicate that reduction of the low level contamination can be achieved through monitored natural attenuation. There is no indication that the contamination would reach the relative point of compliance within a reasonable time period. Institutional controls limit access to the site. The source area has been capped to limit infiltration. There is no need to abandon the on-site non-potable water supply well as part of any corrective action at the facility. In order to determine if the observed cobalt, lead and other metals exceedances in groundwater are the result of source material leaching or are naturally-occurring, an Alternate Source Demonstration may be necessary.

Respectfully submitted,
MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

NORTH CAROLINA LICENSED SEAL 1771 GEOLOGIST STEPHEN MARK BROWN

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APPENDIX C

Methane Extraction System Information
(from the *Lenoir County Transition Plan*)

APPENDIX III

EXPLOSIVE GAS CONTROL PLAN FOR - LENOIR COUNTY

Quarterly the County of Lenoir landfill will monitor the explosive gas at the landfill structures and at or near the landfill boundary. The monitoring system will consist of two phases. Temporary probes (phase 1) will be placed in the ground as depicted in the operation drawings. The probes are holes that are two - three feet deep either poked in the ground or hand excavated. The top of the hole is then plugged by some means such as a plastic soft drink bottle. The second phase (permanent probes) will consist of a plastic stand pipe similar to a pieziometer used for groundwater detection. A typical permanent methane probe is detailed in the operation drawings. The permanent probe will be constructed at a depth of six (6) feet. A 6" diameter hole will contain a one (1) inch slotted PVC pipe. The bottom two (2) feet will be backfilled with non-carbonate pea gravel with a bentonite seal one (1) foot thick above it. The remaining three (3) feet will be backfilled with in-situ soils. The one (1) inch PVC pipe will be approximately three (3) feet above the existing grade. The PVC pipe will be capped with a one (1) inch PVC cap, one quarter (1/4) inch NPT hose barb, and 1" tubing, plugged or capped. The permanent probes will be installed by October 9, 1994.

The location and spacing of the methane monitoring probes is somewhat arbitrary. The locations were determined by the relationship of solid waste with property lines and landfill structures. The spacing of the methane probes varies due to the proximity of the property boundary with the solid waste. On the north end of the landfill the property boundary is several hundred feet away from the creek. The west side boundary is also the creek which is six to seven hundred feet away from solid waste. The probes on these sides are arbitrarily placed near the solid waste to detect any horizontal movement of methane gas. The boundary line is nearest to solid waste at the south end of the right-of-way and at the very southeast corner. These methane probes 1,12, and 13 were placed where nest to solid waste which was buried below ground and net filled above ground. On the east side, Lenoir County owns the land for several hundred feet east of methane probes 1 and 3. A boundary line begins at methane probe 3 and continues northerly past methane probe 5. The migration of methane gas is induced by pressure gradients. The methane will move from areas of high pressure to those of low pressure following the path of least resistance. The methane will migrate vertically until it reaches the landfill cap, where it will begin to flow horizontally. This occurs until it finds a pathway out, either by the installed methane collection trenches or migration through the permeable in-situ soils. Since methane is lighter than air, it wants to escape into the atmosphere. It has been our experience that whenever gas is migrating no matter what the spacing or depth of the monitoring probes, the gas will fill the void created by the monitoring point and an explosive meter will monitor the level. The six foot depth of the monitoring probes is to ensure a stable monitoring point. The only time a shallow monitoring point has not worked is in a very heavy, impermeable clay layer that acts as a seal to the migration of

the gas. If a clay layer is encountered during the construction of the monitoring points, it will either be moved beyond the clay or excavated to a depth that is in the conductive zone below the clay.

The permanent probes surround the existing fill area. The plan has been modified. This is to check if methane is migrating toward the present landfill boundary.

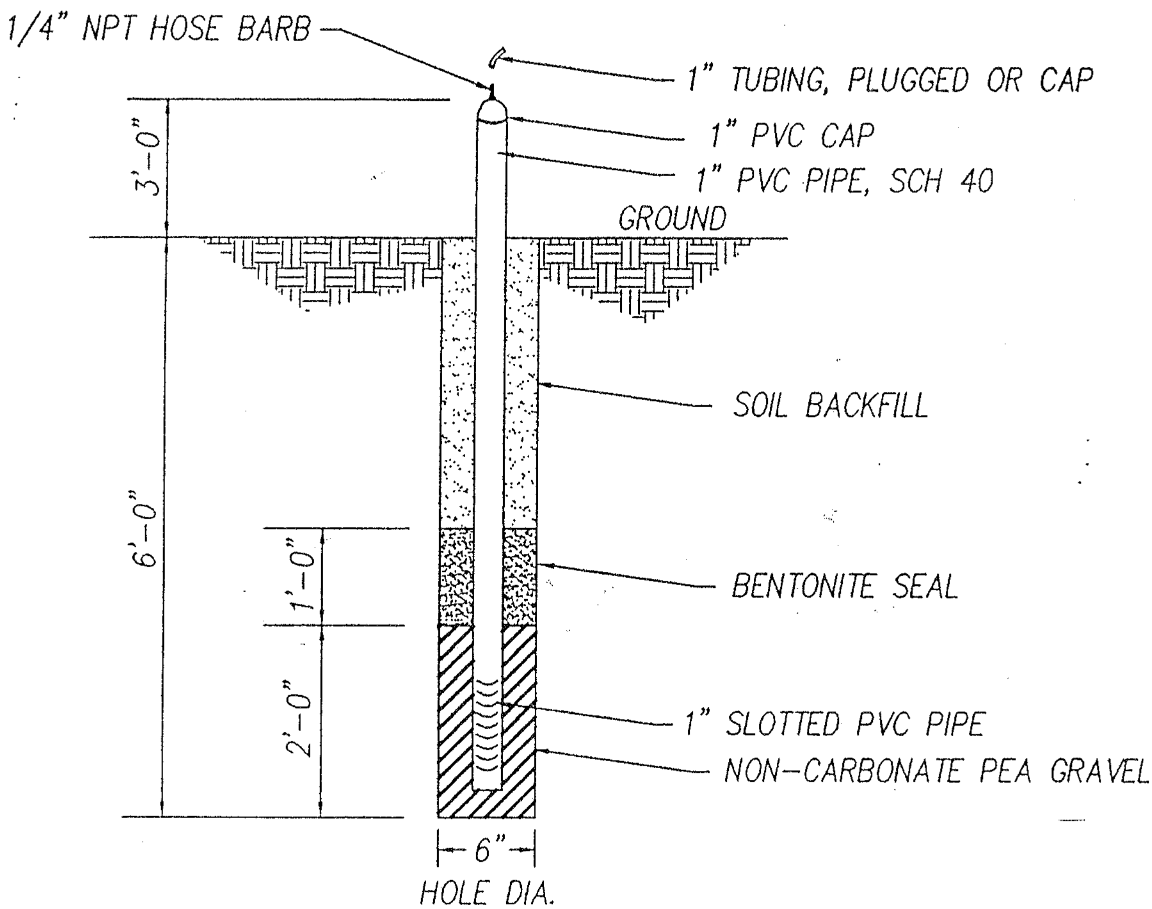
The gas can be detected by use of an instrument that reports the percent of lower explosive limit. An instrument that can be used is the Gas Tech GP 204 which can be purchased from Safety Supply America of Lexington, NC at 704-956-2131. The operation and calibration instructions are included in this appendix.

Quarterly, a County employee will visit each monitoring point either the temporary or permanent. The monitoring points consist of all methane probes. Using the detection instrument, he will determine if methane gas has filled the probes. If the probe is near the property line and methane gas is detected at or beyond the lower explosive limit (100% LEL), it must then be determined if the gas is migrating across the landfill boundary. If the probe is on the boundary or methane gas has migrated beyond the boundary, a remediation plan must be completed by Lenoir County.

Other points of monitoring will be the landfill structures. Each structure will be monitored for methane using the following methods:

1. All crawl spaces will be monitored;
2. All corners in the structure will be monitored;
3. Any holes, cracks and pipes through the foundation will be monitored

If methane gas is detected beyond 25% of its lower explosive limit in any structure, then a remediation plan is stated in the operational requirements.



METHANE GAS MONITORING PROBE

N.T.S.

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