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Corrective Action Plan

Prepared for

Greene County Landfill - Permit #40-02
Walstonburg, Greene County, North Carolina

APPROVED
DIVISION OF WASTE MANAGEMENT
SOLID WASTE SECTION
 DATE 2-15-10 BY Jimith Barber

MESCO Project Number: G07061.0

Prepared on 2/25/2009
Revision 5 (02/12/2009)

LICENSE NUMBER: C-0281		
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Zinith Barbee, Hydrogeologist 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

February 12, 2010

Re: Corrective Action Plan – Revision 5
Greene County Permit #40-02

Dear Mr. Barbee:

Enclosed please find Revision 5 of the *Corrective Action Plan* for the Greene County C&D Landfill over MSW Landfill, Permit #40-02. Please contact us by phone at (919) 772-5393 or electronic mail at mbrown@mesco.com if you have any questions or comments regarding this report.

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

Mark Brown, LG, PG
Senior Geologist

SMB/smb

Enclosure:
Corrective Action Plan

Cc: David Jones – Greene County

EXECUTIVE SUMMARY

The report presents a proposed Corrective Action Plan (CAP) to remediate contamination detected at the Greene County Construction and Demolition (C&D) Landfill located at 105 Landfill Road (SR 1239), Walstonburg, Greene County, North Carolina. Greene County C&D landfill operates under permit #40-02. Prior to operating as a C&D landfill, the site operated as an approximate 9-acre Municipal Solid Waste (MSW) unlined sanitary landfill. The MSW unit stopped receiving waste by January 1, 1998 in accordance with the *Greene County Transition Plan* prepared for Greene County by Municipal Engineering Services Company, P.A (MESCO), April 1994. The C&D landfill is constructed and operating on top of the MSW unit and, in accordance with Solid Waste Section (Section) Guidelines, is monitored under 15A NCAC 13B.1630

As a result of elevated contaminant concentrations detected during previous groundwater sampling events, the following chemical compounds were identified in the *Assessment of Corrective Measures (ACM) for Greene County Landfill* dated August 2007 as contaminants of concern (COCs):

- Benzene, chloroethane, *cis*-1, 2-dichloroethene (*cis*-1,2-DCE), vinyl chloride, *p*-dichlorobenzene, toluene, iron, lead

Greene County selected a remedy to meet the standards listed in Rule 15A NCAC 13B.1636(b) based on the following number of factors:

- The extent of detected contamination lies within the relevant point of compliance.
- There are no potable wells observed or reported within 2,000 feet of the facility.
- A man-made diversion ditch beginning at the northwest corner of the C&D landfill extends easterly along the northern property boundary.
- Contamination is below risk exposure levels.
- Contamination appears to be limited to the unconfined, surficial aquifer.
- Natural attenuation mechanisms appear to be actively controlling groundwater contaminant movement in this area.
- Modeling suggests that *cis*-1,2-DCE and vinyl chloride might reach the relevant point of compliance in approximately 10 years.

Greene County has determined that the most cost effective and efficient system for remediation at the site is monitored natural attenuation (MNA) supplemented by phytoremediation. Institutional controls limit access to the site, public water is available to the surrounding area, and the source area has been capped to limit the infiltration. MNA will be implemented to correspond with semi-annual sampling.

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1 INTRODUCTION

1.1 Site Background

The Greene County Construction and Demolition (C&D) landfill is an approximate 9-acre tract located at 105 Landfill Road (SR 1239), Walstonburg, Greene County, North Carolina. Greene County C&D landfill operates under permit #40-02. Prior to operating as a C&D landfill, the site operated as a Municipal Solid Waste (MSW) unlined sanitary landfill. The MSW unit was closed using an 18-inch cohesive soil cap with a permeability of 1×10^{-5} cm/sec, and 18 inches of erosive layer. The MSW unit stopped receiving waste by January 1, 1998 in accordance with the *Greene County Transition Plan* prepared for Greene County (the County) by Municipal Engineering Services Company, P.A (MESCO), April 1994.^[7] The C&D landfill is constructed and operating on top of the MSW unit and, in accordance with Solid Waste Section (Section) Guidelines, is monitored under 15A NCAC 13B.1630. A topographic map presenting the location of the site is included as **Plate 1**.

1.2 Aquifer Characteristics

The site lies within the Coastal Plain physiographic province, which is characterized by flat or gently undulating topography and dissected by drainage features with narrow to moderately sloped sides. Topographic relief across the facility is approximately 20 feet. Surface drainage across the site is generally northeast towards a tributary of Sandy Run. Sandy Run flows east towards Little Contentnea Creek, which drains into the Neuse River. A site map presenting the layout of the permitted facility is included as **Plate 2**.

The site is underlain by unconsolidated surficial deposits made up of sand, clay and gravel, which generally dip to the southeast. The surficial sediments are underlain by the Yorktown formation, which consists of an overlying confining unit of clay, silty clay, and/or sandy clay that is approximately 25 feet thick; followed by an underlying unit of fine sand, silty sand, and clayey sand.^[4] Groundwater at the site is relatively shallow and typically occurs at depths of less than 20 feet below ground surface (bgs), with the shallowest depths occurring along the eastern side of the property. Groundwater static water level measurements in the monitoring wells have been generally consistent over time, and have been reported in the following depth ranges:

- ≤ 10 ft. bgs: *MW-1R, MW-6*
- 10 to 20 ft. bgs: *MW-4, MW-5, MW-7, MW-8*

Historical groundwater elevations are provided in **Table 2**. Local drainage features control primary groundwater flow dynamics. Groundwater located beneath the site appears to flow in an easterly direction away from the waste limits. A single-day potentiometric map depicting groundwater flow conditions recorded on July 15, 2009 is provided as **Plate 3**.

1.3 Contaminant Distribution

Groundwater contaminants of concern (COCs) at the site consisted of dissolved-phase volatile organic compounds (VOCs) and inorganic compounds (metals) in concentrations exceeding established 15A NCAC 2L Groundwater Standards (2L Standards). Six organic compounds (benzene, chloroethane, chloroethene (vinyl chloride), *cis*-1,2-dichloroethene, 1,4-dichlorobenzene (*p*-dichlorobenzene) and methylbenzene (toluene)) were detected at levels above their respective 2L Standards in MW-4 at the northeastern corner of the site. Inorganic constituents (metals) detected above their respective 2L Standards included cadmium, chromium, iron, lead, and manganese. Cadmium, chromium, iron, lead, vanadium, and zinc have also been detected in surface water samples at levels above the surface water standards promulgated in 15A NCAC 2B (2B Standards).

1.4 Site Conceptual Model

The site conceptual model represents, and is based on, the physical, chemical and biological processes that determine the transport of contaminants from sources through environmental media to potential receptors. Site conceptual and analytical models were developed and originally presented in the *Assessment of Corrective Measures (ACM) Greene County* prepared by MESCO in August 2007. The models consisted of conceptual cross sections and analytical modeling using MODFLOW with MT3D⁹⁶. The lithologic cross-sections presented in the *ACM* are provided herein on **Plate 4**.

1.5 Site Description

The site lies within the Coastal Plain physiographic province that is characterized by flat or gently undulating topography dissected by drainage features with narrow to moderately sloped sides. There is approximately 20 feet of relief across the site. Surface drainage is northeast towards a tributary of Sandy Run. Sandy Run flows east towards little Contentnea Creek and ultimately to the Neuse River.

1.5.1 Geology

The geology of the site consists of surficial sediments overlying the Pliocene Yorktown and Cretaceous Black Creek Formations. The surficial deposits are made up of sand, clay and gravel which dip to the southeast at less than 0.5 degrees and are generally less than forty feet deep. The Yorktown formation

consists of an overlying confining unit of clay, silty clay, or sandy clay that is approximately 25 feet thick, followed by fine sand, silty sand, and clayey sand.^[4]

According to information presented in the *ACM*, the subsurface lithology at location MW-1R consists of orange mottled silty clay to gray mottled sandy clay; the lithology at location MW-4 consists primarily of red-orange mottled clay/silty clay, to red sandy clay, to orange silty clay. The lithology at MW-5 consists of tan silty clay, gray sandy clay to orange clayey sand. Subgrade soils located at location MW-6 consist of orange, mottled gray silty clay/sandy clay. MW-7's lithology consists of mottled gray/red/orange clay, and MW-8 is located primarily in gray/red/orange-mottled clay to orange clayey sand.

1.5.2 Hydrogeology

Hydrogeologic properties of monitoring wells MW-1R, MW-4, MW-5, and MW-6 were reported in a *Water Quality Monitoring System Modifications Report* prepared by GAI Consultants. Hydraulic conductivity (K) values are summarized in **Table 3**. K values, as determined from slug testing performed by others in October 1994^[3] and by MESCO in June 2007 (after installation of monitor wells MW-7 and MW-8), reportedly ranged from 1.10×10^{-4} cm/sec (MW-4) to 1.14×10^{-3} cm/sec (MW-8), with a geometric mean of 2.07×10^{-4} cm/sec.

Average linear groundwater velocities (v_x) were calculated using the following equation:

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

where:

v_x represents the average linear velocity [length/time]

K represents the hydraulic conductivity [length/time]

n_e represents the effective porosity [unitless]

and

i represents 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 hydraulic gradient was calculated graphically by first drawing a perpendicular line from each monitoring well to the closest downgradient equipotential line. The hydraulic head (dh) elevations were calculated by subtracting the equipotential line elevation value from the static water level elevation value measured in the corresponding piezometer. The lateral distance (dl) is the horizontal length of the line between the two points. dl values are further denoted on **Plate 3**. The hydraulic gradient at a given piezometer location was determined by dividing dh by dl . Hydraulic gradient at the site was calculated to

range from 0.015 to 0.025 ft/ft. The calculated average linear velocities were found to have a median value of 33.4 ft/yr.

Porosities for MW-1R, MW-4, MW-5, and MW-6 were reported in the aforementioned *ACM*. Porosities for MW-7 and MW-8 were calculated from Shelby Tube samples collected during installation of the monitoring wells. Values of total porosity ranged from a high of 43.2% in MW-6 to a low of 36.7% in MW-1R with an average of 40.1%.

Effective porosities for MW-1R, MW-4, MW-5, and MW-6 were assumed in the *ACM* at 15%. Effective porosity for MW-7 and MW-8 were estimated using the relationship between effective porosity and grain-size distribution. Johnson (1967) compiled a number of published effective porosity values and developed a relationship between the grain size distribution and the effective porosity. Grain size distribution from monitoring wells MW-7 and MW-8 was applied to the “tri-linear graph of textural classification.” Unfortunately, the grain size distribution fell into an area of no samples. The reported value of 15% does not conform with published values of silty clay or sandy clay. The published value of 7% was, therefore, used as the estimated effective porosity for the Sandy Clay.^[5]

1.5.3 Hydrology

1.5.3.1 Potable Sources

Municipal water is available to the surrounding area. A site reconnaissance and receptor survey performed in the area in 2007 as part of the *Transition Plan* did not identify any potable wells located within 2000 feet of the facility. A man-made diversion ditch beginning at the northwest corner of the C&D landfill extends easterly along the northern property boundary.

1.5.3.2 Groundwater Regime

Regionally the near-surface aquifer occurs in unconsolidated soils. These unconsolidated soils overlie several regional confined aquifers. In the area south of Wooten’s Crossroads, the Yorktown aquifer underlies the surficial aquifer and is confined by a clay/sandy clay-confining unit.^[4]

Locally, groundwater exhibits flow dynamics that are primarily controlled by the local drainage features. Groundwater elevations have been recorded during sampling events. A summary of historical groundwater elevation data is included in **Table 2**. Water elevations appear to be fairly consistent. On average, static groundwater in MW-1R and MW-6 occurs approximately five to six feet below ground surface (bgs), in MW-4 and MW-5 approximately 16 to 17 feet bgs, and in new wells MW-7 and MW-8

approximately 10 to 11 feet bgs. Groundwater flow is generally easterly. A potentiometric map is provided as **Plate 3**.

1.5.3.3 Groundwater Modeling

A conceptual model of the site was developed with Visual MODFLOW designed by Waterloo Hydrogeologic, Inc. The visual MODFLOW package includes the USGS developed MODFLOW, the accompanying particle tracking program, MODPATH, as well as the contamination transport package MT3D⁹⁶ developed by Papadopulos and Associates, Inc.

The model grid consisted of an area 1700 feet x 1200 feet divided into 60 rows, 85 columns and 5 layers. To approximate the aquifer characteristics, each layer was defined with distinct hydraulic properties.

Lithology		Hydraulic Conductivity (cm/sec)	Total Porosity	Effective Porosity
Layer 1	Orange Mottled Silty CLAY	1.15×10^{-4}	38.4	7
Layer 2	Orange/Red/Gray Sandy CLAY	4.90×10^{-4}	40.4	7
Layer 3	Gray Silty CLAY	1.15×10^{-4}	38.4	7
Layer 4	Confining Layer of Yorktown Formation	5.90×10^{-6}	37.6	9
Layer 5	Yorktown Formation	7.7×10^{-3}	51.7	20

Layer 1 and Layer 3 - Estimated from MW-1R and MW-4
 Layer 2 Estimated from MW-5, MW-6 and MW-8
 Layer 4 and Layer 5 estimated from published values^[4]

The contaminant plume was determined from plume models created using MODFLOW (with transport package MT3D⁹⁶) to simulate a release. Modeling parameters assumed leakage occurred prior to installation of the CAP system. As with the development of the MODFLOW model, MT3D⁹⁶ Transport was calibrated through a trial and adjustment procedure. The retardation coefficient and dispersion factors were calibrated to time periods 2006 and 2007. In an attempt to incorporate historical data, MESCO used 1990 as a baseline, and target step periods of 5 years (1995), 16 years (2006), 17 years (2007), 25 years (2015), 35 years (2025), and 50 years (2040) were simulated in the model. The plume contour for 2007 was manually transposed from the simulations onto **Plate 5**. Based on plume contours, groundwater impact appeared to be limited to monitoring well MW-4 and, therefore, the unconfined

surficial aquifer. To date, elevated levels of target analytes have not been detected in compliance wells MW-7 and MW-8. Historically detected organic constituents are presented in **Table 4**.

1.5.4 Physical Processes

The primary mechanism promoting physical movement of the plume is advection. Retardation coefficients (R values) were calculated in the *ACM*. The following table expresses the anticipated time requirements for dissolved target analytes to reach the relevant point of compliance, excluding biological decay and dilution.

<i>Contaminant Velocity (Presented in ACM)</i>		
Monitoring Well	MW-4	Time to relevant point of compliance (approx. 125 ft from MW-4)
Benzene	3.46 ft/year	36.1 years
Chloroethane	6.29 ft/year	19.9years
Vinyl Chloride	12.6 ft/yrs	9.9 years
<i>p</i> -Dichlorobenzene	0.68 ft/year	183.8 year
Toluene	1.58 ft/year	79.1 years
Cis-1,2-dichloroethene	9.58 ft/year	13.0 years

The above table suggests that contamination has the potential to travel at or near the seepage velocities identified in the *ACM*. Summaries of the corrective action screening results as presented in the *ACM* are included as **Tables 8A-8E** (attached).

1.5.5 Chemical/Biochemical Processes

Chemical degradation processes, primarily that of half-life decay, are typically presented in relation to surface water measurements ^[10]. A man-made diversion ditch beginning at the northwest corner of the C&D landfill extends easterly along the northern property boundary and the identified contamination consisted of constituents dissolved in groundwater. Benzene, chloroethane, and vinyl chloride experience rapid volatilization in soil when released near the surface and to surface waters. *p*-Dichlorobenzene and toluene volatilize rapidly when released into surface waters and experiences low to moderate adsorption when released into soils.^[1] Half-life reactions in groundwater vary greatly. A summary of published half-life reactions in groundwater is included below.

<i>Half-Life in Groundwater[6]</i>		
Constituent	Half-Life (high)	Half-Life (low)
Benzene	24 months	10 days
Chloroethane	31 months	5.5 weeks
Vinyl chloride	70 months	14 weeks
<i>p</i> -Dichlorobenzene	12 months	8 weeks
Toluene	12 months	8 weeks
Cis-1,2-dichlorethene	4 months	13 weeks
Lead	Stable	
Iron	Stable	

The identified COCs consisted of aromatic hydrocarbons, chlorinated aliphatic hydrocarbons and heavy metals dissolved in groundwater. Natural biodegradation of most chlorinated hydrocarbons, including halogenated aliphatics, occurs through reductive dechlorination. Reductive dechlorination occurs as the result of microbial activity that 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 activity^[2].

1.6 Regulatory Status

The Greene County Landfill operates as a C&D landfill constructed over a MSWLF landfill under permit #40-02. 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:

- benzene – *aromatic hydrocarbon*
- chloroethane – *chlorinated aliphatic hydrocarbon*
- cis-1,2-dichloroethene - *chlorinated aliphatic hydrocarbon*
- vinyl chloride – *chlorinated aliphatic hydrocarbon*
- *p*-dichlorobenzene – *chlorinated aromatic hydrocarbon*
- toluene – *aromatic hydrocarbon*

- iron – *heavy metal*
- lead – *heavy metal*

2.2 Contaminant Source Confirmation

The source of the release has been identified as the MSW landfill. The mechanism suspected 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 thick cohesive soil cap (permeability of 1×10^{-5} cm/sec) and 18 inches of erosive layer. Ultimately groundwater will discharge into unnamed creeks located east of the landfill. These creeks are tributaries of Sandy Run. There are no known groundwater users located within 2,000 feet of the facility.

2.3 Source Control Measures

The landfill stopped receiving MSW by October 1998 and was closed with an 18-inch thick cap of cohesive soil with a permeability of 1×10^{-5} cm/sec, and an 18-inch erosive layer. As indicated in Appendix III (*Explosive Gas Control Plan for Greene County*) of the *Transition Plan*, the County installed a passive horizontal gas venting system around the perimeter of the landfill in 1994. Permanent probes (sampling points) installed around the perimeter of the landfill were constructed of 1-inch slotted Schedule 40 PVC pipe inserted into a 6-inch diameter augered hole to an approximate depth of six feet bgs. Probes were constructed with sufficient PVC riser to extend approximately three feet above the ground surface. The tops of the probes were capped with a PVC cap equipped with a ¼-inch NPT hose barb and 1-inch sample tubing. The bottom two feet of the borings were backfilled with pea gravel with an approximate one-foot thick cap of bentonite seal hydrated on top. The remaining annular space was backfilled with soil cuttings. Methane gas levels are monitored quarterly in the sampling points and landfill structures by County personnel using a combustible gas meter. Copies of the *Permanent Methane Monitoring Plan* (including the plan, a map of monitoring points, and the last three Methane Gas Monitoring Reports) and the *Permanent Methane Monitoring Plan* Approval Letter, dated September 13, 1994, provided by Greene County are presented in **Appendix C**.

2.4 Risk Assessment

Risk assessment was performed as part of the ACM and assumed direct contact with the identified contamination. Exposure pathways are limited to on-site contact with groundwater. Monitor wells are cased and secured with locking well caps. Access to the site is limited during operational hours. Adult hazard index values for the referenced COCs were “less than 1” from inhalation, dermal, and oral

ingestion exposure. Additionally, child hazard index values for referenced COCs were less than 1 from inhalation, dermal, and oral ingestion exposure.

2.5 Contaminant Concentrations

2.5.1 Background Concentrations

Background water quality data is collected from upgradient monitor well MW-1R. Water quality samples have been collected since 1994. Historical background results are shown in **Table 5**. Current groundwater results are shown in **Table 6**.

2.5.2 Exceedances of Groundwater Quality Standards

Groundwater contaminants that have exceeded 2L Standards include: benzene, chloroethane, chromium, *cis*-1,2-DCE, *p*-dichlorobenzene, toluene, vinyl chloride, cadmium, lead, iron, and vanadium. Cadmium, chromium, and vanadium were found to be statistically insignificant and are, therefore, not considered COCs.

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). Surface water samples are collected off-site at the tributary of Sandy Run. One (1) upstream sample and one (1) downstream sample are collected. Current surfacewater results are shown in **Table 7**. The upstream sampling point was dry during the March 2008 sampling event.

2.6 Media of Concern

Groundwater is the primary medium 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 medium 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.

3 SELECTED AND APPROVED REMEDY / TECHNICAL APPROACH

A number of factors influenced selection of remediation alternatives.

- The extent of detected contamination lies within the relevant point of compliance.
- There are no potable wells observed or reported within 2,000 feet of the facility.
- A man-made diversion ditch beginning at the northwest corner of the C&D landfill extends easterly along the northern property boundary.
- Contamination is below risk exposure levels.
- Contamination appears to be limited to the unconfined, surficial aquifer.
- Natural attenuation mechanisms appear to be actively controlling groundwater contaminant movement in this area.
- Modeling suggests that *cis*-1,2-DCE and vinyl chloride might reach the relevant point of compliance in approximately 10 years. This does not account for the effects of dilution, volatilization, dispersion, or contaminant degradation.

Remediation of relatively low level contamination in the 10 µg/L range can be difficult, expensive and may not be achievable. The most cost effective and efficient system for remediation is monitored natural attenuation (MNA) supplemented by phytoremediation.

3.1 Technical Approach (Monitored Natural Attenuation)

Bioscreen and *Biochlor* were initially run using data from MW-4 to assess the potential effectiveness of MNA. *Bioscreen* was focused on benzene due to the high half-life of two years. *Bioscreen* results presented a 47% decrease in contamination in five years through 1st-order decay and a 100% decrease in contamination through instantaneous reaction model. Results of *Bioscreen* are provided in **Appendix A**.

Biochlor was run using site specific data for *cis*-1,2-dichloroethene and vinyl chloride. Dual modeling was utilized based on high half-lives and low half-lives. High half-life results indicated an 8.1% decrease for *cis*-1,2-DCE and a 5.5% decrease for vinyl chloride in five years through biotransformation modeling. Low half-life results indicated a 51.4% decrease for *cis*-1,2-DCE and a 48.5% decrease for vinyl chloride in five years through biotransformation modeling. *Biochlor* results are provided in **Appendix A**.

To more clearly delineate the extent of dissolved-phase VOCs in groundwater, it is recommended that additional groundwater samples be collected in the vicinity of monitoring well MW-4. To reduce costs, groundwater sampling may be conducted using direct-push methods (e.g. GeoProbe®). Baseline

sampling of monitoring wells MW-1R and MW-4 will be performed semi-annually for a two-year period (four events), and will incorporate the MNA performance parameters listed in **Section 4** and **Appendix B**. Stream water quality monitoring will consist of sampling existing upstream and downstream surfacewater sampling points, located along the unnamed tributary of Sandy Run (see **Plate 2**).

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. All groundwater samples collected from the monitoring wells will be analyzed for Appendix I or Appendix II constituents in accordance with 15A NCAC 13B.1630. Additionally, groundwater samples collected from monitoring wells MW-1R and MW-4 will be analyzed for the following MNA performance parameters:

<i>MNA Performance Parameters</i>		
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	
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.		

4.2 Surfacewater Sampling and Monitoring

Surfacewater sampling will be conducted to monitor COC concentrations in the adjacent stream areas. To date, COC concentrations have been detected below respective 2B Standards. Two (2) surfacewater sampling points designated “Upstream” and “Downstream” have been established along an unnamed tributary of Sandy Run. The locations of both surfacewater sampling points are depicted in **Appendix B, Plate A**. All surfacewater samples are analyzed for Appendix I and Appendix II constituents. The *Groundwater 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 of remediation 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 in order to visualize changing trends in groundwater chemistry that are expected to occur over time as a result of the various remedial mechanisms/processes that are occurring at the site (e.g. biodegradation, reductive dechlorination, 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.

Quantitative Evaluation

Quantitative evaluation will be conducted through annual revision of *Bioplume* and *Bioscreen* models, 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 list above, 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.

5.1.2 Evaluation of Plume Area

Monitoring well MW-1R will be used as the background well for inter-well statistical analysis of MNA data. Monitoring well MW-4 will be used as a performance well, while downgradient wells MW-5, MW-6, MW-7 and MW-8 will be used as compliance wells for assessment monitoring.

COC levels throughout the contaminant plume should decrease as a result of natural attenuation. Direct-push groundwater sampling around MW-4 may be necessary to collect additional information with which to evaluate plume movement and MNA performance.

5.2 Refining the Site Conceptual Model

Over the course of corrective action the site conceptual model will be refined in order to determine the appropriate course of remediation. 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

Corrective action sampling and monitoring reports will be submitted on a semi-annual basis, within 30 days of receiving all complete laboratory analytical reports. All reports submitted regarding evaluation of effectiveness will establish trends of the indicator parameters and contain tables, maps and figures relating to field and laboratory data. Laboratory reports, groundwater maps, contamination concentration maps and cross sections will be included. Specific parameters for individual plume areas will also be ascertained.

6 CONTINGENCY PLAN

6.1 Contingency Plan

Should the selected remedial approach not perform as expected and/or the constituent concentrations do not decrease within five years after implementation of remedial measures, contingency plans will be needed.

6.1.1 Phytoremediation

Should MNA fail to significantly reduce contaminant concentrations within two years of implementation, the process will be enhanced by the introduction of phytoremediation procedures. To accelerate the natural evapotranspiration process and to allow for hydraulic containment (plume control), the area surrounding MW-4, MW-5, MW-7, and MW-8 will be thinned of juvenile trees (those trees with a diameter of less than 3 inches) and pines, and 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. Phytoremediation is expected to occur through several processes: the release of enzymes from the root system that break down hydrocarbons (phytodegradation), limitation of infiltration by increasing evapotranspiration, and eventual uptake of hydrocarbons (phytoextraction). Available literature (e.g., Schnoor^[9]) suggests an initial planting density of 1,000-2,000 trees/acre (~43 ft²/tree). As the trees become established over time (1-2 years) competition between plants will reduce this density to ~600-800 trees/acre. The proposed phytoremediation area comprises approximately 1 acre; therefore, at the aforementioned planting density, a minimum of 1,200 hybrid willow seedlings will need to be planted at the onset of corrective action. Planting of seedlings will likely be performed by mechanical methods to reduce installation costs, and is tentatively scheduled to occur between August and September 2009.

Protective fencing to prevent damage to the seedlings by wildlife (e.g. deer) is recommended around the area of planting. The proposed phytoremediation area is depicted in **Plate 5**.

Groundwater sampling will be performed semi-annually on monitoring wells MW-1R, MW-4, MW- 5, MW-6, MW-7, and MW-8. Baseline sampling for the suite of MNA performance parameters listed in **Section 4** and **Appendix B** shall be performed for two years following planting of hybrid willow trees. Soil sampling may also be conducted to monitor potential salt accumulation in the root zone. Phytoremediation sampling and monitoring results, in addition to information on tree growth and health, shall be included as a separate section within the semi-annual monitoring reports.

6.1.2 Enhanced Bioremediation

Should MNA and phytoremediation fail to significantly reduce contaminant concentrations within three years of implementation, enhanced bioremediation may need to be employed. Several substrates that have been shown to effectively reduce contaminant concentrations include oxygen-release compound (ORC) and hydrogen release compound (HRC). ORC, as manufactured by Regenesis, Ltd., consists of a dry mixture of calcium hydroxides with potassium phosphates that, when mixed with water, is injected into the subsurface as a slurry. Issues to consider prior to its use are its high pH (11-13), and its insolubility, that may lead to settlement during mixing and handling. HRC has been shown to effectively enhance reductive dechlorination of halogenated hydrocarbons, but to be less effective with remediating aromatic hydrocarbons. The design and implementation of alternate injection substrates is beyond the scope of this CAP report.

6.2 Safeguard Measures and Site Security

Exposure pathways are limited to on-site contact with groundwater. Monitoring wells are cased and secured with locking well caps. Access to the site is limited during operational hours. Public water is available to the surrounding area.

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 and Maintenance

Greene County will oversee day-to-day operation and upkeep of the remediation technology. Any equipment required for remediation will be the responsibility of the County. If problems with the remediation system arise, the Solid Waste Section will be notified and a written report will be issued. The Greene County Department of Solid Waste can be contacted at (252) 747-5720 regarding daily activities.

7.2 Timeline

Implementation of corrective action will begin within 30 days of CAP approval. Initial activities will consist primarily of administrative tasks including scheduling of drilling and remediation sub-contractors, permit preparation/submittal, and materials purchasing. A timeline estimate for sampling events and performance evaluation is presented in **Table 9**.

8 FINANCIAL ASSURANCE REQUIREMENTS

In general accordance with 15A NCAC 13B .0546, demonstration of financial assurance was achieved through the local government financial test. MESCO personnel will perform semi-annual sampling and monitoring activities; data analysis, interpretation and validation; and semi-annual compliance reporting. A breakdown of the estimated annual costs for MNA and a one-time start-up cost to implement phytoremediation are presented below.

1. MNA Sampling and Laboratory Cost Estimates

GeoProbe Groundwater Sampling Subcontractor Services.....	\$2,500
MNA Samples (6 samples x \$750/sample x 2 times/year).....	\$9,000
Labor (\$2,000 per sampling event x 2 times/year)	\$4,000
Compliance Reporting (\$2,500 per sampling event x 2 times/year).....	\$5,000
Annual Estimated MNA Costs.....	\$20,500

2. Explosive Gas Control Plan (EGCP)

EGCP (Labor and Equipment).....[Included in County's daily operational costs]

3. Phytoremediation

Purchase and plant approximately 1,000 willow/poplar trees...[one time start-up costs]... \$5,000

4. Estimated Costs for 30 years

\$20,500/year x 30 years..... \$615,000

5. Estimated 30-Year Costs Adjusted for Inflation

\$615,000 x 2.2% (2009 SWS Inflation Multiplier).....\$628,530

A financial assurance mechanism, that includes the above-listed CAP cost estimate, was prepared by the County's Chief Financial Officer, and has been reviewed and approved by the Section.

9 COMPLETENESS OF CORRECTIVE ACTION

Results indicate that reduction of the low level contamination can be achieved through MNA supplemented with phytoremediation. There is no indication that the contamination will reach the relevant point of compliance within a reasonable time period. Institutional controls limit access to the site. Public water is available to the surrounding area. The source area has been capped to limit the infiltration. MNA will be implemented to correspond with semi-annual sampling.

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- [4] Giese, G. L., Eimers, J. L., Coble, R. W., 1997, Simulation of Ground-Water flow in the Coastal Plain Aquifer System of North Carolina. U.S Geological Survey Professional Paper 1404-M, 142p.
- [5] Johnson, A.I., 1967, Specified Yield-Compilation of Specific Yields for Various Materials: US Geological Survey Water-Supply Paper 1662-D.
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- [7] Municipal Engineering Services Company, P.A, April 1994. *Greene County Transition Plan*.
- [8] Municipal Engineering Services Company, P.A, August 2007. *Assessment of Corrective Measures*, Greene County Landfill – Permit #40-02
- [9] Schnoor, J.L., October 1997, *Phytoremediation*, The University of Iowa, Department of Civil and Environmental Engineering, Groundwater Remediation Technologies Analysis Center.
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Tables

Table 1: Well Construction Details

Monitoring Well	Date Installed	Ground Elevation	Top-of-Casing Elevation	Northing	Easting	Well Diameter	Boring Diameter	Screen Interval (BGS)	Confining Layer	Status
MW-1	11/19/1981	-	-	-	-	2	-	9 - 19	-	Not Sampled
MW-1R	8/26/1994	119.79	121.78	648587.3426	2388246.5017	2	8	3.2 - 18.2	-	Background Well
MW-4	8/26/1994	115.14	117.89	649243.8400	2389067.3100	2	8	9.1 - 24.1	-	Performance Well
MW-5	8/28/1994	113.16	115.76	648960.8900	2389109.3900	2	8	14 - 29	-	Monitoring Well
MW-6	8/29/1994	114.54	117.41	648550.1348	2389058.2699	2	8	13.8 - 28.8	-	Monitoring Well
MW-7	6/21/2007	107.75	110.48	649145.8872	2389228.1449	2	8	6.5 - 18.5	-	Compliance Well
MW-8	6/21/2007	108.71	111.36	649291.4753	2389224.0574	2	8	6.98 - 17.98	-	Compliance Well

NOTE:

1. Ground and Top-of-Casing elevations are in feet above mean sea level (amsl), well and boring diameter are in units of inches.

Table 2: Historical Groundwater Elevation Data

WELL	9/15/1994	11/18/1994	1/12/1995	2/6/1995	9/12/1995	9/15/1995	4/19/1996	3/17/1997	3/3/1998	9/9/1998
MW-1R	115.85	114.88	116.04	116.54	113.91	115.85	116.26	116.89	116.66	117.87
MW-4	97.91	97.05	96.75	97.50	98.06	97.91	103.46	105.43	105.52	101.36
MW-5	97.14	96.01	95.94	96.64	96.63	97.14	101.45	103.53	103.15	99.75
MW-6	108.33	106.53	109.09	110.83	104.32	108.33	111.62	112.61	113.42	111.09
MW-7	-	-	-	-	-	-	-	-	-	-
MW-8	-	-	-	-	-	-	-	-	-	-

WELL	3/25/1999	10/5/1999	3/1/2000	9/21/2000	3/8/2001	9/27/2001	3/27/2002	9/19/2002	3/19/2003	9/11/2003
MW-1R	116.84	117.00	116.53	116.87	116.96	116.09	117.91	116.28	117.87	116.37
MW-4	104.66	105.27	105.31	99.85	101.25	98.22	98.85	96.45	103.65	103.35
MW-5	101.62	101.60	102.29	98.61	99.25	97.05	97.45	95.06	100.49	100.73
MW-6	112.85	112.51	112.66	111.21	112.95	108.86	112.49	108.01	113.62	110.44
MW-7	-	-	-	-	-	-	-	-	-	-
MW-8	-	-	-	-	-	-	-	-	-	-

WELL	3/18/2004	9/30/2004	3/29/2005	9/29/2005	3/3/2006	9/21/2006	3/19/2007	5/24/2007	6/22/2007	3/28/2008
MW-1R	116.37	116.25	117.61	115.61	116.65	117.20	116.78	116.17	-	116.65
MW-4	104.30	99.19	104.09	91.73	104.32	104.62	104.56	102.11	-	100.98
MW-5	101.76	98.23	100.56	87.42	101.12	101.09	101.76	99.26	-	97.73
MW-6	112.56	110.84	113.37	107.16	113.01	111.85	112.74	112.10	-	111.99
MW-7	-	-	-	-	-	-	-	-	98.60	97.46
MW-8	-	-	-	-	-	-	-	-	101.26	101.59

WELL	Observed High	Observed Low	Difference	Average
MW-1R	117.91	113.91	4.00	116.51
MW-4	105.52	91.73	13.79	101.16
MW-5	103.53	87.42	16.11	98.98
MW-6	113.62	104.32	9.30	110.94
MW-7	98.60	97.46	1.14	98.03
MW-8	101.59	101.26	0.33	101.43

Table 3: Slug Test Summary

Well	Screen Interval (BGS)	Initial DTW (BTOC)	Initial Head Change	K (cm/sec)	Lithology
MW-1R*	3.2 - 18.2	7.47	7.47	1.20E-04	Silty Clay/Sandy Clay
MW-4*	9.1 - 24.1	20.22	16.22	1.10E-04	Sandy Clay/Silty Clay
MW-5*	14 - 29	19.30	18.30	1.40E-04	Sandy Clay
MW-6*	13.8 - 28.8	9.99	8.99	1.90E-04	Sandy Clay
MW-7	6.5 - 18.5	11.88	5.93	1.98E-04	Clay
MW-8	6.98 - 17.98	10.10	3.63	1.14E-03	Sandy Clay

Summary Statistics				
Geometric Mean (GM)	2.07E-04	Maximum	1.14E-03	
Geo. Std. Deviation (σ_{GSD})	2.38	Minimum	1.10E-04	
GM / GSD ($-1\sigma_{GSD}$)	8.70E-05	Median	1.65E-04	
GM * GSD ($+1\sigma_{GSD}$)	4.94E-04	Count	6	

*Information for MW-1R, MW-4, MW-5, MW-6 obtained from Greene County Water Quality Monitoring System Modifications (1994)

Notes: BGS = Below Ground Surface
BTOC = Below Top-of-Casing

Table 4: Summary of Historical Organic Results

Well ID	Parameter Name ¹	Sample Date	Result	Unit	Qual Code	PQL ²	NCGW2L ³	Exceedance
Downstream	Toluene	09/29/2005	10.9	ug/l		5	1000	
Downstream	Toluene	03/28/2008	0.2	ug/l		0.13	1000	
EB	Toluene	04/19/1996	7	ug/l		5	1000	
MW-4	Benzene	03/19/2007	3.9	ug/l		3	1	2.9
MW-4	Benzene	09/13/2007	1	ug/l		0.16	1	
MW-4	Benzene	03/28/2008	2.2	ug/l		0.16	1	1.2
MW-4	Chloroethane	09/21/2006	20.1	ug/l		10	2800	
MW-4	Chloroethane	03/19/2007	12.5	ug/l		5	2800	
MW-4	cis-1,2-Dichloroethene	03/29/2005	9.4	ug/l		5	70	
MW-4	cis-1,2-Dichloroethene	03/03/2006	10.8	ug/l		5	70	
MW-4	cis-1,2-Dichloroethene	09/21/2006	14.3	ug/l		5	70	
MW-4	cis-1,2-Dichloroethene	05/24/2007	10	ug/l		0.14	70	
MW-4	cis-1,2-Dichloroethene	09/13/2007	9	ug/l		0.14	70	
MW-4	cis-1,2-Dichloroethene	03/28/2008	10.2	ug/l		0.14	70	
MW-4	Ethylbenzene	03/28/2008	0.3	ug/l		0.16	550	
MW-4	p-Dichlorobenzene	03/19/2007	3.4	ug/l		3	1.4	2
MW-4	p-Dichlorobenzene	05/24/2007	2.4	ug/l		0.15	1.4	1
MW-4	p-Dichlorobenzene	09/13/2007	2.9	ug/l		0.21	1.4	1.5
MW-4	p-Dichlorobenzene	03/28/2008	3.9	ug/l		0.21	1.4	2.5
MW-4	Toluene	09/29/2005	10.4	ug/l		5	1000	
MW-4	Toluene	05/24/2007	1.1	ug/l		0.15	1000	
MW-4	Toluene	09/13/2007	2.3	ug/l		0.13	1000	
MW-4	Vinyl chloride	03/19/2007	5.5	ug/l		5	0.015	5.485
MW-4	Vinyl chloride	05/24/2007	2.6	ug/l		0.15	0.015	2.585
MW-4	Vinyl chloride	09/13/2007	2.5	ug/l		0.34	0.015	2.485
MW-4	Vinyl chloride	03/28/2008	4.7	ug/l		0.34	0.015	4.685
MW-5	cis-1,2-Dichloroethene	03/28/2008	1.5	ug/l		0.14	70	
Downstream	1,2-Dichloropropane	03/28/2008	0.2	ug/l	J	0.17	0.51	
Downstream	Acetone	03/28/2008	5.5	ug/l	J	1.21	700	
MW-1R	Acetone	03/28/2008	4.8	ug/l	J	1.21	700	
MW-1R	Carbon disulfide	05/24/2007	1.8	ug/l	J	0.12	700	
MW-4	1,1-Dichloroethane	05/24/2007	2	ug/l	J	0.09	70	
MW-4	1,1-Dichloroethane	09/13/2007	3.4	ug/l	J	0.16	70	
MW-4	1,1-Dichloroethane	03/28/2008	2	ug/l	J	0.16	70	
MW-4	1,1,2-Trichloroethene	09/13/2007	0.3	ug/l	J	0.13	2.8	
MW-4	1,1,2-Trichloroethene	03/28/2008	0.4	ug/l	J	0.13	2.8	
MW-4	Acetone	03/28/2008	9.7	ug/l	J	1.21	700	
MW-4	Bromomethane	09/13/2007	5.8	ug/l	J	0.26		
MW-4	Chlorobenzene	09/13/2007	0.8	ug/l	J	0.13	50	
MW-4	Chlorobenzene	03/28/2008	0.8	ug/l	J	0.13	50	
MW-4	Chloroethane	05/24/2007	9.5	ug/l	J	0.4	2800	
MW-4	Chloroethane	03/28/2008	9.2	ug/l	J	0.29	2800	
MW-4	Ethylbenzene	05/24/2007	0.43	ug/l	J	0.17	550	
MW-4	Methylene chloride	09/13/2007	0.4	ug/l	J	0.14	4.6	
MW-4	Methylene chloride	03/28/2008	0.7	ug/l	J	0.14	4.6	
MW-5	1,1-Dichloroethane	03/28/2008	0.3	ug/l	J	0.16	70	
MW-5	Acetone	03/28/2008	4.9	ug/l	J	1.21	700	
MW-5	Benzene	03/28/2008	0.3	ug/l	J	0.16	1	
MW-5	Chloroethane	03/28/2008	1	ug/l	J	0.29	2800	
MW-5	cis-1,2-Dichloroethene	09/13/2007	0.4	ug/l	J	0.14	70	
MW-5	Vinyl chloride	03/28/2008	0.4	ug/l	J	0.34	0.015	0.385
MW-6	Acetone	03/28/2008	3.6	ug/l	J	1.21	700	
MW-7	2-Butanone	03/28/2008	1.3	ug/l	J	0.85	4200	
MW-7	Acetone	03/28/2008	4.3	ug/l	J	1.21	700	
MW-8	Acetone	03/28/2008	5.4	ug/l	J	1.21	700	

Table 4: Summary of Historical Organic Results

Well ID	Parameter Name ¹	Sample Date	Result	Unit	Qual Code	PQL ²	NCGW2L ³	Exceedance
MW-8	Chloroform	06/22/2007	0.16	ug/l	J	0.16	70	
MW-8	Chloroform	09/13/2007	0.3	ug/l	J	0.13	70	
MW-8	Chloroform	03/28/2008	0.4	ug/l	J	0.13	70	
MW-8	Methyl chloride	09/13/2007	0.3	ug/l	J	0.18		
MW-8	Tribromomethane	09/13/2007	0.2	ug/l	J	0.11	4.43	

¹ Table only contains detected constituents.

² PQL = Practical Quantitation Limit

³ NCGW2L = North Carolina Ground Water 2L Standard

Table 5: Summary of Historical Background Results

Well ID	Parameter Name ¹	Sample Date	Result	Unit	Qual Code	PQL ²	NCGW2L ³	Exceedance
MW-1R	Acetone	03/28/2008	4.8	ug/l	J	1.21	700	
MW-1R	Antimony, total	09/15/1997	0.03	mg/l		0.03	0.0014*	
MW-1R	Antimony, total	09/13/2007	0.1	ug/l	J	0.05	1.4*	
MW-1R	Barium, total	03/19/2007	152	ug/l		100	2000	
MW-1R	Barium, total	05/24/2007	172	ug/l		0.2	2000	
MW-1R	Barium, total	09/13/2007	108	ug/l		0.04	2000	
MW-1R	Barium, total	03/28/2008	171	ug/l		0.11	2000	
MW-1R	Beryllium, total	09/13/2007	0.2	ug/l	J	0.08	4*	
MW-1R	Beryllium, total	03/28/2008	0.3	ug/l	J	0.06	4*	
MW-1R	Cadmium, total	03/25/1999	0.001	mg/l		0.001	0.0018	
MW-1R	Cadmium, total	09/13/2007	0.1	ug/l	J	0.06	1.75	
MW-1R	Cadmium, total	03/28/2008	0.2	ug/l	J	0.04	1.75	
MW-1R	Carbon disulfide	05/24/2007	1.8	ug/l	J	0.12	700	
MW-1R	Chloride	03/19/2007	130000	ug/l		0	250000	
MW-1R	Chloride	09/13/2007	105000	ug/l		5000	250000	
MW-1R	Chloride	03/28/2008	326000	ug/l		5	250000	76000
MW-1R	Chromium, total	09/15/1994	0.026	mg/l		0.01	0.05	
MW-1R	Chromium, total	11/18/1994	0.04	mg/l		0.01	0.05	
MW-1R	Chromium, total	02/06/1995	0.01	mg/l		0.01	0.05	
MW-1R	Chromium, total	09/12/1995	0.016	mg/l		0.01	0.05	
MW-1R	Chromium, total	03/17/1997	0.011	mg/l		0.01	0.05	
MW-1R	Chromium, total	03/03/1998	0.039	mg/l		0.01	0.05	
MW-1R	Chromium, total	09/09/1998	0.022	mg/l		0.01	0.05	
MW-1R	Chromium, total	03/25/1999	0.017	mg/l		0.01	0.05	
MW-1R	Chromium, total	10/05/1999	0.036	mg/l		0.01	0.05	
MW-1R	Chromium, total	03/01/2000	0.039	mg/l		0.01	0.05	
MW-1R	Chromium, total	09/21/2000	0.034	mg/l		0.01	0.05	
MW-1R	Chromium, total	03/27/2002	0.016	mg/l		0.01	0.05	
MW-1R	Chromium, total	09/19/2002	0.033	mg/l		0.01	0.05	
MW-1R	Cobalt, total	09/11/2003	0.011	mg/l		0.01	0.07*	
MW-1R	Cobalt, total	09/13/2007	0.5	ug/l	J	0.41	70*	
MW-1R	Cobalt, total	03/28/2008	0.7	ug/l	J	0.03	70*	
MW-1R	Copper	09/13/2007	0.9	ug/l	J	0.2	1000	
MW-1R	Copper	03/28/2008	1.4	ug/l	J	0.05	1000	
MW-1R	Iron	03/19/2007	80	ug/l		50	300	
MW-1R	Iron	09/13/2007	104	ug/l	J	12	300	
MW-1R	Iron	03/28/2008	97	ug/l	J	14	300	
MW-1R	Lead, total	09/15/1994	0.015	mg/l		0.01	0.015	
MW-1R	Lead, total	11/18/1994	0.032	mg/l		0.01	0.015	0.017
MW-1R	Lead, total	03/03/1998	0.026	mg/l		0.01	0.015	0.011
MW-1R	Lead, total	09/09/1998	0.015	mg/l		0.01	0.015	
MW-1R	Lead, total	10/05/1999	0.011	mg/l		0.01	0.015	
MW-1R	Lead, total	03/27/2002	0.013	mg/l		0.01	0.015	
MW-1R	Lead, total	09/19/2002	0.012	mg/l		0.01	0.015	
MW-1R	Lead, total	09/29/2005	0.014	mg/l		0.01	0.015	
MW-1R	Lead, total	05/24/2007	3.1	ug/l	J	2	15	
MW-1R	Lead, total	09/13/2007	1.5	ug/l	J	0.07	15	
MW-1R	Lead, total	03/28/2008	1.4	ug/l	J	0.04	15	
MW-1R	Manganese	03/19/2007	37	ug/l		10	50	
MW-1R	Manganese	09/13/2007	25	ug/l	J	0.5	50	

Table 5: Summary of Historical Background Results

Well ID	Parameter Name ¹	Sample Date	Result	Unit	Qual Code	PQL ²	NCGW2L ³	Exceedance
MW-1R	Manganese	03/28/2008	39	ug/l	J	0.5	50	
MW-1R	Nickel, total	11/18/1994	0.067	mg/l		0.05	0.1	
MW-1R	Nickel, total	05/24/2007	2	ug/l	J	2	100	
MW-1R	Nickel, total	09/13/2007	1.1	ug/l	J	1.35	100	
MW-1R	Nickel, total	03/28/2008	1.8	ug/l	J	1.35	100	
MW-1R	Selenium	03/28/2008	0.4	ug/l	J	0.14	50	
MW-1R	Sulfate, total	03/19/2007	8.2	ug/l		250000	250000	
MW-1R	Sulfate, total	09/13/2007	8000	ug/l	J	5000	250000	
MW-1R	Thallium	05/24/2007	0.193	ug/l	J	0.044	0.28*	
MW-1R	Thallium	09/13/2007	0.2	ug/l	J	0.07	0.28*	
MW-1R	Thallium	03/28/2008	0.2	ug/l	J	0.04	0.28*	
MW-1R	Total Dissolved Solids	09/13/2007	226000	ug/l		1000	500000	
MW-1R	Total Dissolved Solids	03/28/2008	264000	ug/l		1	500000	
MW-1R	Vanadium	03/03/1998	0.057	mg/l		0.04	0.0035*	
MW-1R	Vanadium	09/09/1998	0.069	mg/l		0.04	0.0035*	
MW-1R	Vanadium	10/05/1999	0.047	mg/l		0.04	0.0035*	
MW-1R	Vanadium	03/01/2000	0.055	mg/l		0.04	0.0035*	
MW-1R	Vanadium	09/19/2002	0.043	mg/l		0.04	0.0035*	
MW-1R	Vanadium	05/24/2007	3	ug/l	J	1	3.5*	
MW-1R	Vanadium	03/28/2008	0.6	ug/l	J	1.21	3.5*	
MW-1R	Zinc	09/15/1994	0.053	mg/l		0.05	1.05	
MW-1R	Zinc	11/18/1994	0.103	mg/l		0.05	1.05	
MW-1R	Zinc	03/03/1998	0.067	mg/l		0.05	1.05	
MW-1R	Zinc	05/24/2007	23	ug/l		1	1050	
MW-1R	Zinc	09/13/2007	5.3	ug/l	J	1.86	1050	
MW-1R	Zinc	03/28/2008	8.6	ug/l	J	1.86	1050	

¹ Table only contains detected constituents.

² PQL = Practical Quantitation Limit

³ NCGW2L = North Carolina Ground Water 2L Standard

* Groundwater Protection Standard

Table 6: Summary of Current Groundwater Results

Well ID	Parameter Name ¹	Sample Date	Result	Unit	Qual Code	PQL ²	NCGW2L ³ Exceedance
MW-1R	Barium, total	03/28/2008	171	ug/l		0.11	2000
MW-4	1,4-Dichlorobenzene	03/28/2008	3.9	ug/l		0.21	1.4 2.5
MW-4	Benzene	03/28/2008	2.2	ug/l		0.16	1 1.2
MW-4	cis-1,2-Dichloroethene	03/28/2008	10.2	ug/l		0.14	70
MW-4	Vinyl chloride	03/28/2008	4.7	ug/l		0.34	0.015 4.685
MW-7	Lead, total	03/28/2008	763	ug/l		0.04	15 748
MW-7	Zinc	03/28/2008	17	ug/l		1.86	1050
MW-8	Acetone	03/28/2008	5.4	ug/l	J	1.21	700
MW-8	Barium, total	03/28/2008	37.8	ug/l	J	0.11	2000
MW-8	Beryllium, total	03/28/2008	0.1	ug/l	J	0.06	4*
MW-8	Chloroform	03/28/2008	0.4	ug/l	J	0.13	70
MW-8	Cobalt, total	03/28/2008	0.4	ug/l	J	0.03	70*
MW-8	Copper	03/28/2008	0.3	ug/l	J	0.05	1000
MW-8	Lead, total	03/28/2008	0.8	ug/l	J	0.04	15
MW-8	Mercury	03/28/2008	0.01	ug/l	J	0.13	1.1
MW-8	Nickel, total	03/28/2008	0.4	ug/l	J	1.35	100
MW-8	Thallium	03/28/2008	0.2	ug/l	J	0.04	0.28*
MW-8	Vanadium	03/28/2008	0.6	ug/l	J	1.21	3.5*
MW-8	Zinc	03/28/2008	1.7	ug/l	J	1.86	1050
MW-7	Acetone	03/28/2008	4.3	ug/l	J	1.21	700
MW-7	Antimony, total	03/28/2008	0.9	ug/l	J	0.08	1.4*
MW-7	Arsenic	03/28/2008	1.4	ug/l	J	0.07	50
MW-7	Barium, total	03/28/2008	47.5	ug/l	J	0.34	2000
MW-7	Beryllium, total	03/28/2008	0.2	ug/l	J	0.06	4*
MW-7	Cadmium, total	03/28/2008	0.1	ug/l	J	0.04	1.75
MW-7	Chromium, total	03/28/2008	4.7	ug/l	J	0.11	50
MW-7	Cobalt, total	03/28/2008	0.9	ug/l	J	0.03	70*
MW-7	Copper	03/28/2008	6.3	ug/l	J	2.24	1000
MW-7	Methyl ethyl ketone	03/28/2008	1.3	ug/l	J	0.85	4200
MW-7	Nickel, total	03/28/2008	13	ug/l	J	1.35	100
MW-7	Thallium	03/28/2008	0.1	ug/l	J	0.04	0.28*
MW-7	Vanadium	03/28/2008	7.1	ug/l	J	1.21	3.5*
MW-6	Acetone	03/28/2008	3.6	ug/l	J	1.21	700
MW-6	Barium, total	03/28/2008	11.6	ug/l	J	0.34	2000
MW-6	Beryllium, total	03/28/2008	0.1	ug/l	J	0.06	4*
MW-6	Cobalt, total	03/28/2008	0.1	ug/l	J	0.03	70*
MW-6	Copper	03/28/2008	0.2	ug/l	J	2.24	1000
MW-6	Lead, total	03/28/2008	0.3	ug/l	J	0.04	15
MW-6	Nickel, total	03/28/2008	0.2	ug/l	J	1.35	100
MW-6	Vanadium	03/28/2008	1.2	ug/l	J	1.21	3.5*
MW-6	Zinc	03/28/2008	2.7	ug/l	J	1.86	1050
MW-5	1,1-Dichloroethane	03/28/2008	0.3	ug/l	J	0.16	70
MW-5	Acetone	03/28/2008	4.9	ug/l	J	1.21	700
MW-5	Arsenic	03/28/2008	0.1	ug/l	J	0.07	50
MW-5	Barium, total	03/28/2008	24	ug/l	J	0.34	2000
MW-5	Benzene	03/28/2008	0.3	ug/l	J	0.16	1
MW-5	Beryllium, total	03/28/2008	0.1	ug/l	J	0.06	4*
MW-5	Cadmium, total	03/28/2008	0.1	ug/l	J	0.04	1.75
MW-5	Chloroethane	03/28/2008	1	ug/l	J	0.29	2800
MW-5	cis-1,2-Dichloroethene	03/28/2008	1.5	ug/l	J	0.14	70

Table 6: Summary of Current Groundwater Results

Well ID	Parameter Name ¹	Sample Date	Result	Unit	Qual Code	PQL ²	NCGW2L ³ Exceedance
MW-5	Cobalt, total	03/28/2008	0.4	ug/l	J	0.03	70*
MW-5	Copper	03/28/2008	0.2	ug/l	J	2.24	1000
MW-5	Lead, total	03/28/2008	0.3	ug/l	J	0.04	15
MW-5	Nickel, total	03/28/2008	0.5	ug/l	J	1.35	100
MW-5	Vanadium	03/28/2008	0.9	ug/l	J	1.21	3.5*
MW-5	Vinyl chloride	03/28/2008	0.4	ug/l	J	0.34	0.015 0.385
MW-5	Zinc	03/28/2008	3.4	ug/l	J	1.86	1050
MW-4	1,1-Dichloroethane	03/28/2008	2	ug/l	J	0.16	70
MW-4	Acetone	03/28/2008	9.7	ug/l	J	1.21	700
MW-4	Arsenic	03/28/2008	2.5	ug/l	J	0.07	50
MW-4	Barium, total	03/28/2008	35.1	ug/l	J	0.34	2000
MW-4	Beryllium, total	03/28/2008	0.1	ug/l	J	0.06	4*
MW-4	Cadmium, total	03/28/2008	0.2	ug/l	J	0.04	1.75
MW-4	Chlorobenzene	03/28/2008	0.8	ug/l	J	0.13	50
MW-4	Chloroethane	03/28/2008	9.2	ug/l	J	0.29	2800
MW-4	Cobalt, total	03/28/2008	1.3	ug/l	J	0.03	70*
MW-4	Copper	03/28/2008	1	ug/l	J	2.24	1000
MW-4	Ethylbenzene	03/28/2008	0.3	ug/l	J	0.16	550
MW-4	Lead, total	03/28/2008	0.8	ug/l	J	0.04	15
MW-4	Methylene chloride	03/28/2008	0.7	ug/l	J	0.14	4.6
MW-4	Nickel, total	03/28/2008	1.2	ug/l	J	1.35	100
MW-4	Selenium	03/28/2008	0.9	ug/l	J	0.14	50
MW-4	Thallium	03/28/2008	0.1	ug/l	J	0.04	0.28*
MW-4	Trichloroethylene	03/28/2008	0.4	ug/l	J	0.13	2.8
MW-4	Vanadium	03/28/2008	2.3	ug/l	J	1.21	3.5*
MW-4	Zinc	03/28/2008	5	ug/l	J	1.86	1050
MW-1R	Acetone	03/28/2008	4.8	ug/l	J	1.21	700
MW-1R	Beryllium, total	03/28/2008	0.3	ug/l	J	0.06	4*
MW-1R	Cadmium, total	03/28/2008	0.2	ug/l	J	0.04	1.75
MW-1R	Cobalt, total	03/28/2008	0.7	ug/l	J	0.03	70*
MW-1R	Copper	03/28/2008	1.4	ug/l	J	0.05	1000
MW-1R	Lead, total	03/28/2008	1.4	ug/l	J	0.04	15
MW-1R	Nickel, total	03/28/2008	1.8	ug/l	J	1.35	100
MW-1R	Selenium	03/28/2008	0.4	ug/l	J	0.14	50
MW-1R	Thallium	03/28/2008	0.2	ug/l	J	0.04	0.28*
MW-1R	Vanadium	03/28/2008	0.6	ug/l	J	1.21	3.5*
MW-1R	Zinc	03/28/2008	8.6	ug/l	J	1.86	1050
EB	Barium, total	03/28/2008	0.2	ug/l	J	0.11	2000
EB	Copper	03/28/2008	0.2	ug/l	J	0.05	1000
EB	Nickel, total	03/28/2008	0.1	ug/l	J	1.35	100
EB	Vanadium	03/28/2008	0.8	ug/l	J	1.21	3.5*
EB	Zinc	03/28/2008	5.8	ug/l	J	1.86	1050

¹ Table only contains detected constituents.

² PQL = Practical Quantitation Limit

³ NCGW2L = North Carolina Ground Water 2L Standard

* Groundwater Protection Standard

Table 7: Summary of Current Surfacewater Results

Well ID	Parameter Name ¹	Sample Date	Result	Unit	Qual Code	PQL ²	NCAC 2B STD ³	Exceedance
Downstream	1,2-Dichloropropane	03/28/2008	0.2	µg/l	J	0.17	-	
Downstream	Acetone	03/28/2008	5.5	µg/l	J	1.21	-	
Downstream	Arsenic	03/28/2008	0.7	µg/l	J	0.07	50	
Downstream	Barium, total	03/28/2008	25.5	µg/l	J	0.34	1000	
Downstream	Cadmium, total	03/28/2008	0.2	µg/l	J	0.04	2	
Downstream	Chromium, total	03/28/2008	0.6	µg/l	J	0.11	50	
Downstream	Cobalt, total	03/28/2008	0.3	µg/l	J	0.03	-	
Downstream	Copper	03/28/2008	1.2	µg/l	J	2.24	7	
Downstream	Lead, total	03/28/2008	0.9	µg/l	J	0.04	25	
Downstream	Nickel, total	03/28/2008	0.7	µg/l	J	1.35	88	
Downstream	Thallium	03/28/2008	0.1	µg/l	J	0.04	-	
Downstream	Toluene	03/28/2008	0.2	µg/l	J	0.13	11	
Downstream	Vanadium	03/28/2008	2.6	µg/l	J	1.21	-	
Downstream	Zinc	03/28/2008	6.6	µg/l	J	1.86	50	

¹ Table only contains detected constituents.

² PQL = Practical Quantitation Limit

³ NCAC 2B STD = North Carolina Surface Water Standard Class C or Class IV as applicable

Table 8A: Carcinogenic Toxicity Values from Oral Ingestion Exposure

Contaminant	Well	Reference Dose	Maximum Concentration (ug/L)	LADD Maximum		Concentration 3/19/2007 (ug/L)	LADD 2007		HI Risk Maximum		HI Risk 2007	
		Oral Sfo (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)	Adult	Child	Adult	Child
Benzene	MW-4	55	3.9	0.05	0.02	3.9	0.05	0.02	8.68E-04	2.87E-04	8.68E-04	2.87E-04
Vinyl Chloride	MW-4	150	5.5	0.07	0.02	2.6	0.03	0.01	4.49E-04	1.49E-04	2.12E-04	7.02E-05

NOTE:

1. LADD is lifetime average daily dose from ingested groundwater at the specified concentration.
2. Sfo values taken from the Region 9 Risk Based Concentration Table. These values represent a carcinogenic slope factor.
3. During 2007 sampling "-" designates none of this constituent was detected.
4. HI is the Hazard Index Risk = LADD/RfD
5. Formula used for calculations:

$$LADD = (C \cdot IR \cdot ED) / (BW \cdot AT)$$

C = Constituent Concentration (ug/L)

IR = Ingestion Rate (L/day)

ED = Exposure Duration (days)

BW = Body Weight (kg)

AT = Average Time (days)

An ingestion rate of 2L/day was used for adults 1L/day for children

An exposure duration of 30 years was used for adults, 8 for children

An average weight of 70 kg was used for adults, 28.2 kg for children

A time of 70 years for adults and children was used

Table 8B: Carcinogenic Toxicity Values for Inhalation Exposure

Contaminant	Well	Reference Dose	Maximum Concentration (ug/L)	LADD Maximum		Concentration 2007 (ug/L)	LADD 2007		HI Risk Maximum		HI Risk 2007	
		Inhalation Sfi (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)	Adult	Child	Adult	Child
Benzene	MW-4	27	3.9	0.24	0.09	3.9	0.24	0.95	8.84E-03	3.51E-03	8.84E-03	3.52E-02
Vinyl Chloride	MW-4	1500	5.5	0.34	0.13	2.6	0.16	0.63	2.24E-04	8.92E-05	1.06E-04	4.22E-04

NOTE:

1. LADD is lifetime average daily dose from inhaled at the specified concentration.
2. Sfi values taken from the Region 9 Risk Based Concentration Table. These values represent a cancer slope factor.
3. During 2007 sampling "-" designates none of this constituent was detected.
4. HI is the Hazard Index Risk = LADD/RfD
5. Formula used for calculations:

$$LADD = (C \cdot IR \cdot ED \cdot K) / (BW \cdot AT)$$

C = Constituent Concentration (ug/L)

K = Volatilization Factor (L/m³)

IR = Inhalation Rate (m³/day)

ED = Exposure Duration (days)

BW = Body Weight (kg)

AT = Average Time (days)

A Volatilization factor of 0.5 (L/m³) was used based on EPA published values

An inhalation rate of 20 m³/day was used for adults and 12m³/day was used for children

An exposure duration of 30 years was used for adults, 8 for children

An average weight of 70 kg was used for adults, 28.2 kg for children

A time of 70 years for adults and children was used

Table 8C: Carcinogenic Toxicity Values for Dermal Exposure

Contaminant	Well	Reference Dose	Maximum Concentration (ug/L)	LADD Maximum		Concentration 2007 (ug/L)	LADD 2007		HI Risk Maximum		HI Risk 2007	
		Oral Sfo (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)	Adult	Child	Adult	Child
Benzene	MW-4	55	3.9	2.50E-04	7.75E-05	3.9	2.50E-04	7.75E-05	4.55E-06	1.41E-06	4.55E-06	1.41E-06
Vinyl Chloride	MW-4	150	5.5	1.23E-04	3.80E-05	2.6	5.80E-05	1.80E-05	8.18E-07	2.53E-07	3.87E-07	1.20E-07

NOTE:

1. LADD is lifetime average daily dose from dermal contact with contaminated groundwater at the specified concentration.
2. Sfo values taken from the Region 9 Risk Based Concentration Table. These values represent the cancer slope factor.
3. During 2007 sampling "-" designates none of this constituent was detected.
4. Dermal Values used the same RfD values as those used for Oral.
5. HI is the Hazard Index Risk = LADD/RfD
6. Formula used for calculations:

$$LADD = (C * K * EV * ED * EF * SA) / (BW * AT)$$

C = Constituent Concentration (ug/L)	
K = Permeability Coefficient (cm/day)	contaminant dependent
EV = Event Frequency	15 min/day
ED = Exposure Duration (years)	30 years for an adult, 8 years for a child
EF = Exposure Frequency (days/year)	365 days per year
SA = Skin Surface Area (cm ²)	20,000cm ² for adults and 9360 cm ² for children
BW = Body Weight (kg)	70 kg was used for adults, 28.2 kg for children
AT = Average Time (days)	70 years for adults and children

Table 8D: Non-Carcinogenic Toxicity Values from Oral Ingestion Exposure

Contaminant	Well	Reference Dose	Maximum Concentration (ug/L)	LADD Maximum		2007 Concentration (ug/L)	LADD 2007		HI Risk Maximum		HI Risk 2007	
		Oral RfD (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)	Adult	Child	Adult	Child
Chloroethane	MW-4	400	20.1	0.57	0.71	9.5	0.27	0.34	1.44E-03	1.78E-03	6.79E-04	8.42E-04
Benzene	MW-4	4	3.9	0.11	0.14	3.9	0.11	0.14	0.03	0.03	0.03	0.03
cis-1,2-dichloroethene	MW-4	10	14.3	0.41	0.51	10	0.29	0.35	0.04	0.05	0.03	0.04
methylbenzene	MW-4	200	10.4	0.30	0.37	1.1	0.03	0.04	1.49E-03	1.84E-03	1.57E-04	1.95E-04
p-Dichlorobenzene	MW-4	30	3.4	0.10	0.12	2.4	0.07	0.09	3.24E-03	4.02E-03	2.29E-03	2.84E-03
Vinyl Chloride	MW-4	3	5.5	0.16	0.20	2.6	0.07	0.09	0.05	0.07	0.02	0.03

NOTE:

1. LADD is lifetime average daily dose from ingested groundwater at the specified concentration.
2. RfD values taken from the Region 9 Risk Based Concentration Table. These values represent a daily exposure level that is not harmful to human health, over a lifetime.
3. During 2007 sampling "-" designates none of this constituent was detected.
4. HI is the Hazard Index Risk = LADD/RfD
5. Formula used for calculations:

$$\text{LADD} = (C \cdot \text{IR} \cdot \text{ED}) / (\text{BW} \cdot \text{AT})$$

C = Constituent Concentration (ug/L)

IR = Ingestion Rate (L/day)

ED = Exposure Duration (days)

BW = Body Weight (kg)

AT = Average Time (days)

An ingestion rate of 2L/day was used for adults 1L/day for children

An exposure duration of 30 years was used for adults, 8 for children

An average weight of 70 kg was used for adults, 28.2 kg for children

Times of 30 years for adults and 8 for children were used

Table 8E: Non-Carcinogenic Toxicity Values for Inhalation Exposure

Contaminant	Well	Reference Dose	Maximum Concentration (ug/L)	LADD Maximum		2007 Concentration (ug/L)	LADD 2007		HI Risk Maximum		HI Risk 2007	
		Inhalation RfD (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)	Adult	Child	Adult	Child
Chloroethane	MW-4	2900	20.1	2.87	4.28	9.5	1.36	2.02	9.90E-04	1.47E-03	4.68E-04	6.97E-04
Benzene	MW-4	8.6	3.9	0.56	0.83	3.9	0.56	0.83	0.06	0.10	0.06	0.10
cis-1,2-dichloroethene	MW-4	10	14.3	2.04	3.04	10	1.43	2.13	0.20	0.30	0.14	0.21
methylbenzene	MW-4	110	10.4	1.49	2.21	1.1	0.16	0.23	0.01	0.02	1.43E-03	2.13E-03
p-Dichlorobenzene	MW-4	230	3.4	0.49	0.72	2.4	0.34	0.51	2.11E-03	3.15E-03	1.49E-03	2.22E-03
Vinyl Chloride	MW-4	29	5.5	0.79	1.17	2.6	0.37	0.55	0.03	0.04	0.01	0.02

NOTE:

1. LADD is lifetime average daily dose from inhaled at the specified concentration.
2. RfD values taken from the Region 9 Risk Based Concentration Table. These values represent a daily exposure level that is not harmful to human health, over a lifetime.
3. During 2007 sampling "-" designates none of this constituent was detected.
4. HI is the Hazard Index Risk = LADD/RfD
5. Formula used for calculations:

$$LADD = (C \cdot IR \cdot ED \cdot K) / (BW \cdot AT)$$

C = Constituent Concentration (ug/L)

K = Volatilization Factor (L/m³)

IR = Inhalation Rate (m³/day)

ED = Exposure Duration (days)

BW = Body Weight (kg)

AT = Average Time (days)

A Volatilization factor of 0.5 (L/m³) was used based on EPA published values

An inhalation rate of 20 m³/day was used for adults and 12m³/day was used for children

An exposure duration of 30 years was used for adults, 8 for children

An average weight of 70 kg was used for adults, 28.2 kg for children

Times of 30 years for adults and 8 for children were used

Table 8F: Non-Carcinogenic Toxicity Values for Dermal Exposure

Contaminant	Well	Reference Dose	Maximum Concentration (ug/L)	LADD Maximum		2007 Concentration (ug/L)	LADD 2007		HI Risk Maximum		HI Risk 2007	
		Oral RfD (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)	Adult	Child	Adult	Child
Chloroethane	MW-4	400	20.1	1.15E-03	1.33E-03	9.5	5.42E-04	6.30E-04	2.87E-06	3.33E-06	1.35E-06	1.57E-06
Benzene	MW-4	4	3.9	5.84E-04	6.79E-04	3.9	5.84E-04	6.79E-04	1.46E-04	1.70E-04	1.46E-04	1.70E-04
cis-1,2-dichloroethene	MW-4	10	14.3	1.02E-03	1.18E-03	10	7.13E-04	8.28E-04	1.02E-04	1.18E-04	7.13E-05	8.28E-05
methylbenzene	MW-4	200	10.4	3.34E-03	3.88E-03	1.1	3.53E-04	4.10E-04	1.67E-05	1.94E-05	1.77E-06	2.05E-06
p-Dichlorobenzene	MW-4	30	3.4	1.50E-03	1.75E-03	2.4	1.06E-03	1.23E-03	5.01E-05	5.82E-05	3.54E-05	4.11E-05
Vinyl Chloride	MW-4	3	5.5	2.86E-04	3.33E-04	2.6	1.35E-04	1.57E-04	9.54E-05	1.11E-04	4.51E-05	5.24E-05

NOTE:

1. LADD is lifetime average daily dose from dermal contact with contaminated groundwater at the specified concentration.
2. RfD values taken from the Region 9 Risk Based Concentration Table. These values represent a daily exposure level that is not harmful to human health, over a lifetime.
3. During 2007 sampling "-" designates none of this constituent was detected.
4. Dermal Values used the same RfD values as those used for Oral.
5. HI is the Hazard Index Risk = LADD/RfD
6. Formula used for calculations:

$$LADD = (C * K * EV * ED * EF * SA) / (BW * AT)$$

C = Constituent Concentration (ug/L)	
K = Permeability Coefficient (cm/day)	contaminant dependent
EV = Event Frequency	15 min/day
ED = Exposure Duration (years)	30 years for an adult, 8 years for a child
EF = Exposure Frequency (days/year)	365 days per year
SA = Skin Surface Area (cm ²)	20,000cm ² for adults and 9360 cm ² for children
BW = Body Weight (kg)	70 kg was used for adults, 28.2 kg for children
AT = Average Time (days)	30 years for adults and 8 for children

Table 9: Timeline / Schedule of Corrective Action

Date after CAP Approval	Description of Event
March - April 2009	Semi-Annual Assessment Sampling & Monitoring. Preparation and submittal of ZVI injection permits. Scheduling of ZVI injection event. GeoProbe groundwater sampling.
September 2009	Semi-Annual Assessment Sampling & Monitoring w/ implementation of full suite of MNA performance parameters. ZVI injection event.
October 2009	Submittal of Injection Event Report (~30 days after injection)
March 2010	Semi-Annual Assessment Sampling & Monitoring.
April 2010	Initial summary report.
September 2010	Semi-Annual Assessment Sampling & Monitoring.
March 2011	Semi-Annual Assessment Sampling & Monitoring.
September 2011	Semi-Annual Assessment Sampling & Monitoring. Evaluation of effectiveness for MNA with ZVI Injection.
October 2011	Cease ZVI injection if Evaluation of Effectiveness indicates and if SWS agrees. Amend ZVI injection permit for additional events if necessary. Reduction of MNA analytical requirements as determined through Evaluation of Effectiveness Report and SWS approval.
March 2012	Semi-Annual Assessment Sampling & Monitoring.

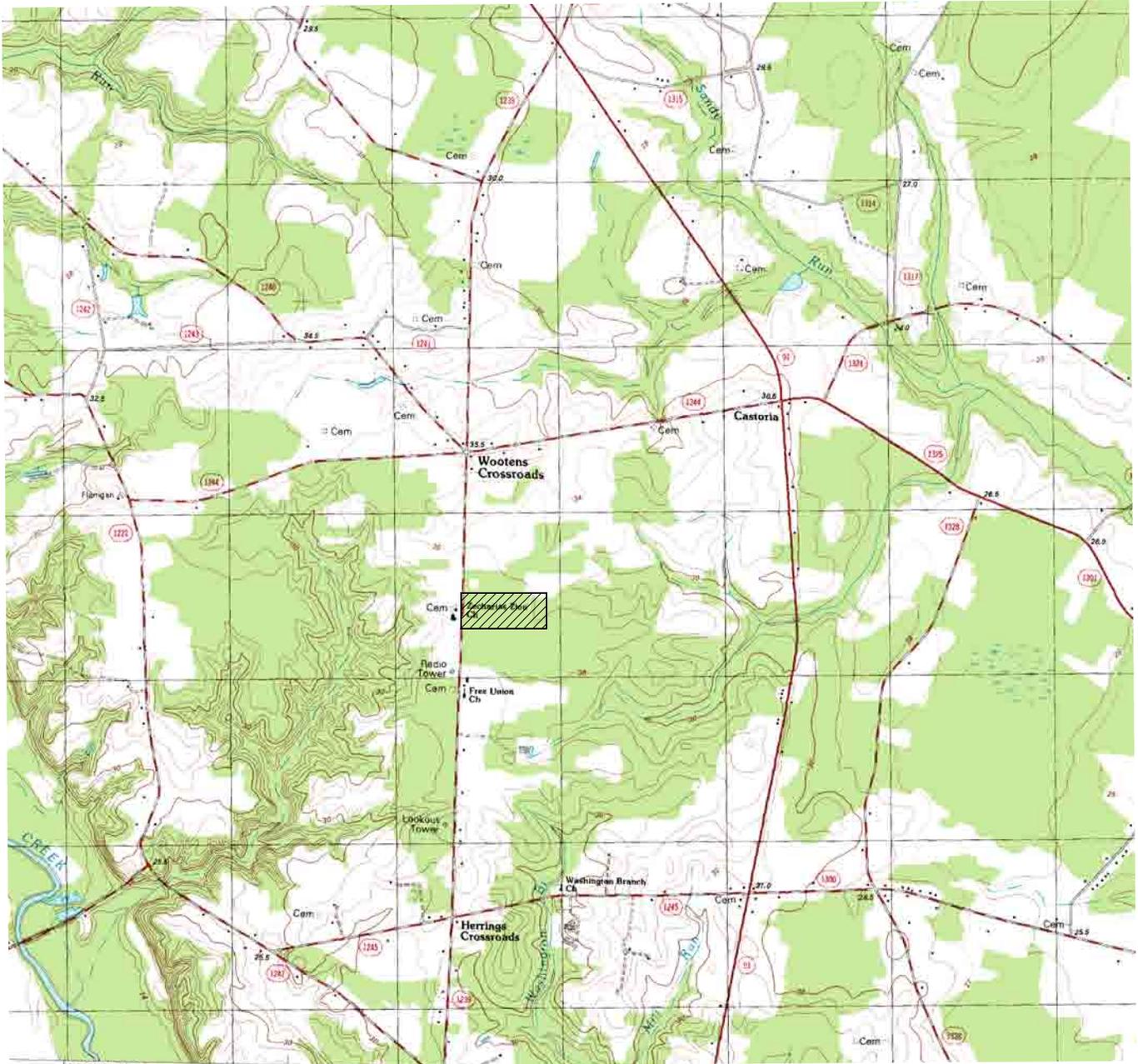
Plates

Topographic Map with Site Location

Corrective Action Plan

Greene County

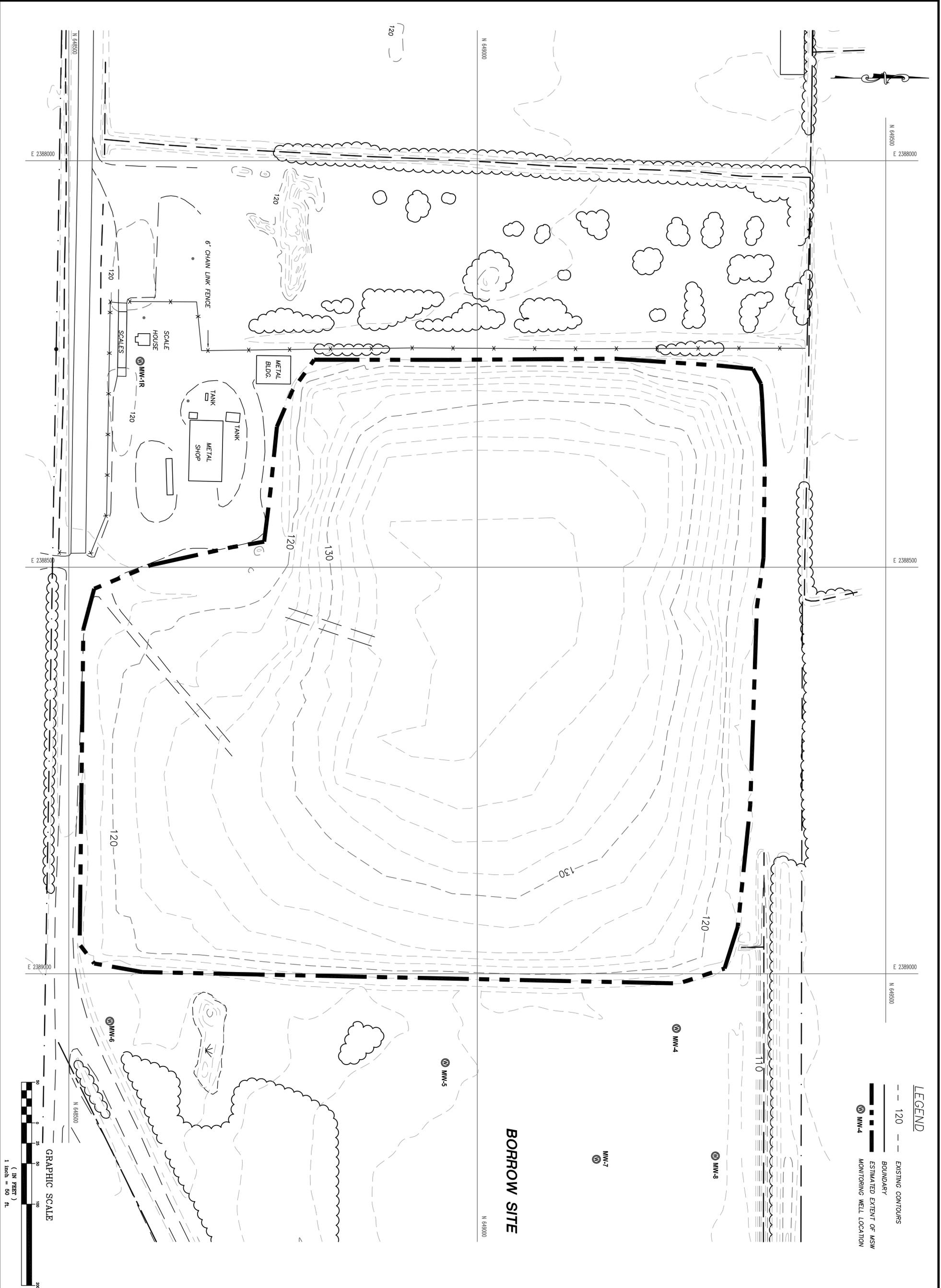
PLATE 1



Date Completed	5/31/2007
Created By	M. German
Project Name	Corrective Action Plan
Site Name	Greene County
Project Number	G07061.0

QUADRANGLE LEGEND

ROAD CLASSIFICATION	
Primary highway, hard surface	Light-duty road, hard or improved surface
Secondary highway, hard surface	Unimproved road
Interstate Route	U. S. Route
State Route	



LEGEND

- 120 --- EXISTING CONTOURS
- BOUNDARY
- - - - - ESTIMATED EXTENT OF MSW
- ⊙ MW-4 MONITORING WELL LOCATION

**GREENE COUNTY
CONSTRUCTION & DEMOLITION
LANDFILL FACILITY
GREENE COUNTY, NORTH CAROLINA**

 Municipal Services P.O. BOX 67 GARNER, N.C. 27626 (919) 772-5393	 Engineering Company, P.A. P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767 P.O. BOX 278 MOREHEAD CITY, N.C. 28567 (252) 725-6461
--	---

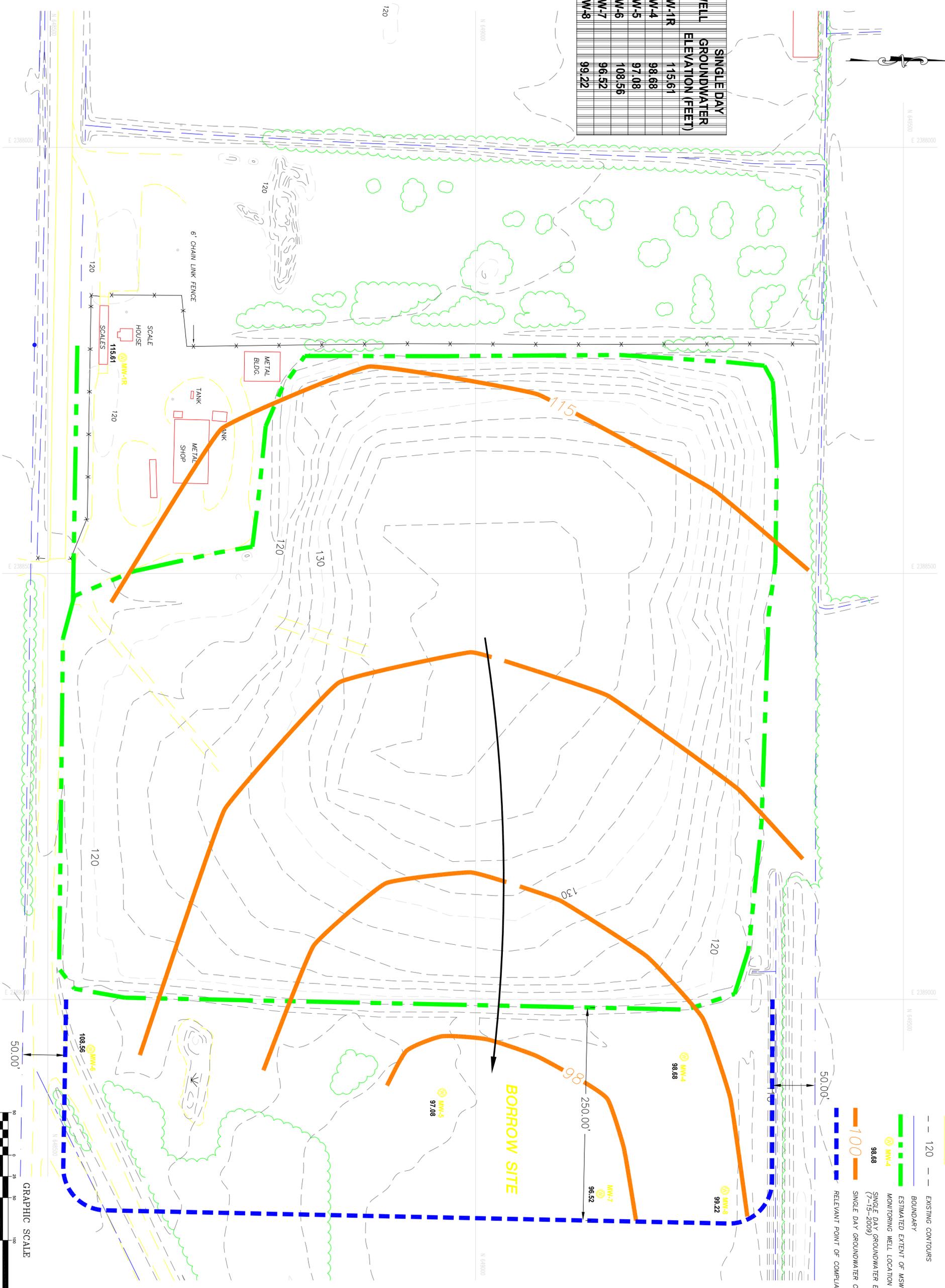
SITE MAP WITH
SAMPLING LOCATIONS

DATE	BY	REV.	DESCRIPTION

SCALE: 1" = 50'	DATE: 2/18/09
DRWN. BY: E. CALDWELL	CHD. BY: S. PATRICK
PROJECT NUMBER: C07061.0	
DRAWING NO. PLATE 2	SHEET NO. 1 OF 1



WELL	GROUNDWATER ELEVATION (FEET)
MW-1R	115.61
MW-4	98.68
MW-5	97.08
MW-6	108.55
MW-7	96.52
MW-8	99.22



LEGEND

- 120 --- EXISTING CONTOURS
- BOUNDARY
- ESTIMATED EXTENT OF MSW
- ⊙ MW-4 MONITORING WELL LOCATION
- 98.68 SINGLE DAY GROUNDWATER ELEVATION (7-15-2009)
- 100 SINGLE DAY GROUNDWATER CONTOURS
- RELEVANT POINT OF COMPLIANCE

GRAPHIC SCALE



DATE	BY	REV.	DESCRIPTION

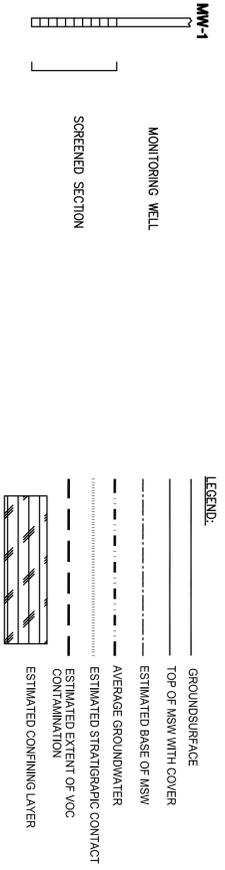
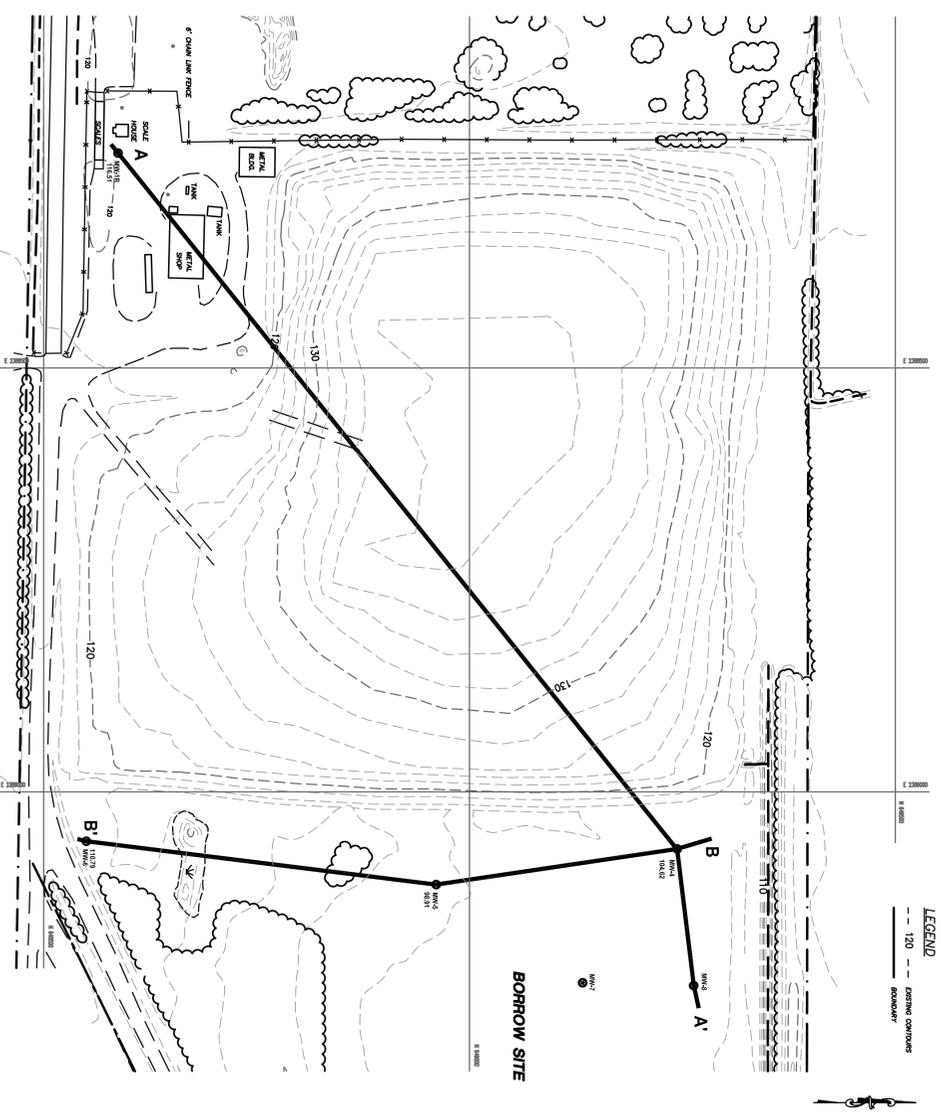
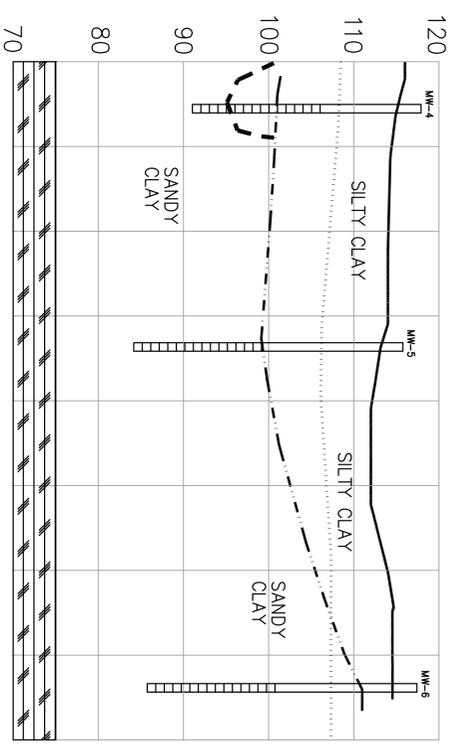
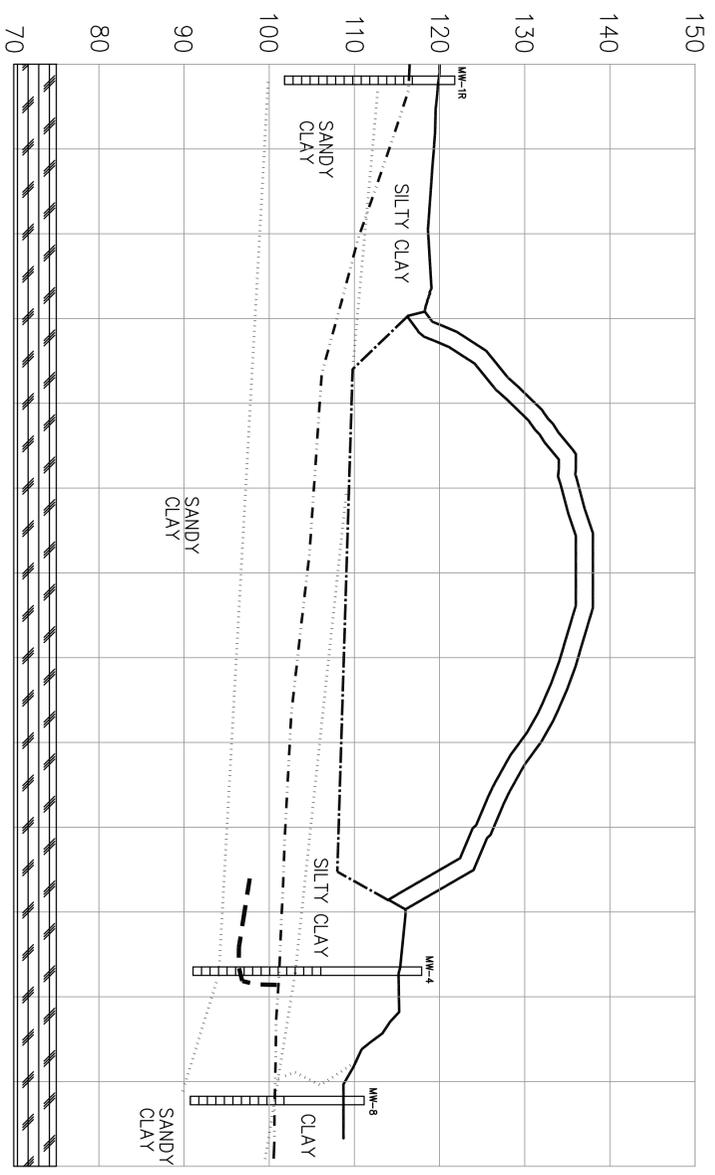
SCALE: 1" = 50'
 DATE: 07/15/09
 DRAWN BY: M. SULLIVAN
 CHECKED BY: M. BROWN
 PROJECT NUMBER: C08010.0
 DRAWING NO.: SHEET NO.
 PLATE 3 1 OF 1

**GREENE COUNTY
 CONSTRUCTION & DEMOLITION
 LANDFILL FACILITY REVISION
 GREENE COUNTY, NORTH CAROLINA**

Municipal Services
 P.O. BOX 97 GARNER, N.C. 27529
 (619) 772-5363

Engineering Company, P.A.
 P.O. BOX 349 BOONE, N.C. 28607
 (828) 262-1767

P.O. BOX 276 MOREHEAD CITY, N.C. 28557
 (252) 726-9481



NOTE:

- NUMBERS SHOWN IN THIS PLATE ARE IN UNITS OF FEET UNLESS INDICATED OTHERWISE.
- SOIL PROFILES SHOWN HEREIN ARE INTERPOLATED FROM AVAILABLE BORING RECORDS.
- SOIL PROFILE BOUNDARIES DO NOT NECESSARILY INDICATE ABRUPT CHANGE IN SOIL TEXTURES.

DATE	BY	REV.	DESCRIPTION

CROSS-SECTION

SCALE: AS SHOWN
 DATE: 8/17/2007
 DRAWN BY: M. CLEMENT
 CHECKED BY: E. CALDWELL
 PROJECT NUMBER: G07061.0
 DRAWING NO. 1
 SHEET NO. 1 OF 1

**GREENE COUNTY
 CONSTRUCTION & DEMOLITION
 LANDFILL FACILITY
 GREENE COUNTY, NORTH CAROLINA**

**Municipal
Services**

P.O. BOX 97 GARNER, N.C. 27529
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**Engineering
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APPENDIX A

BIOSCREEN Natural Attenuation Decision Support System

Version 1.4

Air Force Center for Environmental Excellence

1. HYDROGEOLOGY

Seepage Velocity* (ft/yr)
 or (cm/sec)
 Hydraulic Conductivity (ft/ft)
 Hydraulic Gradient (-)
 Porosity (-)

2. DISPERSION

Longitudinal Dispersion* (ft)
 Transverse Dispersion* (ft)
 Vertical Dispersion* (ft)
 or (ft)
 Estimated Plume Length (ft)

3. ADSORPTION

Retardation Factor* (-)
 or (-)
 Soil Bulk Density (kg/l)
 Partition Coefficient (L/kg)
 Fraction Organic Carbon (-)

4. BIODEGRADATION

1st Order Decay Coeff* (per yr)
 or (year)
 Solute Half-Life (mg/L)
 or **Instantaneous Reaction Model**
 DO (mg/L)
 NO3 (mg/L)
 Fe2+ (mg/L)
 SO4 (mg/L)
 CH4 (mg/L)

5. GENERAL

Modeled Area Length* (ft)
 Modeled Area Width* (ft)
 Simulation Time* (yr)

6. SOURCE DATA

Source Thickness in Sat. Zone* (ft)

Source Zones:	Width* (ft)	Conc. (mg/L)*
1	25	0.005
2	15	0.01
3	25	0.005
4	0	0
5	0	0

Source Half-life (see Help): (yr)
 Inst. React. (yr)
 Soluble Mass (Kg)
 In Source NAPL, Soil (Kg)

7. FIELD DATA FOR COMPARISON

Concentration (mg/L) (mg/L)
 Dist. from Source (ft) (ft)

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* → Value used directly in model. (Don't enter any data).

Run Name:

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells If No Data Leave Blank or Enter "0"

Help

Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

RUN CENTERLINE

View Output

RUN ARRAY

View Output

CHOOSE TYPE OF OUTPUT TO SEE:

Concentration (mg/L) (mg/L)

Dist. from Source (ft) (ft)

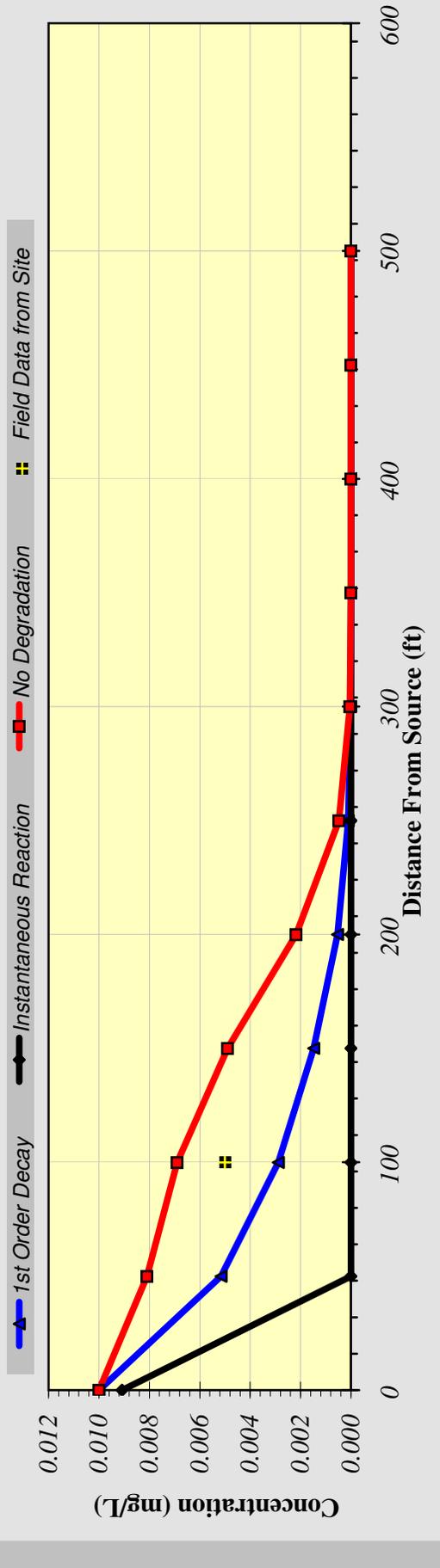
CHOOSE TYPE OF OUTPUT TO SEE:

Concentration (mg/L) (mg/L)

Dist. from Source (ft) (ft)

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft)										
	0	50	100	150	200	250	300	350	400	450	500
No Degradation	0.010	0.008	0.007	0.005	0.002	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.010	0.005	0.003	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site			0.005								



Time:

DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft)	0	50	100	150	200	250	300	350	400	450	500
50	0.000E+00	9.274E-05	3.324E-04	4.167E-04	2.594E-04	7.289E-05	8.485E-06	3.904E-07	6.927E-09	4.676E-11	1.192E-13
25	4.999E-03	4.141E-03	3.781E-03	2.861E-03	1.336E-03	3.078E-04	3.087E-05	1.261E-06	2.031E-08	1.263E-10	3.004E-13
0	9.999E-03	8.096E-03	6.900E-03	4.901E-03	2.171E-03	4.792E-04	4.630E-05	1.833E-06	2.871E-08	1.744E-10	4.062E-13
-25	4.999E-03	4.141E-03	3.781E-03	2.861E-03	1.336E-03	3.078E-04	3.087E-05	1.261E-06	2.031E-08	1.263E-10	3.004E-13
-50	0.000E+00	9.274E-05	3.324E-04	########	2.594E-04	7.289E-05	8.485E-06	3.904E-07	6.927E-09	4.676E-11	1.192E-13
MASS FLUX (mg/day)	7.8E-1	8.0E-1	7.3E-1	5.6E-1	2.6E-1	6.0E-2	6.1E-3	2.5E-4	4.0E-6	2.5E-8	6.0E-11

Model to Display:

No Degradation Model

1st Order Decay Model

Instantaneous Reaction Model

Displayed Model: **No Degradation**

Target Level: **0.001** mg/L

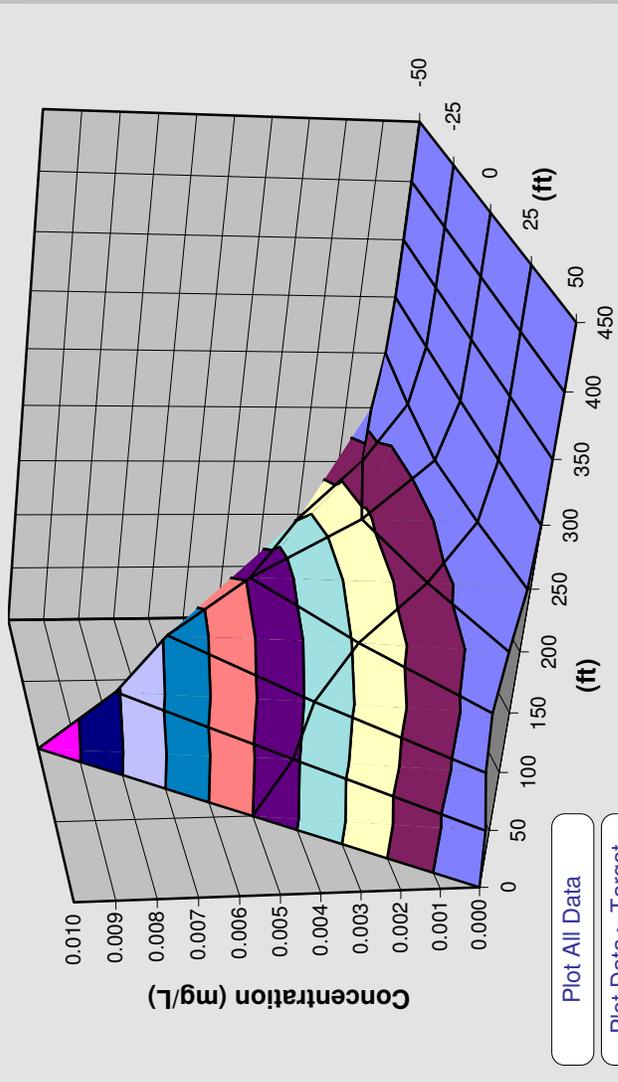
Time: **5 Years**

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	1.42E-03	(Kg)
- Actual Plume Mass	1.4E-03	(Kg)
= Plume Mass Removed by Biodeg	0.00E+00	(Kg)
	0 %	
Change in Electron Acceptor/Byproduct Masses:		
Oxygen	na	na
Nitrate	na	na
Iron II	na	na
Sulfate	na	na
Methane	na	na
		(Kg)
Contam. Mass in Source (t=0 Years)	10.0	(Kg)
Contam. Mass in Source Now (t=5 Years)	10.0	(Kg)
Current Volume of Groundwater in Plume	0.1	(ac-ft)
Flowrate of Water Through Source Zone	0.037	(ac-ft/yr)

Mass HELP

Recalculate



Plot All Data

Plot Data > Target

DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft)	Distance from Source (ft)										Model to Display:	
	0	50	100	150	200	250	300	350	400	450		500
50	0.000E+00	5.905E-05	1.390E-04	1.259E-04	6.416E-05	1.613E-05	1.764E-06	7.816E-08	1.353E-09	8.984E-12	2.263E-14	No Degradation Model
25	4.999E-03	2.637E-03	1.581E-03	8.645E-04	3.303E-04	6.813E-05	6.417E-06	2.525E-07	3.967E-09	2.427E-11	5.702E-14	
0	9.999E-03	5.155E-03	2.885E-03	1.481E-03	5.370E-04	1.060E-04	9.625E-06	3.670E-07	5.610E-09	3.351E-11	7.710E-14	
-25	4.999E-03	2.637E-03	1.581E-03	8.645E-04	3.303E-04	6.813E-05	6.417E-06	2.525E-07	3.967E-09	2.427E-11	5.702E-14	
-50	0.000E+00	5.905E-05	1.390E-04	#####	6.416E-05	1.613E-05	1.764E-06	7.816E-08	1.353E-09	8.984E-12	2.263E-14	
MASS FLUX (mg/day)	7.8E-1	5.1E-1	3.1E-1	1.7E-1	6.4E-2	1.3E-2	1.3E-3	5.0E-5	7.9E-7	4.9E-9	1.1E-11	Instantaneous Reaction Model
	Time: <input type="text" value="5 Years"/> Target Level: <input type="text" value="0.001"/> mg/L Displayed Model: <input type="text" value="1st Order Decay"/>											

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation (Kg)

- Actual Plume Mass (Kg)

= Plume Mass Removed by Biodeg (Kg) (47 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	na											
Nitrate	na											
Sulfate	na											
Methane	na											

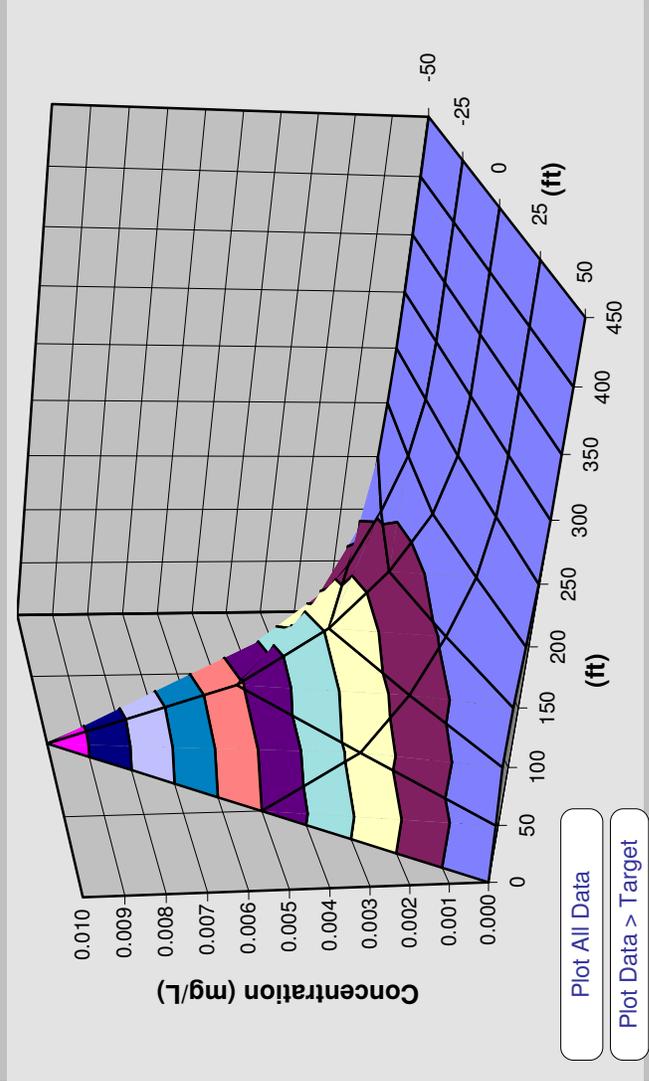
Contam. Mass in Source (t=0 Years) (Kg)

Contam. Mass in Source Now (t=5 Years) (Kg)

Current Volume of Groundwater in Plume (ac-ft)

Flowrate of Water Through Source Zone (ac-ft/yr)

[Mass HELP](#) [Recalculate](#)



DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft)	Distance from Source (ft)										Model to Display:	
	0	50	100	150	200	250	300	350	400	450		500
50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	No Degradation Model
25	4.488E-03	0.000E+00	1st Order Decay Model									
0	9.088E-03	0.000E+00	Instantaneous Reaction Model									
-25	4.488E-03	0.000E+00										
-50	0.000E+00	0.000E+00	0.000E+00	#####	0.000E+00							
MASS FLUX (mg/day)	7.8E-1	0.0E+0										

Time: Target Level: mg/L Displayed Model:

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	<input type="text" value="7.99E-01"/> (Kg)
- Actual Plume Mass	<input type="text" value="2.1E-04"/> (Kg)
= Plume Mass Removed by Biodeg	<input type="text" value="7.99E-01"/> (Kg) (100 %)

Change in Electron Acceptor/Byproduct Masses:

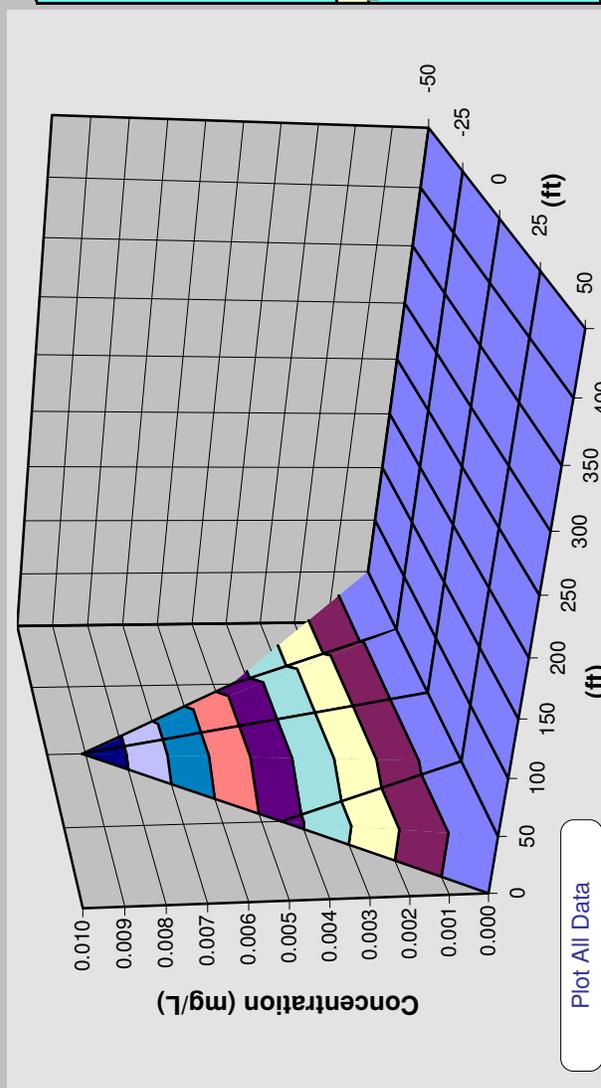
Oxygen	-1.2	Nitrate	-0.1	Iron II	+6.1	Sulfate	-0.4	Methane	+0.0
--------	------	---------	------	---------	------	---------	------	---------	------

Contam. Mass in Source (t=0 Years) (Kg)

Contam. Mass in Source Now (t=5 Years) (Kg)

Current Volume of Groundwater in Plume (ac-ft)

Flowrate of Water Through Source Zone (ac-ft/yr)



BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Data Input Instructions:
 1. Enter value directly....or
 2. Calculate by filling in gray cells. Press Enter, then **C**
 (To restore formulas, hit "Restore Formulas" button)
 Variable* → Data used directly in model.
 Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

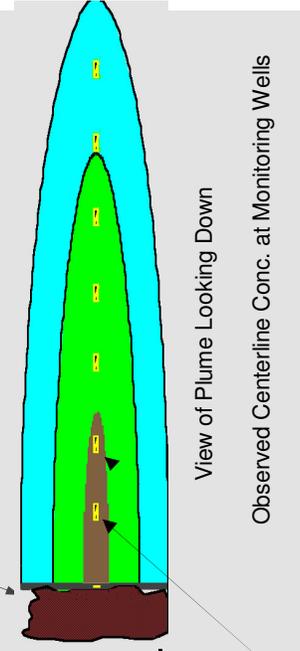
Greene County
 Closed Landfill
 Run Name

TYPE OF CHLORINATED SOLVENT:
 Ethanes
 Ethanes

1. ADVECTION
 Seepage Velocity* Vs (ft/yr)
 Hydraulic Conductivity K (cm/sec)
 Hydraulic Gradient i (ft/ft)
 Effective Porosity n (-)
2. DISPERSION
 Alpha x* (ft)
 (Alpha y) / (Alpha x)* (-)
 (Alpha z) / (Alpha x)* (-)
3. ADSORPTION
 Retardation Factor* R

Simulation Time* (yr)
 Modeled Area Width* (ft)
 Modeled Area Length* (ft)
 Zone 1 Length* (ft)
 Zone 2 Length* (ft)
 Zone 2 = L - Zone 1

6. SOURCE DATA
 Source Options
 TYPE:
 Single Planar
 Source Thickness in Sat. Zone* Y1 (ft)
 Width* (ft)
 Conc. (mg/L)* C1
 PCE
 TCE
 DCE
 VC
 ETH
 k_s* (1/yr)
 PCE
 TCE
 DCE
 VC
 ETH



7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.0
TCE Conc. (mg/L)	.0
DCE Conc. (mg/L)	.01
VC Conc. (mg/L)	4.7E-03
ETH Conc. (mg/L)	0.0
Distance from Source (ft)	100
Date Data Collected	2008

Common R (used in model)* = 4.04

4. BIOTRANSFORMATION

Zone 1
 PCE → TCE
 TCE → DCE
 DCE → VC
 VC → ETH

Zone 2
 PCE → TCE
 TCE → DCE
 DCE → VC
 VC → ETH

-1st Order Decay Coefficient*
 λ (1/yr)
 PCE → 0.000
 TCE → 0.000
 DCE → 0.178
 VC → 0.119
 ETH → 0.000

Yield
 half-life (yrs)
 PCE → 0.79
 TCE → 0.74
 DCE → 3.90
 VC → 5.80
 ETH → 0.45

8. CHOOSE TYPE OF OUTPUT TO SEE:

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

Start Here → PCE
 TCE
 DCE
 VC
 ETH

Transverse Distance (ft)	Distance from Source (ft)										
	0	50	100	150	200	250	300	350	400	450	500
40	3.033E-03	1.260E-03	4.576E-05	4.575E-08	5.938E-13	4.804E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
20	3.033E-03	1.703E-03	6.001E-05	5.765E-08	7.240E-13	5.707E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0	3.033E-03	1.825E-03	6.524E-05	6.215E-08	7.728E-13	6.042E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-20	3.033E-03	1.703E-03	6.001E-05	5.765E-08	7.240E-13	5.707E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-40	3.033E-03	1.260E-03	4.576E-05	4.575E-08	5.938E-13	4.804E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MASS RATE (mg/day)	5.9E-1	3.0E-1	1.1E-2	1.0E-5	1.3E-10	1.1E-16	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0

Time: yr

Target Level: mg/L

Displayed Model: **DCE**

Displayed Compound: **DCE**

Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation (Kg)

- Plume Mass If Biotransformation/Production (Kg)

Mass Removed (Kg)

% Biotransformed =

% Change in Mass Rate = [source to edge]

Current Volume of Ground Water in Plume MGal

Flow Rate of Water Through Source Area MGD

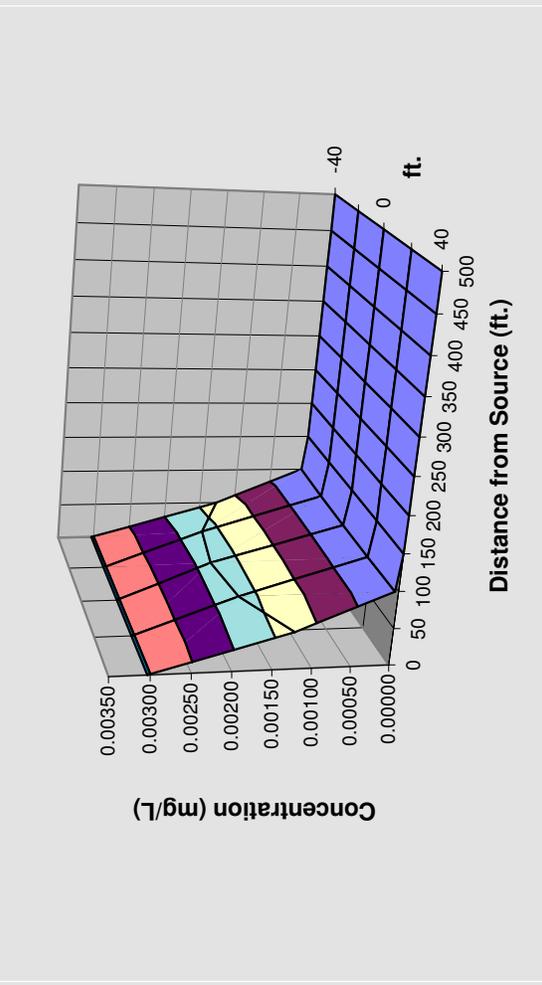
Compare to Pump and Treat

Pumping Rate (gpm)

Pore Volumes Removed Per Yr.

Pore Volumes to Clean-Up

Clean-Up Time (yr)



DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

Start Here →

PCE TCE DCE VC ETH

Show No Degradation

Show Biotransformation

Displayed Compound: **VC**

Transverse Distance (ft)	Distance from Source (ft)										Target Level: <input type="text" value="0.002"/> mg/L	
	0	50	100	150	200	250	300	350	400	450		500
40	3.033E-01	1.327E-01	4.886E-03	4.908E-06	6.346E-11	1.000E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
20	3.033E-01	1.794E-01	6.408E-03	6.186E-06	7.738E-11	1.000E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0	3.033E-01	1.922E-01	6.967E-03	6.668E-06	8.260E-11	1.000E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-20	3.033E-01	1.794E-01	6.408E-03	6.186E-06	7.738E-11	1.000E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-40	3.033E-01	1.327E-01	4.886E-03	4.908E-06	6.346E-11	1.000E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MASS RATE (mg/day)	5.9E+1	3.2E+1	1.1E+0	1.1E-3	1.4E-8	1.9E-2	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0

Time: yr

Displayed Model: **Biotransformation**

Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation: (Kg)

- Plume Mass If Biotransformation/Production: (Kg)

Mass Removed: (Kg)

% Biotransformed =

% Change in Mass Rate = % [source to edge]

Current Volume of Ground Water in Plume: MGal

Flow Rate of Water Through Source Area: MGD

Compare to Pump and Treat

Pumping Rate: (gpm)

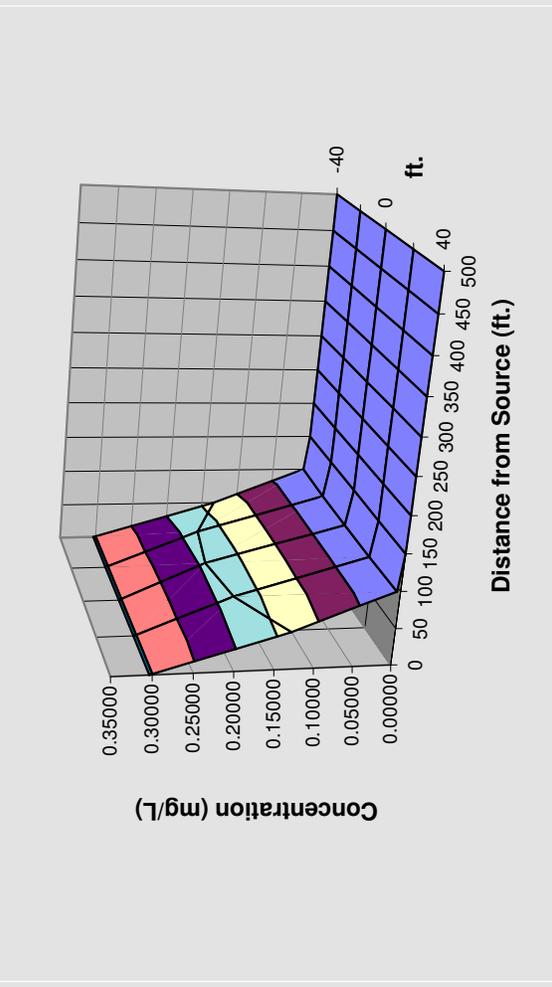
Pore Volumes Removed Per Yr.

Pore Volumes to Clean-Up:

Clean-Up Time: (yr)

If "Can't Calc.", make model area longer

See acre ft



Mass HELP

To Centerline

Return to Input

Plot All Data

Plot Data > Target

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

Start Here → PCE
 TCE
 DCE
 VC
 ETH

Transverse Distance (ft)	0	50	100	150	200	250	300	350	400	450	500
40	3.033E-03	1.473E-03	5.571E-05	5.639E-08	7.244E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
20	3.033E-03	1.991E-03	7.306E-05	7.107E-08	8.832E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0	3.033E-03	2.133E-03	7.942E-05	7.661E-08	9.427E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-20	3.033E-03	1.991E-03	7.306E-05	7.107E-08	8.832E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-40	3.033E-03	1.473E-03	5.571E-05	5.639E-08	7.244E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MASS RATE (mg/day)	5.9E-1	3.5E-1	1.3E-2	1.3E-5	1.6E-10	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0

Time: yr

Target Level: mg/L

Displayed Model:

Displayed Compound: **DCE**

Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation (Kg)

- Plume Mass If Biotransformation/Production (Kg)

Mass Removed (Kg)

% Biotransformed =

% Change in Mass Rate = [source to edge]

If "Can't Calc." make model area longer

Current Volume of Ground Water in Plume MGal

Flow Rate of Water Through Source Area MGD

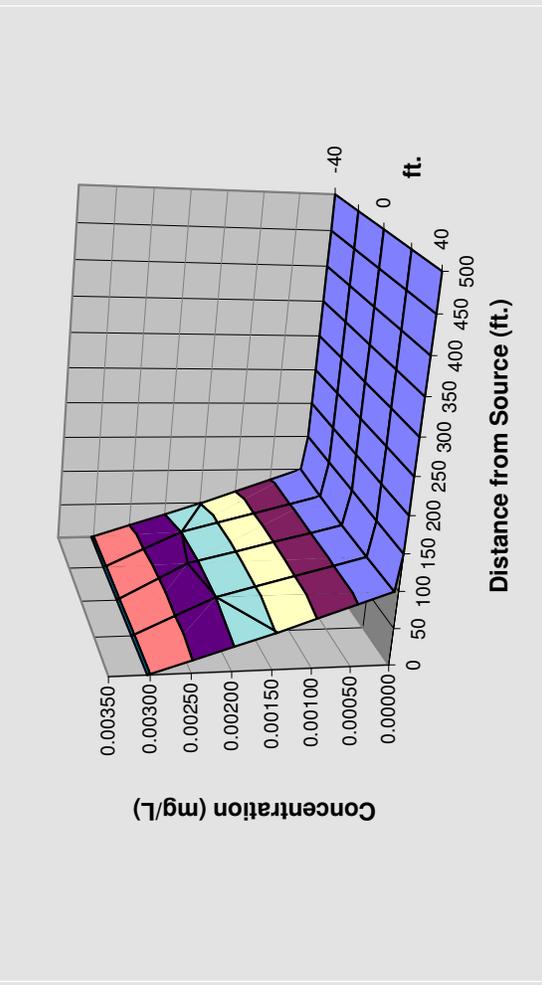
Compare to Pump and Treat

Pumping Rate (gpm)

Pore Volumes Removed Per Yr.

Pore Volumes to Clean-Up

Clean-Up Time (yr)



DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

Start Here → PCE
 TCE
 DCE
 VC
 ETH

Transverse Distance (ft)	Distance from Source (ft)										
	0	50	100	150	200	250	300	350	400	450	500
40	3.033E-01	1.473E-01	5.571E-03	5.639E-06	7.244E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
20	3.033E-01	1.991E-01	7.306E-03	7.107E-06	8.832E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0	3.033E-01	2.133E-01	7.942E-03	7.661E-06	9.427E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-20	3.033E-01	1.991E-01	7.306E-03	7.107E-06	8.832E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-40	3.033E-01	1.473E-01	5.571E-03	5.639E-06	7.244E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MASS RATE (mg/day)	5.9E+1	3.5E+1	1.3E+0	1.3E-3	1.6E-8	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0

Time: yr

Target Level: mg/L

Displayed Model: Displayed Compound

Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation (Kg)

- Plume Mass If Biotransformation/Production (Kg)

Mass Removed (Kg)

If "Can't Calc." make model area longer

% Biotransformed =

% Change in Mass Rate = % [source to edge]

Current Volume of Ground Water in Plume MGal

Flow Rate of Water Through Source Area MGD

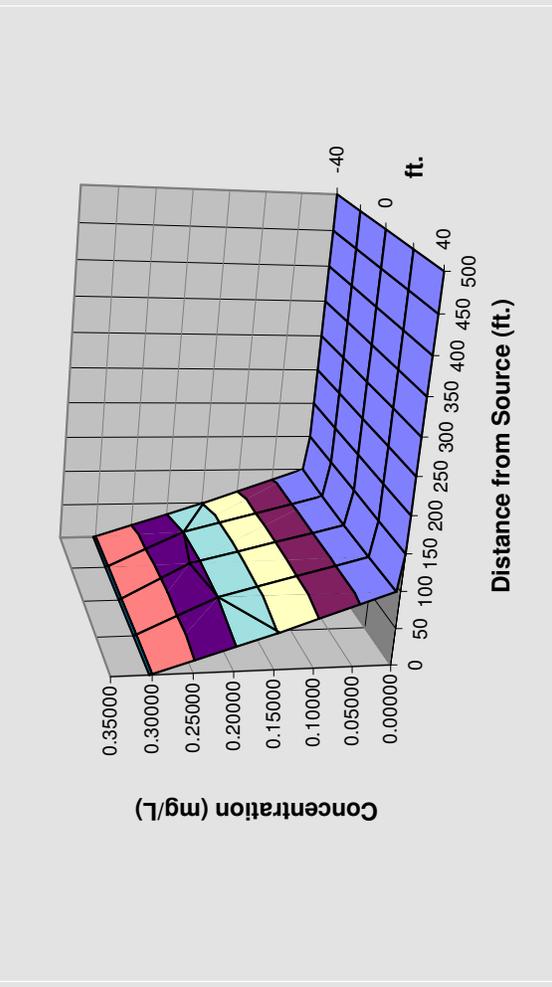
Compare to Pump and Treat

Pumping Rate (gpm)

Pore Volumes Removed Per Yr.

Pore Volumes to Clean-Up (yr)

Clean-Up Time (yr)



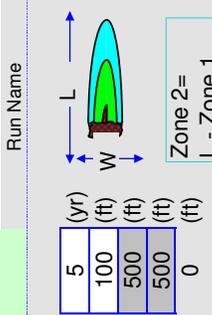
BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Data Input Instructions:
 1. Enter value directly....or
 2. Calculate by filling in gray cells. Press Enter, then (C) (To restore formulas, hit "Restore Formulas" button)
 Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

Greene County
Closed Landfill



Run Name	Zone 2 = L - Zone 1
5 (yr)	
100 (ft)	
500 (ft)	
500 (ft)	
0 (ft)	

TYPE: Decaying Single Planar

Source Options

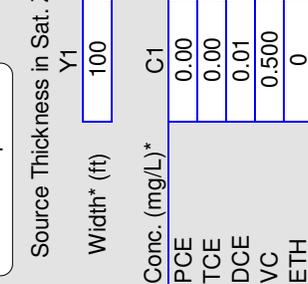
Source Thickness in Sat. Zone* Y1 (ft)

Width* (ft) (ft)

Conc. (mg/L)* C1

PCE	0.00
TCE	0.00
DCE	0.01
VC	0.500
ETH	0

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



TYPE OF CHLORINATED SOLVENT: Ethanes Ethanes

1. ADVECTION

Seepage Velocity* Vs (ft/yr)

Hydraulic Conductivity K (cm/sec)

Hydraulic Gradient i (ft/ft)

Effective Porosity n (-)

2. DISPERSION

Alpha x* (ft)

(Alpha y) / (Alpha x)* (-)

(Alpha z) / (Alpha x)* (-)

3. ADSORPTION

Retardation Factor* (kg/L)

Soil Bulk Density, rho (-)

Fraction Organic Carbon, foc (L/kg)

Partition Coefficient Koc (L/kg)

PCE (L/kg)

TCE (L/kg)

DCE (L/kg)

VC (-)

ETH (-)

Common R (used in model)* = (-)

4. BIOTRANSFORMATION

Zone 1

PCE	→	TCE	→	DCE	→	VC	→	ETH	→
λ (1/yr)	0.000	0.000	3.300	2.567					
half-life (yrs)	0.79	0.74	0.21	0.27					
Yield									

Zone 2

PCE	→	TCE	→	DCE	→	VC	→	ETH	→
λ (1/yr)	0.000	0.000	0.000	0.000					
half-life (yrs)									
Yield									

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.0
TCE Conc. (mg/L)	.0
DCE Conc. (mg/L)	.01
VC Conc. (mg/L)	4.7E-03
ETH Conc. (mg/L)	0.0
Distance from Source (ft)	100
Date Data Collected	2008

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE **RUN ARRAY** **Help** **SEE OUTPUT** **Restore Formulas** **Paste Example** **RESET**

Start Here →

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

- PCE
- TCE
- DCE
- VC
- ETH

Transverse Distance (ft)

Distance from Source (ft)	0	50	100	150	200	250	300	350	400	450	500
40	6.065E-03	2.124E-04	3.097E-06	1.791E-09	3.264E-14	1.300E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
20	6.065E-03	2.872E-04	4.062E-06	2.257E-09	3.979E-14	1.544E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0	6.065E-03	3.077E-04	4.416E-06	2.433E-09	4.248E-14	1.635E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-20	6.065E-03	2.872E-04	4.062E-06	2.257E-09	3.979E-14	1.544E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-40	6.065E-03	2.124E-04	3.097E-06	1.791E-09	3.264E-14	1.300E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Show No Degradation

Show Biotransformation

Displayed Compound

DCE

Displayed Model: **Biotransformation**

Target Level: **0.070** mg/L

Time: **5** yr

MASS RATE (mg/day)

Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation **2.715E-03** (Kg)

- Plume Mass If Biotransformation/Production **1.318E-03** (Kg)

Mass Removed **1.397E-03** (Kg)

% Biotransformed = **+51.4%**

% Change in Mass Rate = **100.0** % [source to edge]

If "Can't Calc." make model area longer

See acre ft

Current Volume of Ground Water in Plume **2.618E-02** MGal

Flow Rate of Water Through Source Area **5.129E-05** MGD

Compare to Pump and Treat

Pumping Rate **0.00** (gpm)

Pore Volumes Removed Per Yr. **0.00**

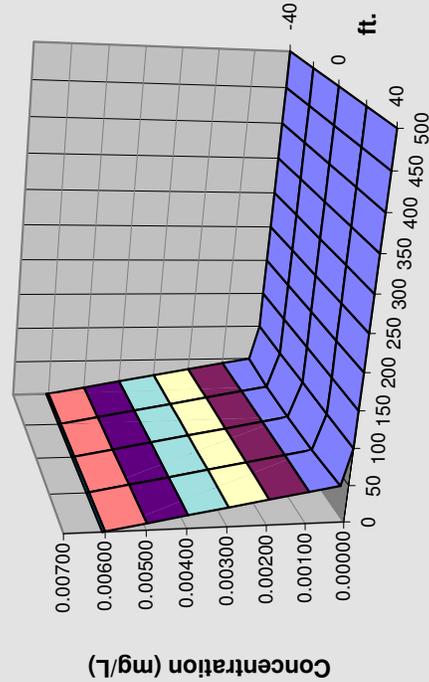
Pore Volumes to Clean-Up **0.00**

Clean-Up Time **0.00** (yr)

Mass HELP

To Centerline

Return to Input



Distance from Source (ft.)

Plot All Data

Plot Data > Target

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

Start Here → PCE
 TCE
 DCE
 VC
 ETH

Transverse Distance (ft)	0	50	100	150	200	250	300	350	400	450	500
40	3.033E-01	1.857E-02	3.492E-04	2.105E-07	3.954E-12	1.599E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
20	3.033E-01	2.510E-02	4.580E-04	2.653E-07	4.821E-12	1.900E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0	3.033E-01	2.690E-02	4.979E-04	2.860E-07	5.147E-12	2.011E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-20	3.033E-01	2.510E-02	4.580E-04	2.653E-07	4.821E-12	1.900E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-40	3.033E-01	1.857E-02	3.492E-04	2.105E-07	3.954E-12	1.599E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MASS RATE (mg/day)	5.9E+1	4.4E+0	8.2E-2	4.8E-5	8.8E-10	3.5E-16	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0

Time: yr

Target Level: mg/L

Displayed Model: **VC**

Displayed Compound: **VC**

Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation (Kg)

- Plume Mass If Biotransformation/Production (Kg)

Mass Removed (Kg)

% Biotransformed = [source to edge]

% Change in Mass Rate =

Current Volume of Ground Water in Plume MGal

Flow Rate of Water Through Source Area MGD

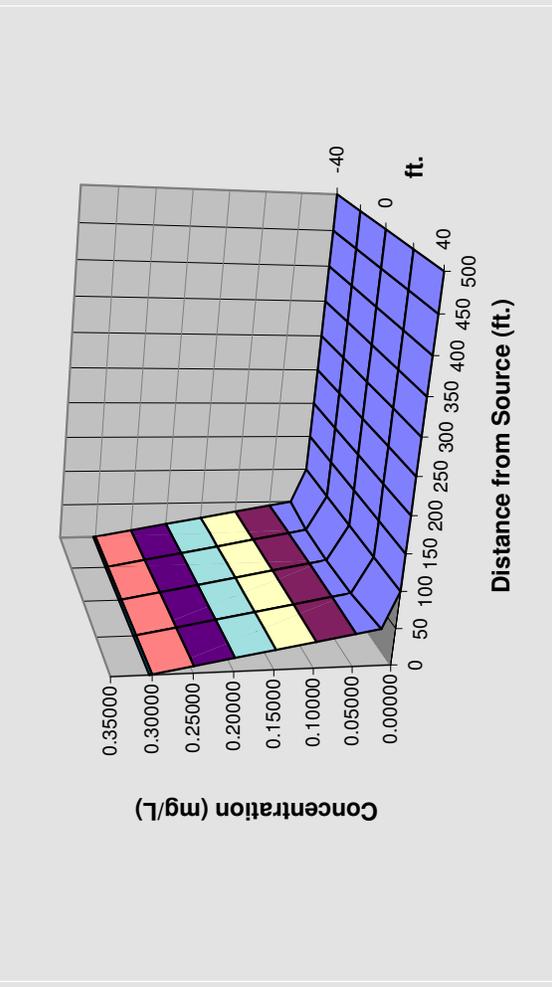
Compare to Pump and Treat

Pumping Rate (gpm)

Pore Volumes Removed Per Yr.

Pore Volumes to Clean-Up

Clean-Up Time (yr)



Start Here →

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

- PCE
- TCE
- DCE
- VC
- ETH

Transverse Distance (ft)

Distance from Source (ft)	0	50	100	150	200	250	300	350	400	450	500
40	6.065E-03	2.945E-03	1.114E-04	1.128E-07	1.449E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
20	6.065E-03	3.982E-03	1.461E-04	1.421E-07	1.766E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0	6.065E-03	4.267E-03	1.588E-04	1.532E-07	1.885E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-20	6.065E-03	3.982E-03	1.461E-04	1.421E-07	1.766E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-40	6.065E-03	2.945E-03	1.114E-04	1.128E-07	1.449E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MASS RATE (mg/day)	1.2E+0	7.0E-1	2.6E-2	2.6E-5	3.2E-10	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0

Time: yr

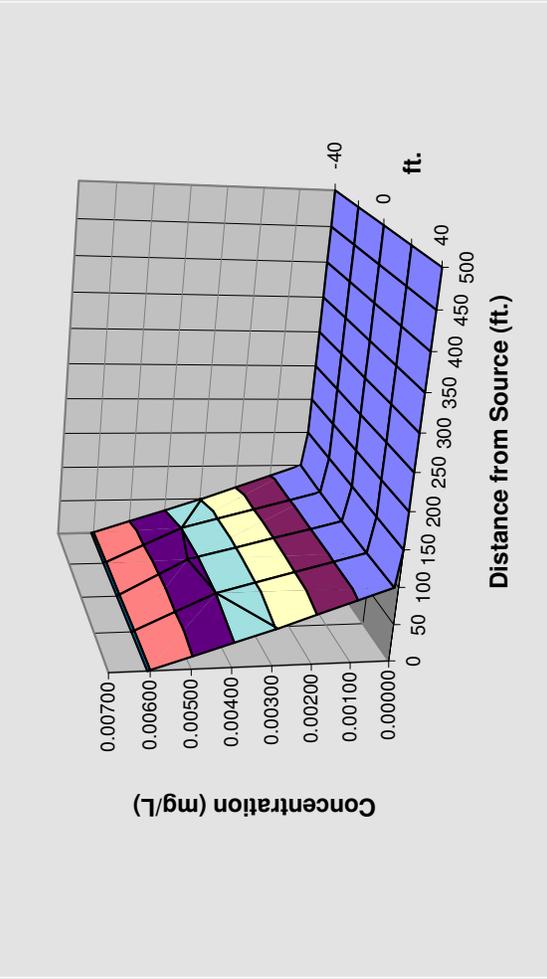
Target Level: mg/L

Displayed Compound

Displayed Model:

Show No Degradation

Show Biotransformation



[Plot All Data](#)

[Plot Data > Target](#)

Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation (Kg)

- Plume Mass If Biotransformation/Production (Kg)

Mass Removed (Kg)

If "Can't Calc." make model area longer

% Biotransformed =

% Change in Mass Rate = [source to edge]

Current Volume of Ground Water in Plume MGal

Flow Rate of Water Through Source Area MGD

Compare to Pump and Treat

Pumping Rate (gpm)

Pore Volumes Removed Per Yr.

Pore Volumes to Clean-Up

Clean-Up Time (yr)

[Mass HELP](#)

[To Centerline](#)

[Return to Input](#)

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

Start Here → PCE
 TCE
 DCE
 VC
 ETH

Transverse Distance (ft)	0	50	100	150	200	250	300	350	400	450	500
40	3.033E-01	1.473E-01	5.571E-03	5.639E-06	7.244E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
20	3.033E-01	1.991E-01	7.306E-03	7.107E-06	8.832E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0	3.033E-01	2.133E-01	7.942E-03	7.661E-06	9.427E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-20	3.033E-01	1.991E-01	7.306E-03	7.107E-06	8.832E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-40	3.033E-01	1.473E-01	5.571E-03	5.639E-06	7.244E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MASS RATE (mg/day)	5.9E+1	3.5E+1	1.3E+0	1.3E-3	1.6E-8	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0

Time: yr

Target Level: mg/L

Displayed Model: **VC**

Displayed Compound: **VC**

Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation (Kg)

- Plume Mass If Biotransformation/Production (Kg)

Mass Removed (Kg)

% Biotransformed =

% Change in Mass Rate = % [source to edge]

Current Volume of Ground Water in Plume MGal

Flow Rate of Water Through Source Area MGD

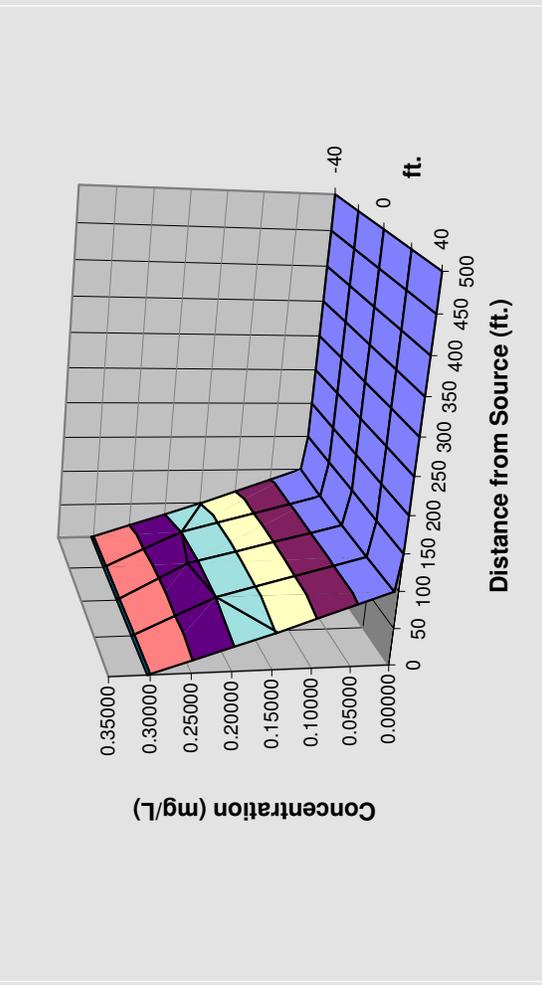
Compare to Pump and Treat

Pumping Rate (gpm)

Pore Volumes Removed Per Yr.

Pore Volumes to Clean-Up (yr)

Clean-Up Time (yr)



APPENDIX B

Groundwater and Surface Water Sampling and Analysis Plan

Prepared for

Greene County Landfill Permit 40-02
Walstonburg, Greene County, North Carolina

MESCO Project Number: G07061.0

This report is included as Appendix B of the
Corrective Action Plan prepared for Greene County.

Prepared on 2/25/2009

Revised on 2/12/2010



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

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5 CONCLUSION 7

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Plate A..... Topographic Map
Plate B..... Site Map
Plate C..... Typical Monitoring Well
Plate D..... Graphical Plot of Standing Volumes of Water

1 INTRODUCTION

1.1 Objective

The objective of this Groundwater and Surface water Sampling and Analysis Plan (SAP) is to provide clear guidelines and procedures for field and laboratory personnel when collecting and analyzing groundwater and surface water samples. This plan is an update that supersedes the November 1995 SAP for the Greene County C&D landfill on top of the municipal solid waste landfill (MSWLF). The sampling procedures outlined in this SAP are guidelines by which sampling will be performed. Deviation from the procedures may be warranted depending on facility conditions or unforeseen sampling variables. Alternative sampling procedures must conform to the N.C. Water Quality Monitoring Guidance Document for Solid Waste Facilities (Guidance Document). Copies of the North Carolina Department of Environment and Natural Resources (NCDENR) Solid Waste Section technical guidelines for sampling and monitoring are presented in the **Attachments**.

All groundwater and surface water monitoring points shall be sampled semi-annually for the constituents listed in 40 CFR Part 258 Appendix I and Appendix II. In addition to the Appendix I and Appendix II constituents, monitoring wells MW-1R and MW-4 will be sampled for the following suite of Monitored Natural Attenuation (MNA) parameters.

<i>MNA Performance Parameters</i>		
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	
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.		

1.2 Water Quality Monitoring Summary

The nature of groundwater flow, geology, location of creeks, and close proximity of several drainage features will require extensive monitoring for early detection of a release. The monitoring plan includes sampling six (6) monitoring wells (MW-1R, MW-4, MW-5, MW-6, MW-7 and MW-8) and two (2) surface water monitoring points labeled “upstream” and “downstream”. Monitoring points included in this plan are summarized on **Table E-1**. A topographic map with surface water sampling locations is provided as **Plate A**. Locations of monitoring wells are presented on **Plate B**.

Monitoring well MW-1R, located southwest and upgradient of the landfill, will serve as the background well. MW-4, located near the northeastern corner of the landfill unit serves as a downgradient well. MW-5 serves as a downgradient well located east of the central portion of the landfill. MW-6 is a downgradient monitoring well located southeast of the landfill unit. MW-7 was installed northeast of the unit in June 2007 approximately 240 feet east of the waste limit, just inside the relevant point of compliance (250 feet from the waste limit). MW-8 was also installed in June 2007 farther northeast of the unit just inside the relevant point of compliance. Surface water sampling points are located off site on the tributary of Sandy Run.

1.3 Assessment Monitoring

Assessment monitoring, consisting of collecting and analyzing groundwater samples for the Appendix I and Appendix II list of constituents will be performed on the background well (MW-1R) and the compliance wells (MW-4, MW-5, MW-6, MW-7 and MW-8). In addition field parameters including dissolved oxygen (DO), oxidation reduction potential (ORP), pH, temperature, turbidity, and conductivity will also be collected.

2 SAMPLING EQUIPMENT

Groundwater purging and sampling will be performed using a submersible pump and/or disposable polyethylene bailers. . The following procedure will be used to decontaminate the submersible pump:

1. Phosphate-free detergent & de-ionized or distilled water rinse.
2. De-ionized or distilled water rinse.
3. Isopropyl alcohol (isopropanol) rinse.
4. De-ionized or distilled water rinse.

A new bailer will be used to sample each individual well. *Under no circumstance will a disposable bailer used to sample a given well be used to sample any remaining well*

At least one (1) equipment blank will be collected during pump decontamination procedures to ensure that cross-contamination has not occurred as a result of the decontamination process. The standard equipment necessary to conduct sampling for each well consists of:

- Sample containers (including trip blanks and equipment blanks)
- Wide-mouth container
- Bailing twine
- Disposable latex/nitrile gloves
- Temperature/pH/ORP/conductivity indicator
- Electronic water level indicator
- Transport or storage coolers with ice.

All equipment subject to damage and contamination will be transported in sealed, plastic bags or storage containers. The water level indicator will be decontaminated in accordance with Steps 2 and 3 described above prior to placement in a clean plastic bag or storage container.

2.1 Appendix I and Appendix II Sample Containers

Groundwater and surface water samples will be collected for the various analyses in the appropriate laboratory-supplied containers.

- Each sample container will be clearly labeled providing the following information: site name, county location, sample identification number, parameters to be analyzed, preservative added, date and time of sampling, and initials of the sampler.
- Samples to be analyzed for VOCs will be collected first in three 40-ml glass vials with Teflon septa caps. The sample vials will be completely filled to create zero headspace in the vials.
- Samples to be analyzed for inorganic constituents will be collected second in a quart/1-liter polyethylene container.
- Samples to be analyzed for the remaining target analytes will be collected in the appropriate laboratory-supplied containers.

All sample containers will be obtained from an independent laboratory in a sterilized condition and with the appropriate, method-specific preservative. Care will be taken by the field technician to not allow the preservative to wash out of the sample containers during sampling.

2.2 MNA Sampling Containers

Groundwater samples to be analyzed for MNA performance parameters will be collected into the container types listed in the table below.

MNA Parameter	Volume	Bottle Type	Preservative
Alkalinity	250 mL	Plastic	none; cool to 4°C
Chloride	125 mL	Plastic	none; cool to 4°C
TOC/COD	250 mL	Glass	Sulfuric acid (H ₂ SO ₄)
BOD	500 mL	Polyethylene	none; cool to 4°C
Iron	125 mL	Plastic	Nitric acid (HNO ₃)
Nitrate	125 mL	Plastic	Sulfuric acid (H ₂ SO ₄)
Sulfate	125 mL	Plastic	none; cool to 4°C
Sulfide	250 mL	Glass	Sodium hydroxide (NaOH)
Methane/Ethane/Ethene	125 mL	Plastic	none; cool to 4°C
Hydrogen	-	-	proprietary lab sampler
Volatile Fatty Acids	40 mL	Glass	Hydrochloric Acid (HCl)

3 SAMPLING

Wells will be sampled from upgradient to downgradient; or when previous analytical data is available, from least to greatest contamination. This procedure is required to limit the potential of cross contamination between sampling points.

A clean sheet of plastic will be placed around the well to provide a clean surface for sampling equipment. The total well depth read from the well tag and the measured depth to water, determined using the water level indicator, will be used to compute the depth of water in the well. The total well depth will be measured and compared to the depth indicated on the well tag as a check for silt buildup or blockage at depth.

All meters used to monitor purge parameters will be calibrated immediately prior to purging and sampling, and those readings recorded in a field logbook. Entries will always include pre- and post-calibration readings as well as the model and serial number of the equipment and the date, time, and person performing the calibration(s). Two standards, which bracket the average or suspected measurements for pH and specific conductance, will be used at the site. Since natural waters (including

those impacted by environmental contaminants) tend to have pH values less than 7.0, pH buffers of 4.0 and 7.0 will typically be used for instrument calibration.

Disposable nitrile gloves will be worn by the field technician during sampling to minimize the risk of personal exposure to potentially harmful chemical substances and to minimize the risk of sample cross-contamination. Fresh pairs of nitrile gloves will be worn during each purge and sampling event. The groundwater samples will be transferred from the bailers into method-specific and appropriately preserved containers and placed into a clean cooler containing ice to chill the samples to a temperature of approximately 4°C.

Indicator parameters such as pH, temperature and specific conductance will be measured during purging as an indication that groundwater representative of the formation surrounding a given well is being sampled. Purging is considered complete when at least three well volumes have been purged and indicator parameters have stabilized such that three successive readings vary by no more than 10%. Purging may need to be continued beyond five well volumes if indicator parameters have not stabilized. All information will be recorded on a field data sheet or in a field logbook with copies submitted to the Division of Waste Management with the analytical results.

3.1 Purging

Each well will be purged of approximately three (3) to five (5) volumes of standing water and allowed to settle prior to collection of groundwater samples. If the well should go dry and not recharge before the requisite well volumes are removed, the well will be allowed to recharge and a sample will be collected within 24 hours of the initial purging. The amount of standing water will be calculated by first subtracting the depth-to-water from total well depth. The amount of water in the well (in gallons) will then be determined by using the chart on **Plate C**. For example, a two-inch well that is 29 feet deep and contains 19 feet of standing water will have a well volume of ~3.3 gallons.

After determination of the amount of water to be purged from a given well, the equipment necessary for purging will be assembled at the well. The disposable bailer will be maintained in a stable, upright position while the upper portion of the plastic wrapping will be pulled away to expose only the eyelet used for securing twine to the bailer. After the twine has been secured to the bailer with gloved hands, the bailer will be suspended as the remaining plastic is removed. The bailer will be lowered slowly into the well until the bailer contacts groundwater. The bailer twine will then be cut to an adequate length and secured to prevent loss of the bailer in the well. At no time during purging will the bailer twine be

allowed to touch the ground. In order to not allow the twine to touch the ground during purging, the twine will be collected when raising the bailer either by loops gathered in one hand or by alternating hand-to-hand as the bailer is pulled from the well. When purging deep wells (in excess of 40 feet), the ground and the well head may be covered with a clean plastic bag or sheet of plastic with a slit cut to allow the plastic to slide over the well head. This will be a separate sheet of plastic from the one used for the sampling equipment.

3.2 Groundwater Sample Collection

The bailer will be lowered slowly into the well to avoid volatilization of any dissolved-phase compounds that may be present in the groundwater. Once full, the bailer will be retrieved and containers filled by emptying the water through the hole at the bottom of the bailer. Glass 40-mL vials for VOC analyses will be filled in such a manner as to produce zero headspace in the vials. Polyethylene containers for metals analyses will be filled and sealed with the cap, leaving about ½-inch of airspace at the top. In addition to collecting the samples, water will be collected in the wide-mouth container for pH, temperature, and conductivity measurements. Upon completion of sampling, all groundwater samples, including equipment and trip blanks, will be placed in labeled and sealed plastic bags and stored in ice-filled coolers to chill the samples to 4°C pending transport to an NCDENR-certified analytical laboratory. Contaminated nitrile gloves and twine will be discarded.

3.3 Surface water Sample Collection

Surface water sampling will be taken with given consideration to minimize turbulence and aeration. As during groundwater sampling, surface water samples will be collected by a field technician wearing disposable gloves. Containers will be dipped at sampling location points by gently dipping the sample container into surface water and allowing surface water to flow over the mouth of container so as not to displace any preservative within the sample container. If there is little current movement, the container will be moved slowly through the water laterally. During times of low water, if the water is not deep enough to allow filling of sample containers, an appropriately decontaminated sampling cup will be used to retrieve the sample. All containers will be treated in the same manner as the groundwater samples. The samples will be sealed in labeled, plastic bags, and stored in an ice-filled cooler to chill the samples to 4°C pending transport to an NCDENR-certified analytical laboratory.

3.4 Chain of Custody

Chain-of-custody forms will be used to document the handling of all samples collected and listing all individuals who have taken possession of a given set of samples, including field personnel, laboratory couriers, and laboratory personnel. Trip blanks, equipment blanks, and sample containers will all travel

and be stored together. Trip blanks will remain in the condition they are received from the laboratory and will not be opened or tampered with during the sampling. A chain-of-custody record will be completed for each day's samples, indicating the date and time, sample location, sample matrix (soil, water, etc.), and laboratory analyses to be conducted.

4 ANALYSIS

When the water samples reach the laboratory, they will be transferred to a sample custodian who will sign the chain of custody documentation as receipt of the samples. Internal control of the water samples in the laboratory will be in accordance with QA/QC procedures for the laboratory. Copies of QA/QC manuals for approved laboratories are on file at the Division of Waste Management.

Groundwater and surface water will be analyzed for the Appendix I and Appendix II list of constituents. QA/QC procedures utilized during the testing will be in conformance with laboratory QA/QC manual. Monitoring wells MW-1R and MW-4 will be sampled for the Appendix I list and the aforementioned MNA performance parameters.

5 CONCLUSION

This plan is included as part of the *Corrective Action Plan* for the Greene County Landfill. The groundwater and surface water monitoring plan is designed to be effective in the early detection of any possible release of hazardous constituents to the unconfined surficial aquifer, and to provide indicator parameters of natural degradation of target analytes.

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

Mark Brown, LG, PG
Licensed Geologist

Table E-1. Summary of Ground and Surface water Monitoring Points

Sampling Point	Type	Gradient	Total Depth (ft)	Designation
MW-1R	Monitoring Well	Up	18.2	Background Well
MW-4	Monitoring Well	Down	24.1	Performance Well
MW-5	Monitoring Well	Down	29	Monitoring Well
MW-6	Monitoring Well	Down	28.8	Monitoring Well
MW-7	Monitoring Well	Down	18.5	Compliance Well
MW-8	Monitoring Well	Down	17.98	Compliance Well
Upstream	Surface water	Upstream	-	Sandy Run tributary
Downstream	Surface water	Downstream	-	Sandy Run tributary

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TABLES

Table E-1	Summary of Ground and Surfacewater Monitoring Points
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PLATES

Plate A.....	Topographic Map
Plate B.....	Site Map
Plate C.....	Typical Monitoring Well
Plate D.....	Graphical Plot of Standing Volumes of Water

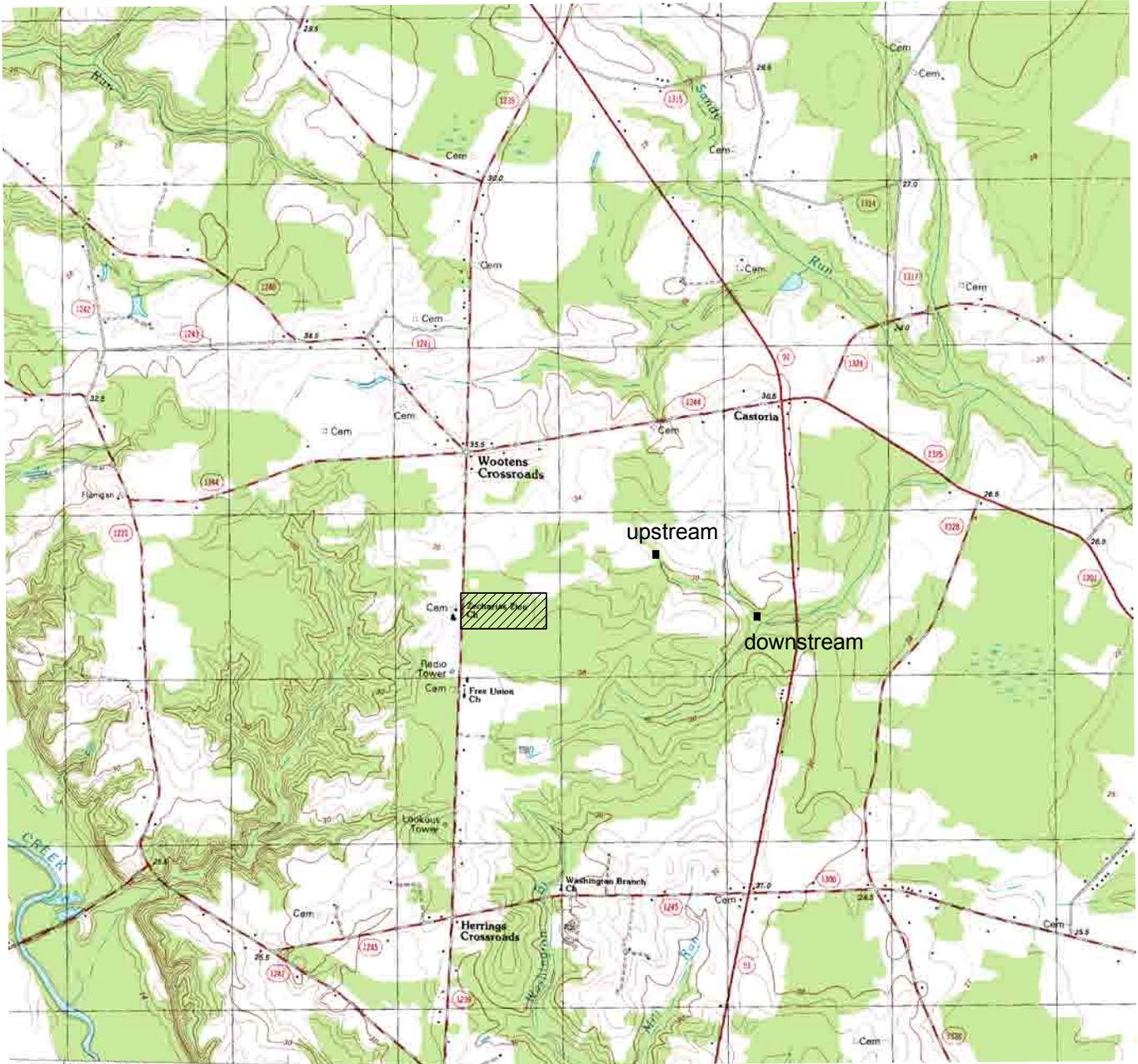
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MW-8	Monitoring Well	Down	17.98	Compliance Well
Upstream	Surfacewater	Upstream	-	Sandy Run tributary
Downstream	Surfacewater	Downstream	-	Sandy Run tributary

Topographic Map with Site Location

Greene County

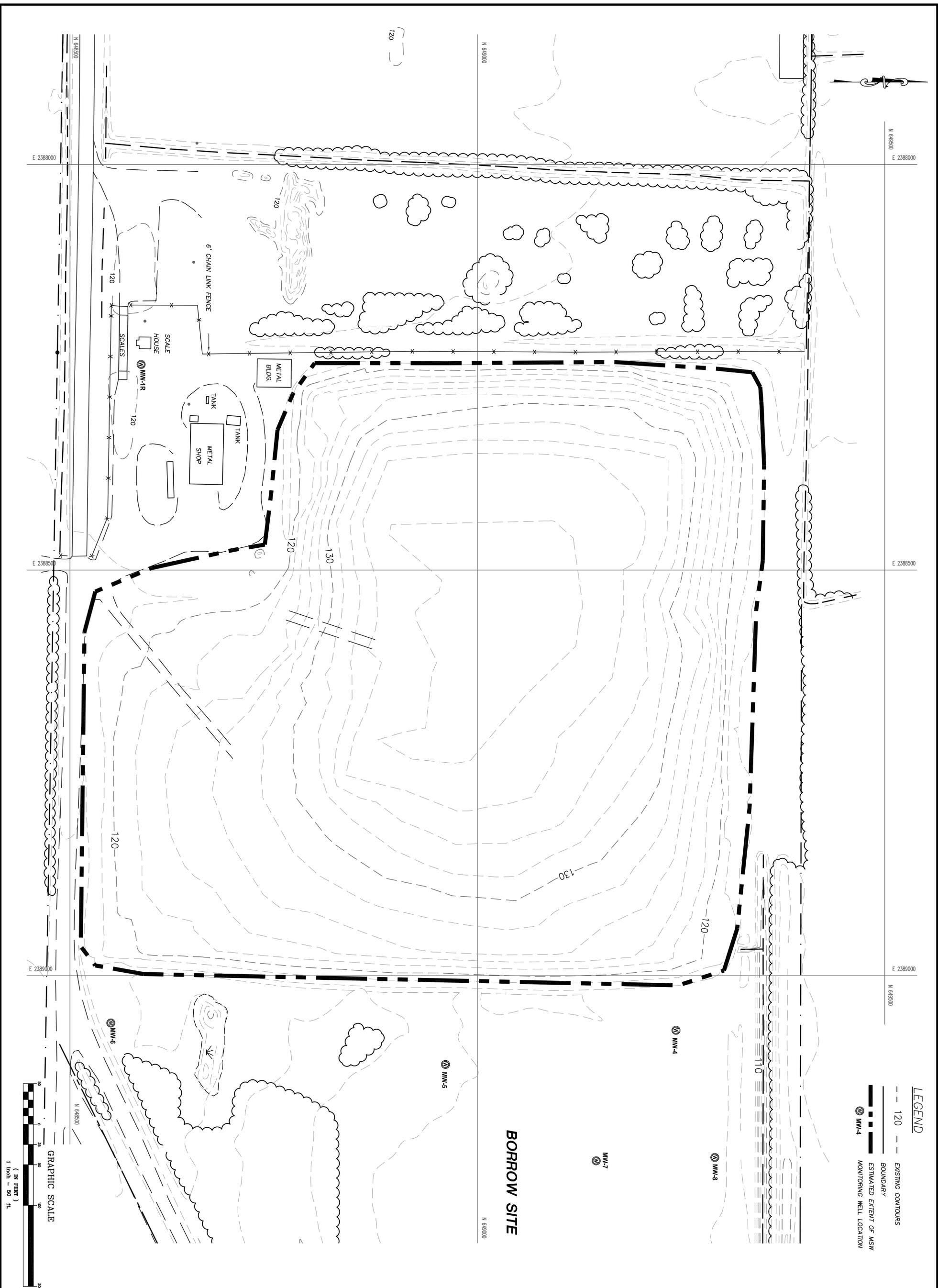
PLATE A



QUADRANGLE LEGEND

Date Completed	6/20/2008
Created By	M. German
Project Name	Sampling and Analysis Plan
Site Name	Greene County
Project Number	G07061.0

ROAD CLASSIFICATION	
Primary highway, hard surface	Light-duty road, hard or improved surface
Secondary highway, hard surface	Unimproved road
Interstate Route	U. S. Route
State Route	



LEGEND

- 120 --- EXISTING CONTOURS
- BOUNDARY
- - - - - ESTIMATED EXTENT OF MSW
- ⊙ MW-4 MONITORING WELL LOCATION



BORROW SITE

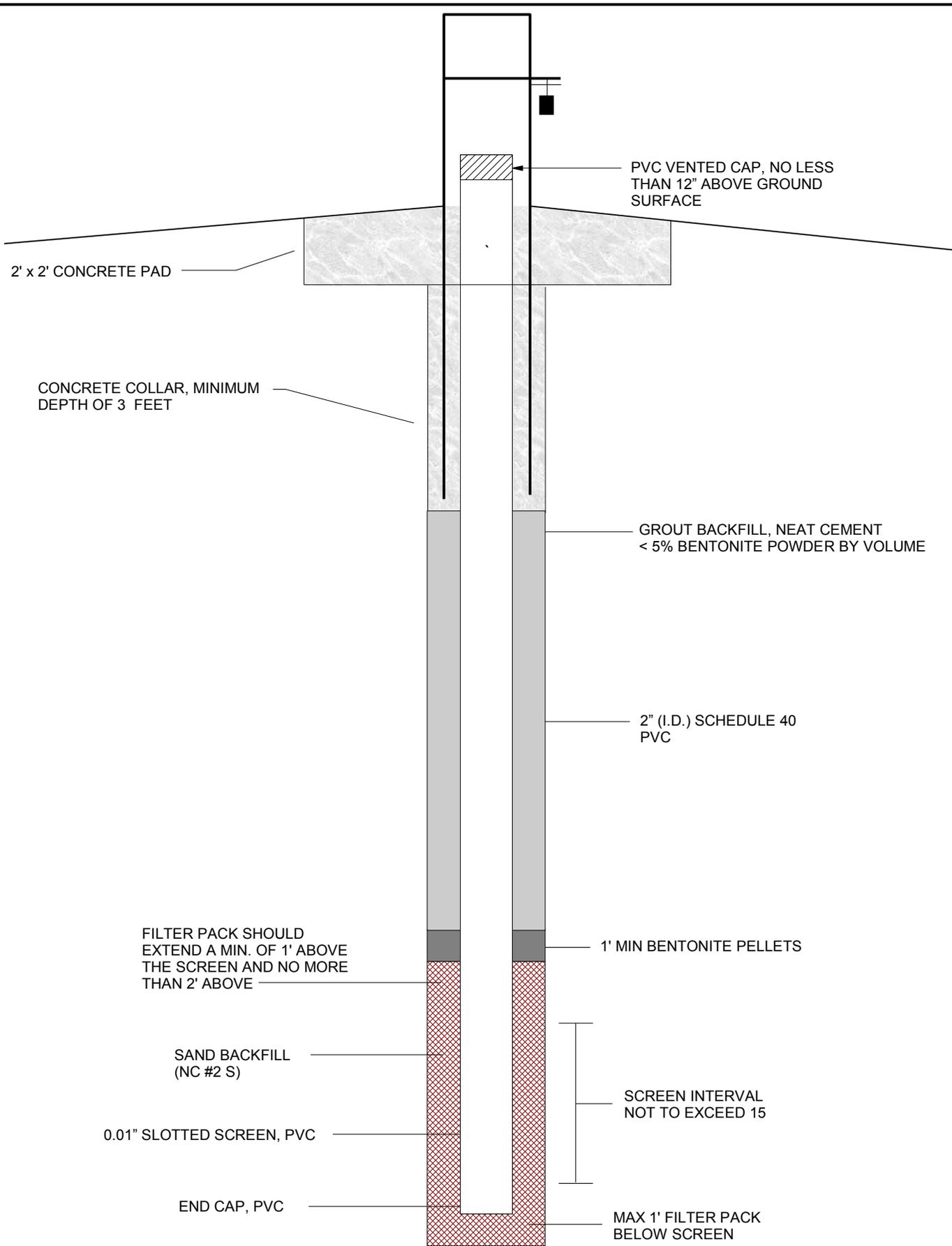
**GREENE COUNTY
CONSTRUCTION & DEMOLITION
LANDFILL FACILITY REVISION
GREENE COUNTY, NORTH CAROLINA**


Municipal Services Engineering Company, P.A.
 P.O. BOX 97 GARNER, N.C. 27629 (919) 772-5393
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 P.O. BOX 278 MOREHEAD CITY, N.C. 28557 (252) 726-9481

DATE	BY	REV.	DESCRIPTION

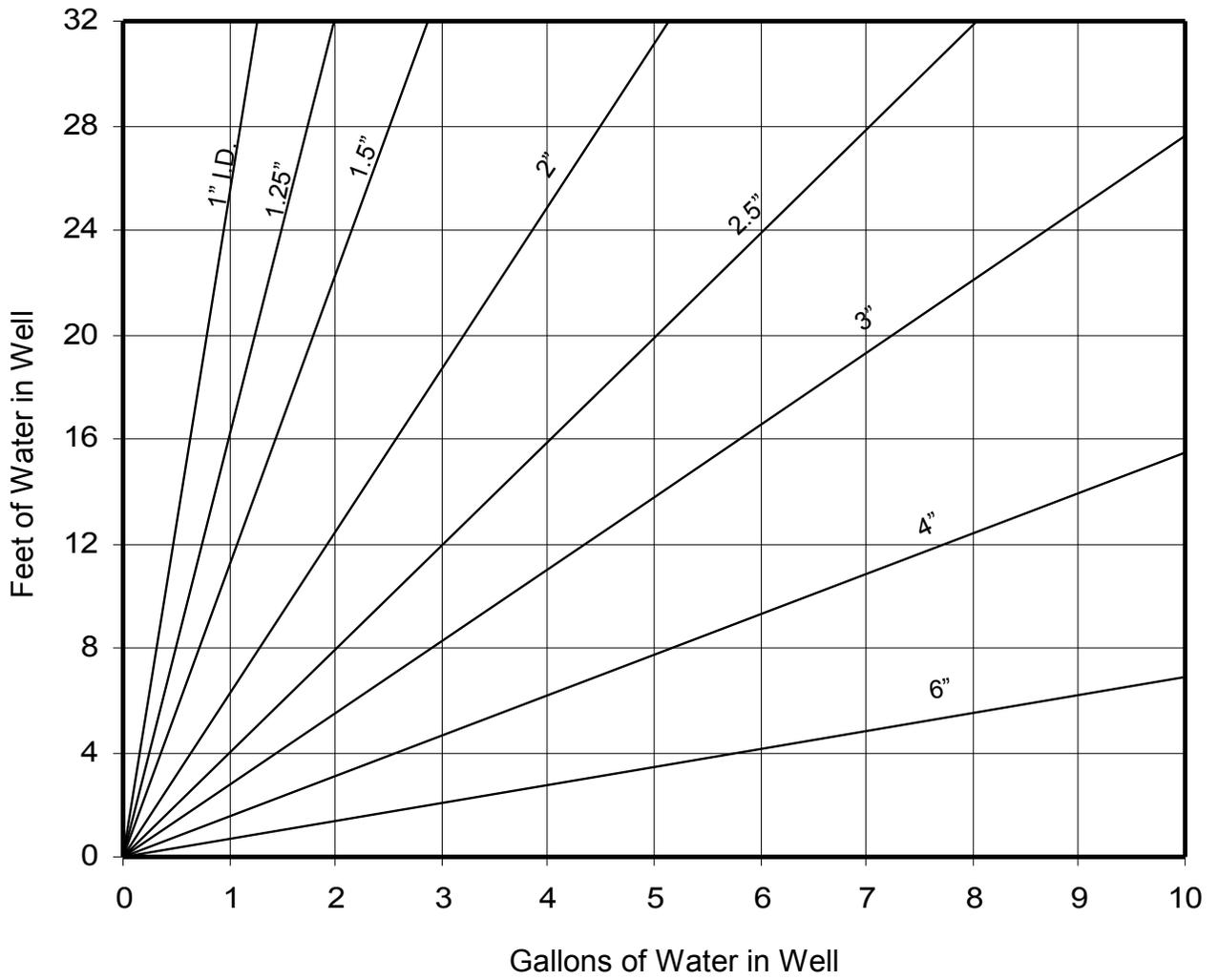
SAMPLING LOCATIONS

SCALE: 1" = 50'
 DATE: 8/24/2007
 DRAWN BY: E. CALDWELL
 CHECK BY: E. CALDWELL
 PROJECT NUMBER: G07061.0
 DRAWING NO.: PLATE B
 SHEET NO.: 1 OF 1



NOTE: SHALLOW WELLS REQUIRE A MINIMUM OF 5' COMBINED THICKNESS OF GROUT AND BENTONITE.

**TYPICAL MONITORING WELL
PLATE C**



GRAPHICAL PLOT OF STANDING VOLUMES OF WATER
PLATE D

Solid Waste Section

Guidelines for Groundwater, Soil, and Surface Water Sampling

STATE OF NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF WASTE MANAGEMENT
SOLID WASTE SECTION

General Sampling Procedures

The following guidance is provided to insure a consistent sampling approach so that sample collection activities at solid waste management facilities provide reliable data. Sampling must begin with an evaluation of facility information, historical environmental data and site geologic and hydrogeologic conditions. General sampling procedures are described in this document.

Planning

Begin sampling activities with planning and coordination. The party contracting with the laboratory is responsible for effectively communicating reporting requirements and evaluating data reliability as it relates to specific monitoring activities.

Sample Collection

Contamination Prevention

- a.) Take special effort to prevent cross contamination or environmental contamination when collecting samples.
 1. If possible, collect samples from the least contaminated sampling location (or background sampling location, if applicable) to the most contaminated sampling location.
 2. Collect the ambient or background samples first, and store them in separate ice chests or separate shipping containers within the same ice chest (e.g. untreated plastic bags).
 3. Collect samples in flowing water at designated locations from upstream to downstream.
- b.) Do not store or ship highly contaminated samples (concentrated wastes, free product, etc.) or samples suspect of containing high concentrations of contaminants in the same ice chest or shipping containers with other environmental samples.
 1. Isolate these sample containers by sealing them in separate, untreated plastic bags immediately after collecting, preserving, labeling, etc.
 2. Use a clean, untreated plastic bag to line the ice chest or shipping container.
- c.) All sampling equipment should be thoroughly decontaminated and transported in a manner that does not allow it to become contaminated. Arrangements should be made ahead of time to decontaminate any sampling or measuring equipment that will be reused when taking samples from more than one well. Field decontamination of

sampling equipment will be necessary before sampling each well to minimize the risk of cross contamination. Decontamination procedures should be included in reports as necessary. Certified pre-cleaned sampling equipment and containers may be used. When collecting aqueous samples, rinse the sample collection equipment with a portion of the sample water before taking the actual sample. Sample containers do not need to be rinsed. In the case of petroleum hydrocarbons, oil and grease, or containers with pre-measured preservatives, the sample containers cannot be rinsed.

- d.) Place all fuel-powered equipment away from, and downwind of, any site activities (e.g., purging, sampling, decontamination).
 1. If field conditions preclude such placement (i.e., the wind is from the upstream direction in a boat), place the fuel source(s) as far away as possible from the sampling activities and describe the conditions in the field notes.
 2. Handle fuel (i.e., filling vehicles and equipment) prior to the sampling day. If such activities must be performed during sampling, the personnel must wear disposable gloves.
 3. Dispense all fuels downwind. Dispose of gloves well away from the sampling activities.

Filling Out Sample Labels

Fill out label, adhere to vial and collect sample. Print legibly with indelible ink. At a minimum, the label or tag should identify the sample with the following information:

1. Sample location and/or well number
2. Sample identification number
3. Date and time of collection
4. Analysis required/requested
5. Sampler's initials
6. Preservative(s) used, if any [i.e., HCl, Na₂S₂O₃, NO₃, ice, etc.]
7. Any other pertinent information for sample identification

Sample Collection Order

Unless field conditions justify other sampling regimens, collect samples in the following order:

1. Volatile Organics and Volatile Inorganics
2. Extractable Organics, Petroleum Hydrocarbons, Aggregate Organics and Oil and Grease
3. Total Metals
4. Inorganic Nonmetallics, Physical and Aggregate Properties, and Biologicals
5. Microbiological

NOTE: *If the pump used to collect groundwater samples cannot be used to collect volatile or extractable organics then collect all other parameters and withdraw the pump and tubing. Then collect the volatile and extractable organics.*

Health and Safety

Implement all local, state, and federal requirements relating to health and safety. Follow all local, state and federal requirements pertaining to the storage and disposal of any hazardous or investigation derived wastes.

- a.) The Solid Waste Section recommends wearing protective gloves when conducting all sampling activities.
 1. Gloves serve to protect the sample collector from potential exposure to sample constituents, minimize accidental contamination of samples by the collector, and preserve accurate tare weights on preweighed sample containers.
 2. Do not let gloves come into contact with the sample or with the interior or lip of the sample container. Use clean, new, unpowdered and disposable gloves. Various types of gloves may be used as long as the construction materials do not contaminate the sample or if internal safety protocols require greater protection.
 3. Note that certain materials that may potentially be present in concentrated effluent can pass through certain glove types and be absorbed in the skin. Many vendor catalogs provide information about the permeability of different gloves and the circumstances under which the glove material might be applicable. The powder in powdered gloves can contribute significant contamination. Powdered gloves are not recommended unless it can be demonstrated that the powder does not interfere with the sample analysis.
 4. Change gloves after preliminary activities, after collecting all the samples at a single sampling point, if torn or used to handle extremely dirty or highly contaminated surfaces. Properly dispose of all used gloves as investigation derived wastes.
- b.) Properly manage all investigation derived waste (IDW).
 5. To prevent contamination into previously uncontaminated areas, properly manage all IDW. This includes all water, soil, drilling mud, decontamination wastes, discarded personal protective equipment (PPE), etc. from site investigations, exploratory borings, piezometer and monitoring well installation, refurbishment, abandonment, and other investigative activities. Manage all IDW that is determined to be RCRA-regulated hazardous waste according to the local, state and federal requirements.
 6. Properly dispose of IDW that is not a RCRA-regulated hazardous waste but is contaminated above the Department's Soil Cleanup Target Levels or the state standards and/or minimum criteria for ground water quality. If the drill cuttings/mud or purged well water is contaminated with hazardous waste, contact the DWM Hazardous Waste Section (919-508-8400) for disposal options. Maintain all containers holding IDW in good condition. Periodically inspect the containers for damage and ensure that all required labeling (DOT, RCRA, etc.) are clearly visible.

Sample Storage and Transport

Store samples for transport carefully. Pack samples to prevent from breaking and to maintain a temperature of approximately 4 degrees Celsius (°C), adding ice if necessary. Transport samples to a North Carolina-certified laboratory as soon as possible. Avoid unnecessary handling of sample containers. Avoid heating (room temperature or above, including exposure to sunlight) or freezing of the sample containers. Reduce the time between sample collection and delivery to a laboratory whenever possible and be sure that the analytical holding times of your samples can be met by the laboratory.

- a.) A complete chain-of-custody (COC) form must be maintained to document all transfers and receipts of the samples. Be sure that the sample containers are labeled with the sample location and/or well number, sample identification, the date and time of collection, the analysis to be performed, the preservative added (if any), the sampler's initials, and any other pertinent information for sample identification. The labels should contain a unique identifier (i.e., unique well numbers) that can be traced to the COC form. The details of sample collection must be documented on the COC. The COC must include the following:
 1. Description of each sample (including QA/QC samples) and the number of containers (sample location and identification)
 2. Signature of the sampler
 3. Date and time of sample collection
 4. Analytical method to be performed
 5. Sample type (i.e., water or soil)
 6. Regulatory agency (i.e., NCDENR/DWM – SW Section)
 7. Signatures of all persons relinquishing and receiving custody of the samples
 8. Dates and times of custody transfers
- b.) Pack samples so that they are segregated by site, sampling location or by sample analysis type. When COC samples are involved, segregate samples in coolers by site. If samples from multiple sites will fit in one cooler, they may be packed in the same cooler with the associated field sheets and a single COC form for all. Coolers should not exceed a maximum weight of 50 lbs. Use additional coolers as necessary. All sample containers should be placed in plastic bags (segregated by analysis and location) and completely surrounded by ice.
 1. Prepare and place trip blanks in an ice filled cooler before leaving for the field.
 2. Segregate samples by analysis and place in sealable plastic bags.
 3. Pack samples carefully in the cooler placing ice around the samples.
 4. Review the COC. The COC form must accompany the samples to the laboratory. The trip blank(s) must also be recorded on the COC form.
 5. Place completed COC form in a waterproof bag, sealed and taped under the lid of the cooler.
 6. Secure shipping containers with strapping tape to avoid accidental opening.
 7. For COC samples, a tamper-proof seal may also be placed over the cooler lid or over a bag or container containing the samples inside the shipping cooler.

8. "COC" or "EMERG" should be written in indelible ink on the cooler seal to alert sample receipt technicians to priority or special handling samples.
9. The date and sample handler's signature must also be written on the COC seal.
10. Deliver the samples to the laboratory or ship by commercial courier.

NOTE: *If transport time to the laboratory is not long enough to allow samples to be cooled to 4° C, a temperature reading of the sample source must be documented as the field temperature on the COC form. A downward trend in temperature will be adequate even if cooling to 4° C is not achieved. The field temperature should always be documented if there is any question as to whether samples will have time to cool to 4° C during shipment. Thermometers must be calibrated annually against an NIST traceable thermometer and documentation must be retained.*

Appendix A - Decontamination of Field Equipment

Decontamination of personnel, sampling equipment, and containers - before and after sampling - must be used to ensure collection of representative samples and to prevent the potential spread of contamination. Decontamination of personnel prevents ingestion and absorption of contaminants. It must be done with a soap and water wash and deionized or distilled water rinse. Certified pre-cleaned sampling equipment and containers may also be used.

All previously used sampling equipment must be properly decontaminated before sampling and between sampling locations. This prevents the introduction of contamination into uncontaminated samples and avoids cross-contamination of samples. Cross-contamination can be a significant problem when attempting to characterize extremely low concentrations of organic compounds or when working with soils that are highly contaminated.

Clean, solvent-resistant gloves and appropriate protective equipment must be worn by persons decontaminating tools and equipment.

Cleaning Reagents

Recommendations for the types and grades of various cleaning supplies are outlined below. The recommended reagent types or grades were selected to ensure that the cleaned equipment is free from any detectable contamination.

- a.) Detergents: Use Liqui-Nox (or a non-phosphate equivalent) or Alconox (or equivalent). Liqui-Nox (or equivalent) is recommended by EPA, although Alconox (or equivalent) may be substituted if the sampling equipment will not be used to collect phosphorus or phosphorus containing compounds.
- b.) Solvents: Use pesticide grade isopropanol as the rinse solvent in routine equipment cleaning procedures. This grade of alcohol must be purchased from a laboratory supply vendor. Rubbing alcohol or other commonly available sources of isopropanol **are not acceptable**. Other solvents, such as acetone or methanol, may be used as the final rinse solvent if they are pesticide grade. However, methanol is more toxic to the environment and acetone may be an analyte of interest for volatile organics.
 1. **Do not** use acetone if volatile organics are of interest
 2. Containerize all methanol wastes (including rinses) and dispose as a hazardous waste.

Pre-clean equipment that is heavily contaminated with organic analytes. Use reagent grade acetone and hexane or other suitable solvents. Use pesticide grade methylene chloride when cleaning sample containers. Store all solvents away from potential sources of contamination.

- c.) Analyte-Free Water Sources: Analyte-free water is water in which all analytes of interest and all interferences are below method detection limits. Maintain documentation (such as results from equipment blanks) to demonstrate the reliability and purity of analyte-free water source(s). The source of the water must meet the requirements of the analytical method and must be free from the analytes of interest. In general, the following water types are associated with specific analyte groups:
 1. *Milli-Q (or equivalent polished water)*: suitable for all analyses.

2. *Organic-free*: suitable for volatile and extractable organics.
3. *Deionized water*: may not be suitable for volatile and extractable organics.
4. *Distilled water*: not suitable for volatile and extractable organics, metals or ultratrace metals.

Use analyte-free water for blank preparation and the final decontamination water rinse. In order to minimize long-term storage and potential leaching problems, obtain or purchase analyte-free water just prior to the sampling event. If obtained from a source (such as a laboratory), fill the transport containers and use the contents for a single sampling event. Empty the transport container(s) at the end of the sampling event. Discard any analyte-free water that is transferred to a dispensing container (such as a wash bottle or pump sprayer) at the end of each sampling day.

d.) Acids:

1. *Reagent Grade Nitric Acid*: 10 - 15% (one volume concentrated nitric acid and five volumes deionized water). Use for the acid rinse unless nitrogen components (e.g., nitrate, nitrite, etc.) are to be sampled. If sampling for ultra-trace levels of metals, use an ultra-pure grade acid.
2. *Reagent Grade Hydrochloric Acid*: 10% hydrochloric acid (one volume concentrated hydrochloric and three volumes deionized water). Use when nitrogen components are to be sampled.
3. If samples for both metals and the nitrogen-containing components are collected with the equipment, use the hydrochloric acid rinse, or thoroughly rinse with hydrochloric acid after a nitric acid rinse. If sampling for ultra trace levels of metals, use an ultra-pure grade acid.
4. Freshly prepared acid solutions may be recycled during the sampling event or cleaning process. Dispose of any unused acids according to local ordinances.

Reagent Storage Containers

The contents of all containers must be clearly marked.

a.) Detergents:

1. Store in the original container or in a HDPE or PP container.

b.) Solvents:

1. Store solvents to be used for cleaning or decontamination in the original container until use in the field. If transferred to another container for field use, use either a glass or Teflon container.
2. Use dispensing containers constructed of glass, Teflon or stainless steel.
Note: If stainless steel sprayers are used, any gaskets that contact the solvents must be constructed of inert materials.

c.) Analyte-Free Water:

1. Transport in containers appropriate for the type of water stored. If the water is commercially purchased (e.g., grocery store), use the original containers when transporting the water to the field. Containers made of glass, Teflon, polypropylene or HDPE are acceptable.
2. Use glass or Teflon to transport organic-free sources of water on-site. Polypropylene or HDPE may be used, but are not recommended.

3. Dispense water from containers made of glass, Teflon, HDPE or polypropylene.
4. Do not store water in transport containers for more than three days before beginning a sampling event.
5. If working on a project that has oversight from EPA Region 4, use glass containers for the transport and storage of all water.
6. Store and dispense acids using containers made of glass, Teflon or plastic.

General Requirements

- a.) Prior to use, clean/decontaminate all sampling equipment (pumps, tubing, lanyards, split spoons, etc.) that will be exposed to the sample.
- b.) Before installing, clean (or obtain as certified pre-cleaned) all equipment that is dedicated to a single sampling point and remains in contact with the sample medium (e.g., permanently installed groundwater pump). If you use certified pre-cleaned equipment no cleaning is necessary.
 1. Clean this equipment any time it is removed for maintenance or repair.
 2. Replace dedicated tubing if discolored or damaged.
- c.) Clean all equipment in a designated area having a controlled environment (house, laboratory, or base of field operations) and transport it to the field, pre-cleaned and ready to use, unless otherwise justified.
- d.) Rinse all equipment with water after use, even if it is to be field-cleaned for other sites. Rinse equipment used at contaminated sites or used to collect in-process (e.g., untreated or partially treated wastewater) samples immediately with water.
- e.) Whenever possible, transport sufficient clean equipment to the field so that an entire sampling event can be conducted without the need for cleaning equipment in the field.
- f.) Segregate equipment that is only used once (i.e., not cleaned in the field) from clean equipment and return to the in-house cleaning facility to be cleaned in a controlled environment.
- g.) Protect decontaminated field equipment from environmental contamination by securely wrapping and sealing with one of the following:
 1. Aluminum foil (commercial grade is acceptable)
 2. Untreated butcher paper
 3. Clean, untreated, disposable plastic bags. Plastic bags may be used for all analyte groups except volatile and extractable organics. Plastic bags may be used for volatile and extractable organics, if the equipment is first wrapped in foil or butcher paper, or if the equipment is completely dry.

Cleaning Sample Collection Equipment

- a.) On-Site/In-Field Cleaning – Cleaning equipment on-site is not recommended because environmental conditions cannot be controlled and wastes (solvents and acids) must be containerized for proper disposal.
 1. Ambient temperature water may be substituted in the hot, sudsy water bath and hot water rinses.

NOTE: Properly dispose of all solvents and acids.

2. Rinse all equipment with water after use, even if it is to be field-cleaned for other sites.
 3. Immediately rinse equipment used at contaminated sites or used to collect in-process (e.g., untreated or partially treated wastewater) samples with water.
- b.) Heavily Contaminated Equipment - In order to avoid contaminating other samples, isolate heavily contaminated equipment from other equipment and thoroughly decontaminate the equipment before further use. Equipment is considered heavily contaminated if it:
1. Has been used to collect samples from a source known to contain significantly higher levels than background.
 2. Has been used to collect free product.
 3. Has been used to collect industrial products (e.g., pesticides or solvents) or their byproducts.

NOTE: *Cleaning heavily contaminated equipment in the field is not recommended.*

c.) On-Site Procedures:

1. Protect all other equipment, personnel and samples from exposure by isolating the equipment immediately after use.
2. At a minimum, place the equipment in a tightly sealed, untreated, plastic bag.
3. Do not store or ship the contaminated equipment next to clean, decontaminated equipment, unused sample containers, or filled sample containers.
4. Transport the equipment back to the base of operations for thorough decontamination.
5. If cleaning must occur in the field, document the effectiveness of the procedure, collect and analyze blanks on the cleaned equipment.

d.) Cleaning Procedures:

1. If organic contamination cannot be readily removed with scrubbing and a detergent solution, pre-rinse equipment by thoroughly rinsing or soaking the equipment in acetone.
2. Use hexane only if preceded and followed by acetone.
3. In extreme cases, it may be necessary to steam clean the field equipment before proceeding with routine cleaning procedures.
4. After the solvent rinses (and/or steam cleaning), use the appropriate cleaning procedure. Scrub, rather than soak, all equipment with sudsy water. If high levels of metals are suspected and the equipment cannot be cleaned without acid rinsing, soak the equipment in the appropriate acid. Since stainless steel equipment should not be exposed to acid rinses, do not use stainless steel equipment when heavy metal contamination is suspected or present.
5. If the field equipment cannot be cleaned utilizing these procedures, discard unless further cleaning with stronger solvents and/or oxidizing solutions is effective as evidenced by visual observation and blanks.
6. Clearly mark or disable all discarded equipment to discourage use.

- e.) General Cleaning - Follow these procedures when cleaning equipment under controlled conditions. Check manufacturer's instructions for cleaning restrictions and/or recommendations.
1. *Procedure for Teflon, stainless steel and glass sampling equipment:* This procedure must be used when sampling for ALL analyte groups. (Extractable organics, metals, nutrients, etc. or if a single decontamination protocol is desired to clean all Teflon, stainless steel and glass equipment.) Rinse equipment with hot tap water. Soak equipment in a hot, sudsy water solution (Liqui-Nox or equivalent). If necessary, use a brush to remove particulate matter or surface film. Rinse thoroughly with hot tap water. If samples for trace metals or inorganic analytes will be collected with the equipment that is not stainless steel, thoroughly rinse (wet all surfaces) with the appropriate acid solution. Rinse thoroughly with analyte-free water. Make sure that all equipment surfaces are thoroughly flushed with water. If samples for volatile or extractable organics will be collected, rinse with isopropanol. Wet equipment surfaces thoroughly with free-flowing solvent. Rinse thoroughly with analyte-free water. Allow to air dry. Wrap and seal as soon as the equipment has air-dried. If isopropanol is used, the equipment may be air-dried without the final analyte-free water rinse; however, the equipment must be completely dry before wrapping or use. Wrap clean sampling equipment according to the procedure described above.
 2. *General Cleaning Procedure for Plastic Sampling Equipment:* Rinse equipment with hot tap water. Soak equipment in a hot, sudsy water solution (Liqui-Nox or equivalent). If necessary, use a brush to remove particulate matter or surface film. Rinse thoroughly with hot tap water. Thoroughly rinse (wet all surfaces) with the appropriate acid solution. Check manufacturer's instructions for cleaning restrictions and/or recommendations. Rinse thoroughly with analyte-free water. Be sure that all equipment surfaces are thoroughly flushed. Allow to air dry as long as possible. Wrap clean sampling equipment according to the procedure described above.

Appendix B - Collecting Soil Samples

Soil samples are collected for a variety of purposes. A methodical sampling approach must be used to assure that sample collection activities provide reliable data. Sampling must begin with an evaluation of background information, historical data and site conditions.

Soil Field Screening Procedures

Field screening is the use of portable devices capable of detecting petroleum contaminants on a real-time basis or by a rapid field analytical technique. Field screening should be used to help assess locations where contamination is most likely to be present.

When possible, field-screening samples should be collected directly from the excavation or from the excavation equipment's bucket. If field screening is conducted only from the equipment's bucket, then a minimum of one field screening sample should be collected from each 10 cubic yards of excavated soil. If instruments or other observations indicate contamination, soil should be separated into stockpiles based on apparent degrees of contamination. At a minimum, soil suspected of contamination must be segregated from soil observed to be free of contamination.

- a.) Field screening devices – Many field screen instruments are available for detecting contaminants in the field on a rapid or real-time basis. Acceptable field screening instruments must be suitable for the contaminant being screened. The procedure for field screening using photoionization detectors (PIDs) and flame ionization detectors (FIDs) is described below. If other instruments are used, a description of the instrument or method and its intended use must be provided to the Solid Waste Section. Whichever field screening method is chosen, its accuracy must be verified throughout the sampling process. Use appropriate standards that match the use intended for the data. Unless the Solid Waste Section indicates otherwise, wherever field screening is recommended in this document, instrumental or analytical methods of detection must be used, not olfactory or visual screening methods.
- b.) Headspace analytical screening procedure for field screening (semi-quantitative field screening) - The most commonly used field instruments for Solid Waste Section site assessments are FIDs and PIDs. When using FIDs and PIDs, use the following headspace screening procedure to obtain and analyze field-screening samples:
 1. Partially fill (one-third to one-half) a clean jar or clean ziplock bag with the sample to be analyzed. The total capacity of the jar or bag may not be less than eight ounces (app. 250 ml), but the container should not be so large as to allow vapor diffusion and stratification effects to significantly affect the sample.
 2. If the sample is collected from a spilt-spoon, it must be transferred to the jar or bag for headspace analysis immediately after opening the split-spoon. If the sample is collected from an excavation or soil pile, it must be collected from freshly uncovered soil.

3. If a jar is used, it must be quickly covered with clean aluminum foil or a jar lid; screw tops or thick rubber bands must be used to tightly seal the jar. If a zip lock bag is used, it must be quickly sealed shut.
4. Headspace vapors must be allowed to develop in the container for at least 10 minutes but no longer than one hour. Containers must be shaken or agitated for 15 seconds at the beginning and the end of the headspace development period to assist volatilization. Temperatures of the headspace must be warmed to at least 5° C (approximately 40° F) with instruments calibrated for the temperature used.
5. After headspace development, the instrument sampling probe must be inserted to a point about one-half the headspace depth. The container opening must be minimized and care must be taken to avoid the uptake of water droplets and soil particulates.
6. After probe insertion, the highest meter reading must be taken and recorded. This will normally occur between two and five seconds after probe insertion. If erratic meter response occurs at high organic vapor concentrations or conditions of elevated headspace moisture, a note to that effect must accompany the headspace data.
7. All field screening results must be documented in the field record or log book.

Soil Sample Collection Procedures for Laboratory Samples

The number and type of laboratory samples collected depends on the purpose of the sampling activity. Samples analyzed with field screening devices may not be substituted for required laboratory samples.

- a.) General Sample Collection - When collecting samples from potentially contaminated soil, care should be taken to reduce contact with skin or other parts of the body. Disposable gloves should be worn by the sample collector and should be changed between samples to avoid cross-contamination. Soil samples should be collected in a manner that causes the least disturbance to the internal structure of the sample and reduces its exposure to heat, sunlight and open air. Likewise, care should be taken to keep the samples from being contaminated by other materials or other samples collected at the site. When sampling is to occur over an extended period of time, it is necessary to insure that the samples are collected in a comparable manner. All samples must be collected with disposable or clean tools that have been decontaminated. Disposable gloves must be worn and changed between sample collections. Sample containers must be filled quickly. Soil samples must be placed in containers in the order of volatility, for example, volatile organic aromatic samples must be taken first, organics next, then heavier range organics, and finally soil classification samples. Containers must be quickly and adequately sealed, and rims must be cleaned before tightening lids. Tape may be used only if known not to affect sample analysis. Sample containers must be clearly labeled. Containers must immediately be preserved according to procedures in this Section. Unless specified

otherwise, at a minimum, the samples must be immediately cooled to $4 \pm 2^{\circ}\text{C}$ and this temperature must be maintained throughout delivery to the laboratory.

- b.) Surface Soil Sampling - Surface soil is generally classified as soil between the ground surface and 6-12 inches below ground surface. Remove leaves, grass and surface debris from the area to be sampled. Select an appropriate, pre-cleaned sampling device and collect the sample. Transfer the sample to the appropriate sample container. Clean the outside of the sample container to remove excess soil. Label the sample container, place on wet ice to preserve at 4°C , and complete the field notes.
- c.) Subsurface Soil Sampling – The interval begins at approximately 12 inches below ground surface. Collect samples for volatile organic analyses. For other analyses, select an appropriate, pre-cleaned sampling device and collect the sample. Transfer the sample to the appropriate sample container. Clean the outside of the sample container to remove excess soil. Label the sample container, place on wet ice to preserve at 4°C , and complete field notes.
- d.) Equipment for Reaching the Appropriate Soil Sampling Depth - Samples may be collected using a hollow stem soil auger, direct push, Shelby tube, split-spoon sampler, or core barrel. These sampling devices may be used as long as an effort is made to reduce the loss of contaminants through volatilization. In these situations, obtain a sufficient volume of so the samples can be collected without volatilization and disturbance to the internal structure of the samples. Samples should be collected from cores of the soil. Non-disposable sampling equipment must be decontaminated between each sample location. **NOTE:** *If a confining layer has been breached during sampling, grout the hole to land.*
- e.) Equipment to Collect Soil Samples - Equipment and materials that may be used to collect soil samples include disposable plastic syringes and other “industry-standard” equipment and materials that are contaminant-free. Non-disposable sampling equipment must be decontaminated between each sample location.

Appendix C - Collecting Groundwater Samples

Groundwater samples are collected to identify, investigate, assess and monitor the concentration of dissolved contaminant constituents. To properly assess groundwater contamination, first install sampling points (monitoring wells, etc.) to collect groundwater samples and then perform specific laboratory analyses. All monitoring wells should be constructed in accordance with 15A NCAC 2C .0100 and sampled as outlined in this section. Groundwater monitoring is conducted using one of two methods:

1. Portable Monitoring: Monitoring that is conducted using sampling equipment that is discarded between sampling locations. Equipment used to collect a groundwater sample from a well such as bailers, tubing, gloves, and etc. are disposed of after sample collection. A new set of sampling equipment is used to collect a groundwater sample at the next monitor well.
2. Dedicated Monitoring: Monitoring that utilizes permanently affixed down-well and well head components that are capped after initial set-up. Most dedicated monitoring systems are comprised of an in-well submersible bladder pump, with air supply and sample discharge tubing, and an above-ground driver/controller for regulation of flow rates and volumes. The pump and all tubing housed within the well should be composed of Teflon or stainless steel components. This includes seals inside the pump, the pump body, and fittings used to connect tubing to the pump. Because ground water will not be in contact with incompatible constituents and because the well is sealed from the surface, virtually no contamination is possible from intrinsic sources during sampling and between sampling intervals. All dedicated monitoring systems must be approved by the Solid Waste Section before installation.

Groundwater samples may be collected from a number of different configurations. Each configuration is associated with a unique set of sampling equipment requirements and techniques:

1. Wells without Plumbing: These wells require equipment to be brought to the well to purge and sample unless dedicated equipment is placed in the well.
2. Wells with In-Place Plumbing: Wells with in-place plumbing do not require equipment to be brought to the well to purge and sample. In-place plumbing is generally considered permanent equipment routinely used for purposes other than purging and sampling, such as for water supply.
3. Air Strippers or Remedial Systems: These types of systems are installed as remediation devices.

Groundwater Sample Preparation

The type of sample containers used depends on the type of analysis performed. First, determine the type(s) of contaminants expected and the proper analytical method(s). Be sure to consult your selected laboratory for its specific needs and requirements prior to sampling.

Next, prepare the storage and transport containers (ice chest, etc.) before taking any samples so that each sample can be placed in a chilled environment immediately after collection.

Use groundwater purging and sampling equipment constructed of only non-reactive, non-leachable materials that are compatible with the environment and the selected analytes. In selecting groundwater purging and sampling equipment, give consideration to the depth of the well, the depth to groundwater, the volume of water to be evacuated, the sampling and purging technique, and the analytes of interest. Additional supplies, such as reagents and preservatives, may be necessary.

All sampling equipment (bailers, tubing, containers, etc.) must be selected based on its chemical compatibility with the source being sampled (e.g., water supply well, monitoring well) and the contaminants potentially present.

- a.) Pumps - All pumps or pump tubing must be lowered and retrieved from the well slowly and carefully to minimize disturbance to the formation water. This is especially critical at the air/water interface.
 1. *Above-Ground Pumps*
 - Variable Speed Peristaltic Pump: Use a variable speed peristaltic pump to purge groundwater from wells when the static water level in the well is no greater than 20- 25 feet below land surface (BLS). If the water levels are deeper than 18-20 feet BLS, the pumping velocity will decrease. A variable speed peristaltic pump can be used for normal purging and sampling, and sampling low permeability aquifers or formations. Most analyte groups can be sampled with a peristaltic pump if the tubing and pump configurations are appropriate.
 - Variable Speed Centrifugal Pump: A variable speed centrifugal pump can be used to purge groundwater from 2-inch and larger internal diameter wells. **Do not use** this type of pump to collect groundwater samples. When purging is complete, do not allow the water that remains in the tubing to fall back into the well. Install a check valve at the end of the purge tubing.
 2. *Submersible Pumps*
 - Variable Speed Electric Submersible Pump: A variable speed submersible pump can be used to purge and sample groundwater from 2-inch and larger internal diameter wells. A variable speed submersible pump can be used for normal purging and sampling, and sampling low permeability aquifers or formations. The pump housing, fittings, check valves and associated hardware must be constructed of stainless steel. All other materials must be

compatible with the analytes of interest. Install a check valve at the output side of the pump to prevent backflow. If purging **and** sampling for organics, the entire length of the delivery tube must be Teflon, polyethylene or polypropylene (PP) tubing; the electrical cord must be sealed in Teflon, polyethylene or PP and any cabling must be sealed in Teflon, polyethylene or PP, or be constructed of stainless steel; and all interior components that contact the sample water (impeller, seals, gaskets, etc.) must be constructed of stainless steel or Teflon.

3. *Variable Speed Bladder Pump*: A variable speed, positive displacement, bladder pump can be used to purge and sample groundwater from 3/4-inch and larger internal diameter wells.
 - A variable speed bladder pump can be used for normal purging and sampling, and sampling low permeability aquifers or formations.
 - The bladder pump system is composed of the pump, the compressed air tubing, the water discharge tubing, the controller and a compressor, or a compressed gas supply.
 - The pump consists of a bladder and an exterior casing or pump body that surrounds the bladder and two (2) check valves. These parts can be composed of various materials, usually combinations of polyvinyl chloride (PVC), Teflon, polyethylene, PP and stainless steel. Other materials must be compatible with the analytes of interest.
 - If purging and sampling for organics, the pump body must be constructed of stainless steel. The valves and bladder must be Teflon, polyethylene or PP; the entire length of the delivery tube must be Teflon, polyethylene or PP; and any cabling must be sealed in Teflon, polyethylene or PP, or be constructed of stainless steel.
 - Permanently installed pumps may have a PVC pump body as long as the pump remains in contact with the water in the well.

b.) Bailers

1. *Purging*: Bailers must be used with caution because improper bailing can cause changes in the chemistry of the water due to aeration and loosening particulate matter in the space around the well screen. Use a bailer if there is non-aqueous phase liquid (free product) in the well or if non-aqueous phase liquid is suspected to be in the well.
2. *Sampling*: Bailers must be used with caution.
3. *Construction and Type*: Bailers must be constructed of materials compatible with the analytes of interest. Stainless steel, Teflon, rigid medical grade PVC, polyethylene and PP bailers may be used to sample all analytes. Use disposable bailers when sampling grossly contaminated sample sources. NCDENR recommends using dual check valve bailers when collecting samples. Use bailers with a controlled flow bottom to collect volatile organic samples.

4. *Contamination Prevention:* Keep the bailer wrapped (foil, butcher paper, etc.) until just before use. Use protective gloves to handle the bailer once it is removed from its wrapping. Handle the bailer by the lanyard to minimize contact with the bailer surface.

c.) Lanyards

1. Lanyards must be made of non-reactive, non-leachable material. They may be cotton twine, nylon, stainless steel, or may be coated with Teflon, polyethylene or PP.
2. Discard cotton twine, nylon, and non-stainless steel braided lanyards after sampling each monitoring well.
3. Decontaminate stainless steel, coated Teflon, polyethylene and PP lanyards between monitoring wells. They do not need to be decontaminated between purging and sampling operations.

Water Level and Purge Volume Determination

The amount of water that must be purged from a well is determined by the volume of water and/or field parameter stabilization.

- a.) General Equipment Considerations - Selection of appropriate purging equipment depends on the analytes of interest, the well diameter, transmissivity of the aquifer, the depth to groundwater, and other site conditions.
1. Use of a pump to purge the well is recommended unless no other equipment can be used or there is non-aqueous phase liquid in the well, or non-aqueous phase liquid is suspected to be in the well.
 2. Bailers must be used with caution because improper bailing:
 - Introduces atmospheric oxygen, which may precipitate metals (i.e., iron) or cause other changes in the chemistry of the water in the sample (i.e., pH).
 - Agitates groundwater, which may bias volatile and semi-volatile organic analyses due to volatilization.
 - Agitates the water in the aquifer and resuspends fine particulate matter.
 - Surges the well, loosening particulate matter in the annular space around the well screen.
 - May introduce dirt into the water column if the sides of the casing wall are scraped.

NOTE: *It is critical for bailers to be slowly and gently immersed into the top of the water column, particularly during the final stages of purging. This minimizes turbidity and disturbance of volatile organic constituents.*

b.) Initial Inspection

1. Remove the well cover and remove all standing water around the top of the well casing (manhole) before opening the well.
2. Inspect the exterior protective casing of the monitoring well for damage. Document the results of the inspection if there is a problem.
3. It is recommended that you place a protective covering around the well head. Replace the covering if it becomes soiled or ripped.

4. Inspect the well lock and determine whether the cap fits tightly. Replace the cap if necessary.
- c.) Water Level Measurements - Use an electronic probe or chalked tape to determine the water level. Decontaminate all equipment before use. Measure the depth to groundwater from the top of the well casing to the nearest 0.01 foot. Always measure from the same reference point or survey mark on the well casing. Record the measurement.
1. *Electronic Probe*: Decontaminate all equipment before use. Follow the manufacturer's instructions for use. Record the measurement.
 2. *Chalked Line Method*: Decontaminate all equipment before use. Lower chalked tape into the well until the lower end is in the water. This is usually determined by the sound of the weight hitting the water. Record the length of the tape relative to the reference point. Remove the tape and note the length of the wetted portion. Record the length. Determine the depth to water by subtracting the length of the wetted portion from the total length. Record the result.
- d.) Water Column Determination - To determine the length of the water column, subtract the depth to the top of the water column from the total well depth (or gauged well depth if silting has occurred). The total well depth depends on the well construction. If gauged well depth is used due to silting, report total well depth also. Some wells may be drilled in areas of sinkhole, karst formations or rock leaving an open borehole. Attempt to find the total borehole depth in cases where there is an open borehole below the cased portion.
- e.) Well Water Volume - Calculate the total volume of water, in gallons, in the well using the following equation:

$$V = (0.041)d \times d \times h$$

Where:

V = volume in gallons

d = well diameter in inches

h = height of the water column in feet

The total volume of water in the well may also be determined with the following equation by using a casing volume per foot factor (Gallons per Foot of Water) for the appropriate diameter well:

$$V = [\text{Gallons per Foot of Water}] \times h$$

Where:

V = volume in gallons

h = height of the water column in feet

Record all measurements and calculations in the field records.

- f.) Purging Equipment Volume - Calculate the total volume of the pump, associated tubing and flow cell (if used), using the following equation:

$$V = p + ((0.041)d \times d \times l) + fc$$

Where:

V = volume in gallons

p = volume of pump in gallons

d = tubing diameter in inches

l = length of tubing in feet

fc = volume of flow cell in gallons

- g.) If the groundwater elevation data are to be used to construct groundwater elevation contour maps, all water level measurements must be taken within the same 24 hour time interval when collecting samples from multiple wells on a site, unless a shorter time period is required. If the site is tidally influenced, complete the water level measurements within the time frame of an incoming or outgoing tide.

Well Purging Techniques

The selection of the purging technique and equipment is dependent on the hydrogeologic properties of the aquifer, especially depth to groundwater and hydraulic conductivity.

- a.) Measuring the Purge Volume - The volume of water that is removed during purging must be recorded. Therefore, you must measure the volume during the purging operation.
1. Collect the water in a graduated container and multiply the number of times the container was emptied by the volume of the container, OR
 2. Estimate the volume based on pumping rate. This technique may be used only if the pumping rate is constant. Determine the pumping rate by measuring the amount of water that is pumped for a fixed period of time, or use a flow meter.
 - Calculate the amount of water that is discharged per minute: $D = \text{Measured Amount} / \text{Total Time In Minutes}$
 - Calculate the time needed to purge one (1) well volume or one (1) purging equipment volume: $\text{Time} = V / D$
Where: $V = \text{well volume or purging equipment volume}$
 $D = \text{discharge rate}$
 - Make new measurements each time the pumping rate is changed.
 3. Use a totalizing flow meter.
 - Record the reading on the totalizer prior to purging.
 - Record the reading on the totalizer at the end of purging.
 - To obtain the volume purged, subtract the reading on the totalizer prior to purging from the reading on the totalizer at the end of purging.
 - Record the times that purging begins and ends in the field records.
- b.) Purging Measurement Frequency - When purging a well that has the well screen fully submerged and the pump or intake tubing is placed within the well casing above the well screen or open hole, purge a minimum of one (1) well volume prior to collecting measurements of the field parameters. Allow at least one quarter (1/4) well volume to purge between subsequent measurements. When purging a well that has the pump or intake tubing placed within a fully submerged well screen or open hole, purge until the water level has stabilized (well recovery rate equals the purge rate), then purge a minimum of one (1) volume of the pump, associated tubing and flow cell (if used) prior to collecting measurements of the field parameters. Take measurements of the field parameters no sooner than two (2) to three (3) minutes apart. Purge at least

three (3) volumes of the pump, associated tubing and flow cell, if used, prior to collecting a sample. When purging a well that has a partially submerged well screen, purge a minimum of one (1) well volume prior to collecting measurements of the field parameters. Take measurements of the field parameters no sooner than two (2) to three (3) minutes apart.

c.) Purging Completion - Wells must be adequately purged prior to sample collection to ensure representation of the aquifer formation water, rather than stagnant well water. This may be achieved by purging three volumes from the well or by satisfying any one of the following three purge completion criteria:

1.) Three (3) consecutive measurements in which the three (3) parameters listed below are within the stated limits, dissolved oxygen is no greater than 20 percent of saturation at the field measured temperature, and turbidity is no greater than 20 Nephelometric Turbidity Units (NTUs).

- Temperature: + 0.2° C
- pH: + 0.2 Standard Units
- Specific Conductance: + 5.0% of reading

Document and report the following, as applicable. The last four items only need to be submitted once:

- Purging rate.
- Drawdown in the well, if any.
- A description of the process and the data used to design the well.
- The equipment and procedure used to install the well.
- The well development procedure.
- Pertinent lithologic or hydrogeologic information.

2.) If it is impossible to get dissolved oxygen at or below 20 percent of saturation at the field measured temperature or turbidity at or below 20 NTUs, then three (3) consecutive measurements of temperature, pH, specific conductance and the parameter(s) dissolved oxygen and/or turbidity that do not meet the requirements above must be within the limits below. The measurements are:

- Temperature: + 0.2° C
- pH: + 0.2 Standard Units
- Specific Conductance: + 5.0% of reading
- Dissolved Oxygen: + 0.2 mg/L or 10%, whichever is greater
- Turbidity: + 5 NTUs or 10%, whichever is greater

Additionally, document and report the following, as applicable, except that the last four(4) items only need to be submitted once:

- Purging rate.
- Drawdown in the well, if any.
- A description of conditions at the site that may cause the dissolved oxygen to be high and/or dissolved oxygen measurements made within the screened or open hole portion of the well with a downhole dissolved oxygen probe.

- A description of conditions at the site that may cause the turbidity to be high and any procedures that will be used to minimize turbidity in the future.
 - A description of the process and the data used to design the well.
 - The equipment and procedure used to install the well.
 - The well development procedure.
 - Pertinent lithologic or hydrogeologic information.
- 3.) If after five (5) well volumes, three (3) consecutive measurements of the field parameters temperature, pH, specific conductance, dissolved oxygen, and turbidity are not within the limits stated above, check the instrument condition and calibration, purging flow rate and all tubing connections to determine if they might be affecting the ability to achieve stable measurements. It is at the discretion of the consultant/contractor whether or not to collect a sample or to continue purging. Further, the report in which the data are submitted must include the following, as applicable. The last four (4) items only need to be submitted once.
- Purging rate.
 - Drawdown in the well, if any.
 - A description of conditions at the site that may cause the Dissolved Oxygen to be high and/or Dissolved Oxygen measurements made within the screened or open hole portion of the well with a downhole dissolved oxygen probe.
 - A description of conditions at the site that may cause the turbidity to be high and any procedures that will be used to minimize turbidity in the future.
 - A description of the process and the data used to design the well.
 - The equipment and procedure used to install the well.
 - The well development procedure.
 - Pertinent lithologic or hydrogeologic information.

If wells have previously and consistently purged dry, and the current depth to groundwater indicates that the well will purge dry during the current sampling event, minimize the amount of water removed from the well by using the same pump to purge and collect the sample:

- Place the pump or tubing intake within the well screened interval.
- Use very small diameter Teflon, polyethylene or PP tubing and the smallest possible pump chamber volume. This will minimize the total volume of water pumped from the well and reduce drawdown.
- Select tubing that is thick enough to minimize oxygen transfer through the tubing walls while pumping.

- Pump at the lowest possible rate (100 mL/minute or less) to reduce drawdown to a minimum.
- Purge at least two (2) volumes of the pumping system (pump, tubing and flow cell, if used).
- Measure pH, specific conductance, temperature, dissolved oxygen and turbidity, then begin to collect the samples.

Collect samples immediately after purging is complete. The time period between completing the purge and sampling cannot exceed six hours. If sample collection does not occur within one hour of purging completion, re-measure the five field parameters: temperature, pH, specific conductance, dissolved oxygen and turbidity, just prior to collecting the sample. If the measured values are not within 10 percent of the previous measurements, re-purge the well. The exception is “dry” wells.

d.) Lanyards

1. Securely fasten lanyards, if used, to any downhole equipment (bailers, pumps, etc.).
2. Use bailer lanyards in such a way that they do not touch the ground surface.

Wells Without Plumbing

a.) Tubing/Pump Placement

1. If attempting to minimize the volume of purge water, position the intake hose or pump at the midpoint of the screened or open hole interval.
2. If monitoring well conditions do not allow minimizing of the purge water volume, position the pump or intake hose near the top of the water column. This will ensure that all stagnant water in the casing is removed.
3. If the well screen or borehole is partially submerged, and the pump will be used for both purging and sampling, position the pump midway between the measured water level and the bottom of the screen. Otherwise, position the pump or intake hose near the top of the water column.

b.) Non-dedicated (portable) pumps

1. *Variable Speed Peristaltic Pump*

- Wear sampling gloves to position the decontaminated pump and tubing.
- Attach a short section of tubing to the discharge side of the pump and into a graduated container.
- Attach one end of a length of new or precleaned tubing to the pump head flexible hose.
- Place the tubing as described in one of the options listed above.
- Change gloves before beginning to purge.
- Measure the depth to groundwater at frequent intervals.
- Record these measurements.
- Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

- If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.
- If the water table continues to drop during pumping, lower the tubing at the approximate rate of drawdown so that water is removed from the top of the water column.
- Record the purging rate each time the rate changes.
- Measure the purge volume.
- Record this measurement.
- Decontaminate the pump and tubing between wells (see Appendix C) or if precleaned tubing is used for each well, only the pump.

2. *Variable Speed Centrifugal Pump*

- Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
- Wear sampling gloves to position the decontaminated pump and tubing.
- Place the decontaminated suction hose so that water is always pumped from the top of the water column.
- Change gloves before beginning to purge.
- Equip the suction hose with a foot valve to prevent purge water from re-entering the well.
- Measure the depth to groundwater at frequent intervals.
- Record these measurements.
- To minimize drawdown, adjust the purging rate so that it is equivalent to the well recovery rate.
- If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.
- If the water table continues to drop during pumping, lower the tubing at the approximate rate of drawdown so that the water is removed from the top of the water column.
- Record the purging rate each time the rate changes.
- Measure the purge volume.
- Record this measurement.
- Decontaminate the pump and tubing between wells or if precleaned tubing is used for each well, only the pump.

3. *Variable Speed Electric Submersible Pump*

- Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
- Wear sampling gloves to position the decontaminated pump and tubing.
- Carefully position the decontaminated pump.

- Change gloves before beginning to purge.
- Measure the depth to groundwater at frequent intervals.
- Record these measurements.
- To minimize drawdown, adjust the purging rate so that it is equivalent to the well recovery rate.
- If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.
- If the water table continues to drop during pumping, lower the tubing or pump at the approximate rate of drawdown so that water is removed from the top of the water column.
- Record the purging rate each time the rate changes.
- Measure the purge volume.
- Record this measurement.
- Decontaminate the pump and tubing between wells or only the pump if precleaned tubing is used for each well.

4. *Variable Speed Bladder Pump*

- Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
- Wear sampling gloves to position the decontaminated pump and tubing.
- Attach the tubing and carefully position the pump.
- Change gloves before beginning purging.
- Measure the depth to groundwater at frequent intervals.
- Record these measurements.
- To minimize drawdown, adjust the purging rate so that it is equivalent to the well recovery rate.
- If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.
- If the water table continues to drop during pumping, lower the tubing or pump at the approximate rate of drawdown so that water is removed from the top of the water column.
- Record the purging rate each time the rate changes.
- Measure the purge volume.
- Record this measurement.
- Decontaminate the pump and tubing between wells or if precleaned tubing is used for each well, only the pump.

c.) Dedicated Portable Pumps

1. *Variable Speed Electric Submersible Pump*

- Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
- Wear sampling gloves.

- Measure the depth to groundwater at frequent intervals.
 - Record these measurements.
 - Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.
 - If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdraw with the recharge rate.
 - Record the purging rate each time the rate changes.
 - Measure the purge volume.
 - Record this measurement.
2. *Variable Speed Bladder Pump*
- Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
 - Wear sampling gloves.
 - Measure the depth to groundwater at frequent intervals.
 - Record these measurements.
 - Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.
 - If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdraw with the recharge rate.
 - Record the purging rate each time the rate changes.
 - Measure the purge volume.
 - Record this measurement.
3. *Bailers* - Using bailers for purging is not recommended unless care is taken to use proper bailing technique, or if free product is present in the well or suspected to be in the well.
- Minimize handling the bailer as much as possible.
 - Wear sampling gloves.
 - Remove the bailer from its protective wrapping just before use.
 - Attach a lanyard of appropriate material.
 - Use the lanyard to move and position the bailer.
 - Lower and retrieve the bailer slowly and smoothly.
 - Lower the bailer carefully into the well to a depth approximately a foot above the water column.
 - When the bailer is in position, lower the bailer into the water column at a rate of 2 cm/sec until the desired depth is reached.
 - Do not lower the top of the bailer more than one (1) foot below the top of the water table so that water is removed from the top of the water column.
 - Allow time for the bailer to fill with aquifer water as it descends into the water column.

- Carefully raise the bailer. Retrieve the bailer at the same rate of 2 cm/sec until the bottom of the bailer has cleared to top of the water column.
- Measure the purge volume.
- Record the volume of the bailer.
- Continue to carefully lower and retrieve the bailer as described above until the purging is considered complete, based on either the removal of 3 well volumes.
- Remove at least one (1) well volume before collecting measurements of the field parameters. Take each subsequent set of measurements after removing at least one quarter (1/4) well volume between measurements.

Groundwater Sampling Techniques

- a.) Purge wells.
- b.) Replace protective covering around the well if it is soiled or torn after completing purging operations.
- c.) Equipment Considerations
 1. The following pumps are approved to collect volatile organic samples:
 - Stainless steel and Teflon variable speed submersible pumps
 - Stainless steel and Teflon or polyethylene variable speed bladder pumps
 - Permanently installed PVC bodied pumps (As long as the pump remains in contact with the water in the well at all times)
 2. Collect sample from the sampling device and store in sample container. Do not use intermediate containers.
 3. To avoid contamination or loss of analytes from the sample, handle sampling equipment as little as possible and minimize equipment exposure to the sample.
 4. To reduce chances of cross-contamination, use dedicated equipment whenever possible. “Dedicated” is defined as equipment that is to be used solely for one location for the life of that equipment (e.g., permanently mounted pump). Purchase dedicated equipment with the most sensitive analyte of interest in mind.
 - Clean or make sure dedicated pumps are clean before installation. They do not need to be cleaned prior to each use, but must be cleaned if they are withdrawn for repair or servicing.
 - Clean or make sure any permanently mounted tubing is clean before installation.
 - Change or clean tubing when the pump is withdrawn for servicing.
 - Clean any replaceable or temporary parts.

- Collect equipment blanks on dedicated pumping systems when the tubing is cleaned or replaced.
- Clean or make sure dedicated bailers are clean before placing them into the well.
- Collect an equipment blank on dedicated bailers before introducing them into the water column.
- Suspend dedicated bailers above the water column if they are stored in the well.

Sampling Wells Without Plumbing

a.) Sampling with Pumps – The following pumps may be used to sample for organics:

- Peristaltic pumps
- Stainless steel, Teflon or polyethylene bladder pumps
- Variable speed stainless steel and Teflon submersible pumps

1. *Peristaltic Pump*

- Volatile Organics: One of three methods may be used.
 - Remove the drop tubing from the inlet side of the pump; submerge the drop tubing into the water column; prevent the water in the tubing from flowing back into the well; remove the drop tubing from the well; carefully allow the groundwater to drain into the sample vials; avoid turbulence; do not aerate the sample; repeat steps until enough vials are filled. OR
 - Use the pump to fill the drop tubing; quickly remove the tubing from the pump; prevent the water in the tubing from flowing back into the well; remove the drop tubing from the well; carefully allow the groundwater to drain into the sample vials; avoid turbulence; do not aerate the sample; repeat steps until enough vials are filled. OR
 - Use the pump to fill the drop tubing; withdraw the tubing from the well; reverse the flow on the peristaltic pumps to deliver the sample into the vials at a slow, steady rate; repeat steps until enough vials are filled.
- Extractable Organics: If delivery tubing is not polyethylene or PP, or is not Teflon lined, use pump and vacuum trap method. Connect the outflow tubing from the container to the influent side of the peristaltic pump. Turn pump on and reduce flow until smooth and even. Discard a

small portion of the sample to allow for air space. Preserve (if required), label, and complete field notes.

- Inorganic samples: These samples may be collected from the effluent tubing. If samples are collected from the pump, decontaminate all tubing (including the tubing in the head) or change it between wells. Preserve (if required), label, and complete field notes.

2. *Variable Speed Bladder Pump*

- If sampling for organics, the pump body must be constructed of stainless steel and the valves and bladder must be Teflon. All tubing must be Teflon, polyethylene, or PP and any cabling must be sealed in Teflon, polyethylene or PP, or made of stainless steel.
- After purging to a smooth even flow, reduce the flow rate.
- When sampling for volatile organic compounds, reduce the flow rate to 100-200mL/minute, if possible.

3. *Variable Speed Submersible Pump*

- The housing must be stainless steel.
- If sampling for organics, the internal impellers, seals and gaskets must be constructed of stainless steel, Teflon, polyethylene or PP. The delivery tubing must be Teflon, polyethylene or PP; the electrical cord must be sealed in Teflon; any cabling must be sealed in Teflon or constructed of stainless steel.
- After purging to a smooth even flow, reduce the flow rate.
- When sampling for volatile organic compounds, reduce the flow rate to 100-200mL/minute, if possible.

b.) Sampling with Bailers - A high degree of skill and coordination are necessary to collect representative samples with a bailer.

1. *General Considerations*

- Minimize handling of bailer as much as possible.
- Wear sampling gloves.
- Remove bailer from protective wrapping just before use.
- Attach a lanyard of appropriate material.
- Use the lanyard to move and position the bailers.
- Do not allow bailer or lanyard to touch the ground.
- If bailer is certified precleaned, no rinsing is necessary.
- If both a pump and a bailer are to be used to collect samples, rinse the exterior and interior of the bailer with sample water from the pump before removing the pump.
- If the purge pump is not appropriate for collecting samples (e.g., non-inert components), rinse the bailer by collecting a single bailer of the groundwater to be sampled.
- Discard the water appropriately.

- Do not rinse the bailer if Oil and Grease samples are to be collected.

2. *Bailing Technique*

- Collect all samples that are required to be collected with a pump before collecting samples with the bailer.
- Raise and lower the bailer gently to minimize stirring up particulate matter in the well and the water column, which can increase sample turbidity.
- Lower the bailer carefully into the well to a depth approximately a foot above the water column. When the bailer is in position, lower the bailer into the water column at a rate of 2 cm/sec until the desired depth is reached.
- Do not lower the top of the bailer more than one foot below the top of the water table, so that water is removed from the top of the water column.
- Allow time for the bailer to fill with aquifer water as it descends into the water column.
- Do not allow the bailer to touch the bottom of the well or particulate matter will be incorporated into the sample. Carefully raise the bailer. Retrieve the bailer at the same rate of 2 cm/sec until the bottom of the bailer has cleared to top of the water column.
- Lower the bailer to approximately the same depth each time.
- Collect the sample. Install a device to control the flow from the bottom of the bailer and discard the first few inches of water. Fill the appropriate sample containers by allowing the sample to slowly flow down the side of the container. Discard the last few inches of water in the bailer.
- Repeat steps for additional samples.
- As a final step measure the DO, pH, temperature, turbidity and specific conductance after the final sample has been collected. Record all measurements and note the time that sampling was completed.

c.) Sampling Low Permeability Aquifers or Wells that have Purged Dry

1. Collect the sample(s) after the well has been purged. Minimize the amount of water removed from the well by using the same pump to purge and collect the sample. If the well has purged dry, collect samples as soon as sufficient sample water is available.
2. Measure the five field parameters temperature, pH, specific conductance, dissolved oxygen and turbidity at the time of sample collection.
3. Advise the analytical laboratory and the client that the usual amount of sample for analysis may not be available.

Appendix D - Collecting Samples from Wells with Plumbing in Place

In-place plumbing is generally considered permanent equipment routinely used for purposes other than purging and sampling, such as for water supply.

a.) Air Strippers or Remedial Systems - These types of systems are installed as remediation devices. Collect influent and effluent samples from air stripping units as described below.

1. Remove any tubing from the sampling port and flush for one to two minutes.
2. Remove all hoses, aerators and filters (if possible).
3. Open the spigot and purge sufficient volume to flush the spigot and lines and until the purging completion criteria have been met.
4. Reduce the flow rate to approximately 500 mL/minute (a 1/8" stream) or approximately 0.1 gal/minute before collecting samples.
5. Follow procedures for collecting samples from water supply wells as outlined below.

b.) Water Supply Wells – Water supply wells with in-place plumbing do not require equipment to be brought to the well to purge and sample. Water supply wells at UST facilities must be sampled for volatile organic compounds (VOCs) and semivolatile compounds (SVOCs).

1. *Procedures for Sampling Water Supply Wells*

- Label sample containers prior to sample collection.
- Prepare the storage and transport containers (ice chest, etc.) before taking any samples so each collected sample can be placed in a chilled environment immediately after collection.
- You must choose the tap closest to the well, preferably at the wellhead. The tap must be before any holding or pressurization tank, water softener, ion exchange, disinfection process or before the water line enters the residence, office or building. If no tap fits the above conditions, a new tap that does must be installed.
- The well pump must not be lubricated with oil, as that may contaminate the samples.
- The sampling tap must be protected from exterior contamination associated with being too close to a sink bottom or to the ground. If the tap is too close to the ground for direct collection into the appropriate container, it is acceptable to use a smaller (clean) container to transfer the sample to a larger container.
- Leaking taps that allow water to discharge from around the valve stem handle and down the outside of the faucet, or taps in which water tends to run up on the outside of the lip, are to be avoided as sampling locations.

- Disconnect any hoses, filters, or aerators attached to the tap before sampling.
- Do not sample from a tap close to a gas pump. The gas fumes could contaminate the sample.

2. *Collecting Volatile Organic Samples*

- Equipment Needed: VOC sample vials [40 milliliters, glass, may contain 3 to 4 drops of hydrochloric acid (HCl) as preservative]; Disposable gloves and protective goggles; Ice chest/cooler; Ice; Packing materials (sealable plastic bags, bubble wrap, etc.); and Lab forms.
- Sampling Procedure: Run water from the well for at least 15 minutes. If the well is deep, run water longer (purging three well volumes is best). If tap or spigot is located directly before a holding tank, open a tap after the holding tank to prevent any backflow into the tap where you will take your sample. This will ensure that the water you collect is “fresh” from the well and not from the holding tank. After running the water for at least 15 minutes, reduce the flow of water. The flow should be reduced to a trickle but not so slow that it begins to drip. A smooth flow of water will make collection easier and more accurate. Remove the cap of a VOC vial and hold the vial under the stream of water to fill it. Be careful not to spill any acid that is in the vial. For best results use a low flow of water and angle the vial slightly so that the water runs down the inside of the vial. This will help keep the sample from being agitated, aerated or splashed out of the vial. It will also increase the accuracy of the sample. As the vial fills and is almost full, turn the vial until it is straight up and down so the water won't spill out. Fill the vial until the water is just about to spill over the lip of the vial. The surface of the water sample should become mounded. It is a good idea not to overfill the vial, especially if an acid preservative is present in the vial. Carefully replace and screw the cap onto the vial. Some water may overflow as the cap is put on. After the cap is secure, turn the vial upside down and gently tap the vial to see if any bubbles are present. If bubbles are present in the vial, remove the cap, add more water and check again to see if bubbles are present. Repeat as necessary. After two samples without bubbles have been collected, the samples should be labeled and prepared for shipment. Store samples at 4° C.

3. *Collecting Extractable Organic and/or Metals Samples*

- Equipment Needed: SVOC sample bottle [1 liter, amber glass] and/or Metals sample bottle [0.5 liter, polyethylene or glass, 5 milliliters of nitric acid (HNO₃) preservative]; Disposable gloves and protective goggles; Ice Chest/Cooler; Ice; Packing materials (sealable plastic bags, bubble wrap, etc.); and Lab forms.
- Sampling Procedure: Run water from the well for at least 15 minutes. If the well is deep, run the water longer (purging three well volumes is best). If tap or spigot is located directly before a holding tank, open a tap after the holding tank to prevent any backflow into the tap where you will take your sample. This will ensure that the water you collect is “fresh” from the well and not from the holding tank. After running the water for at least 15 minutes, reduce the flow. Low water flow makes collection easier and more accurate. Remove the cap of a SVOC or metals bottle and hold it under the stream of water to fill it. The bottle does not have to be completely filled (i.e., you can leave an inch or so of headspace in the bottle). After filling, screw on the cap, label the bottle and prepare for shipment. Store samples at 4° C.

Appendix E - Collecting Surface Water Samples

The following topics include 1.) acceptable equipment selection and equipment construction materials and 2.) standard grab, depth-specific and depth-composited surface water sampling techniques.

Facilities which contain or border small rivers, streams or branches should include surface water sampling as part of the monitoring program for each sampling event. A simple procedure for selecting surface water monitoring sites is to locate a point on a stream where drainage leaves the site. This provides detection of contamination through, and possibly downstream of, site via discharge of surface waters. The sampling points selected should be downstream from any waste areas. An upstream sample should be obtained in order to determine water quality upstream of the influence of the site.

a.) General Cautions

1. When using watercraft take samples near the bow away and upwind from any gasoline outboard engine. Orient watercraft so that bow is positioned in the upstream direction.
2. When wading, collect samples upstream from the body. Avoid disturbing sediments in the immediate area of sample collection.
3. Collect water samples prior to taking sediment samples when obtaining both from the same area (site).
4. Unless dictated by permit, program or order, sampling at or near man-made structures (e.g., dams, weirs or bridges) may not provide representative data because of unnatural flow patterns.
5. Collect surface water samples from downstream towards upstream.

b.) Equipment and Supplies - Select equipment based on the analytes of interest, specific use, and availability.

c.) Surface Water Sampling Techniques - Adhere to all general protocols applicable to aqueous sampling when following the surface water sampling procedures addressed below.

1. *Manual Sampling*: Use manual sampling for collecting grab samples for immediate in-situ field analyses. Use manual sampling in lieu of automatic equipment over extended periods of time for composite sampling, especially when it is necessary to observe and/or note unusual conditions.
 - Surface Grab Samples - Do not use sample containers containing premeasured amounts of preservatives to collect grab samples. If the sample matrix is homogeneous, then the grab method is a simple and effective technique for collection purposes. If homogeneity is not apparent, based on flow or vertical variations (and should never be assumed), then use other collection protocols. Where practical, use the actual sample container submitted to the laboratory for collecting samples to be analyzed for oil and grease, volatile organic compounds (VOCs), and microbiological samples. This procedure eliminates the possibility of contaminating the sample with an intermediate collection container. The use of

unpreserved sample containers as direct grab samplers is encouraged since the same container can be submitted for laboratory analysis after appropriate preservation. This procedure reduces sample handling and eliminates potential contamination from other sources (e.g., additional sampling equipment, environment, etc.).

1. Grab directly into sample container.
 2. Slowly submerge the container, opening neck first, into the water.
 3. Invert the bottle so the neck is upright and pointing towards the direction of water flow (if applicable). Allow water to run slowly into the container until filled.
 4. Return the filled container quickly to the surface.
 5. Pour out a few mL of sample away from and downstream of the sampling location. This procedure allows for the addition of preservatives and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.
 6. Add preservatives, securely cap container, label, and complete field notes. If sample containers are attached to a pole via a clamp, submerge the container and follow steps 3 – 5 but omit steps 1 and 2.
- Sampling with an Intermediate Vessel or Container: If the sample cannot be collected directly into the sample container to be submitted to the laboratory, or if the laboratory provides prepreserved sample containers, use an unpreserved sample container or an intermediate vessel (e.g., beakers, buckets or dippers) to obtain the sample. These vessels must be constructed appropriately, including any poles or extension arms used to access the sample location.
 1. Rinse the intermediate vessel with ample amounts of site water prior to collecting the first sample.
 2. Collect the sample as outlined above using the intermediate vessel.
 3. Use pole mounted containers of appropriate construction to sample at distances away from shore, boat, etc. Follow the protocols above to collect samples.
 - Peristaltic Pump and Tubing: The most portable pump for this technique is a 12 volt peristaltic pump. Use appropriately precleaned, silastic tubing in the pump head and attach polyethylene, Tygon, etc. tubing to the pump. This technique is not acceptable for Oil and Grease, EPH, VPH or VOCs. Extractable organics can be collected through the pump if flexible interior-wall Teflon, polyethylene or PP tubing is used in the pump head or if used with the organic trap setup.

1. Lower appropriately precleaned tubing to a depth of 6 – 12 inches below water surface, where possible.
 2. Pump 3 – 5 tube volumes through the system to acclimate the tubing before collecting the first sample.
 3. Fill individual sample bottles via the discharge tubing. Be careful not to remove the inlet tubing from the water.
 4. Add preservatives, securely cap container, label, and complete field notes.
- **Mid-Depth Grab Samples:** Mid-depth samples or samples taken at a specific depth can approximate the conditions throughout the entire water column. The equipment that may be used for this type of sampling consists of the following depth-specific sampling devices: Kemmerer, Niskin, Van Dorn type, etc. You may also use pumps with tubing or double check-valve bailers. Certain construction material details may preclude its use for certain analytes. Many Kemmerer samplers are constructed of plastic and rubber that preclude their use for all volatile and extractable organic sampling. Some newer devices are constructed of stainless steel or are all Teflon or Teflon-coated. These are acceptable for all analyte groups without restriction.
 1. Measure the water column to determine maximum depth and sampling depth prior to lowering the sampling device.
 2. Mark the line attached to the sampler with depth increments so that the sampling depth can be accurately recorded.
 3. Lower the sampler slowly to the appropriate sampling depth, taking care not to disturb the sediments.
 4. At the desired depth, send the messenger weight down to trip the closure mechanism.
 5. Retrieve the sampler slowly.
 6. Rinse the sampling device with ample amounts of site water prior to collecting the first sample. Discard rinsate away from and downstream of the sampling location.
 7. Fill the individual sample bottles via the discharge tube.
 - **Double Check-Valve Bailers:** Collect samples using double check-valve bailers if the data requirements do not necessitate a sample from a strictly discrete interval of the water column. Bailers with an upper and lower check-valve can be lowered through the water column. Water will continually be displaced through the bailer until the desired depth is reached, at which point the bailer is retrieved. Sampling with this type of bailer must follow the same protocols outlined above, except that a messenger weight is not applicable. Although not designed specifically for this kind of sampling, a bailer is acceptable when a mid-depth sample is required

1. As the bailer is dropped through the water column, water is displaced through the body of the bailer. The degree of displacement depends upon the check-valve ball movement to allow water to flow freely through the bailer body.
 2. Slowly lower the bailer to the appropriate depth. Upon retrieval, the two check valves seat, preventing water from escaping or entering the bailer.
 3. Rinse the sampling device with ample amounts of site water prior to collecting the first sample.
 4. Fill the individual sample bottles via the discharge tube. Sample bottles must be handled as described above.
- Peristaltic Pump and Tubing: The most portable pump for this technique is a 12 volt peristaltic pump. Use appropriately precleaned, silastic tubing in the pump head and attach HDPE, Tygon, etc. tubing to the pump. This technique is not acceptable for Oil and Grease, EPH, VPH or VOCs. Extractable organics can be collected through the pump if flexible interior-wall Teflon, polyethylene or PP tubing is used in the pump head, or if used with an organic trap setup.
 1. Measure the water column to determine the maximum depth and the sampling depth.
 2. Tubing will need to be tied to a stiff pole or be weighted down so the tubing placement will be secure. Do not use a lead weight. Any dense, non-contaminating, non-interfering material will work (brick, stainless steel weight, etc.). Tie the weight with a lanyard (braided or monofilament nylon, etc.) so that it is located below the inlet of the tubing.
 3. Turn the pump on and allow several tubing volumes of water to be discharged before collecting the first sample.
 4. Fill the individual sample bottles via the discharge tube. Sample bottles must be handled as described above.

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North Carolina Department of Environment and Natural Resources

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Leachate Sampling and Analysis

To maintain sample quality, leachate samples are to be taken as close to the sump as possible. Because of dubious results, pond and storage tank samples should be avoided. The leachate data is to be submitted with the semi-annual monitoring report. Leachate is to be analyzed for the Appendix I list of constituents plus the following required additional parameters: 1) biological oxygen demand (BOD), 2) chemical oxygen demand (COD), 3) phosphate, 4) nitrate, 5) sulfate, and 6) pH. Based upon sample results, compliance history and waste screening practices, additional parameters may be required.

North Carolina Division of Waste Management
1646 Mail Service Center, Raleigh, NC 27699-1646
(919)508-8400



Electronic Data need to be in the following format such that they can be uploaded into the Solid Waste Section database.

Please see the "Data Format Explanation" tab at the bottom of this sheet for an explanation of each column.

FACILITY PERMIT	WELL ID	CAS Number	SWS ID	PARAMETER	RESULT	UNITS	QUALIFIER	METHOD	MDL	SWSL	DILUTION FACTOR	COLLECT DATE	EXTRACTION DATE	ANALYSIS DATE
12-34	1234-MW3A	74-87-3	137	Chloromethane	BQL	ug/L	U	SW846 8260B	0.18	1	1	07/23/2007	07/24/2007	7/27/2007
12-34	1234-MW3A		325	Temperature	19.1	oC						07/23/2007		
12-34	1234-MW5	74-83-9	136	Bromomethane	35	ug/L		SW846 8260B	0.26	10	1	07/23/2007	07/24/2007	7/27/2007
12-34	1234-MW5	7440-39-3	15	Barium	50	ug/L	J	SW846 6020	0.04	100	1	07/23/2007		7/27/2007
12-34	1234-MW5		411	Total Well Depth	54.3	ft						07/23/2007		

ALL DATA SHOULD INCLUDE THE PERMIT NUMBER. If unsure, contact the operator/owner of the facility.

The unit of concentration should be ug/L for ALL constituents.



North Carolina Department of Environment and Natural Resources

Dexter R. Matthews, Director

Division of Waste Management

Michael F. Easley, Governor
William G. Ross Jr., Secretary

October 16, 2007

MEMORANDUM

To: Solid Waste Directors, Landfill Operators, North Carolina Certified Laboratories, and Consultants

From: North Carolina Division of Waste Management, Solid Waste Section

Re: Environmental Monitoring Data for North Carolina Solid Waste Management Facilities

The purpose of this memorandum is to provide a reiteration of the use of the Solid Waste Section Limits (SWSLs), provide new information on the Groundwater Protection Standards, and provide a reminder of formats for environmental monitoring data submittals.

The updated guidelines are in large part due to questions and concerns from laboratories, consultants, and the regulated community regarding the detection of constituents in groundwater at levels below the previous Practical Quantitation Limits (PQLs). The North Carolina Solid Waste Section solicited feedback from the regulated community, and, in conjunction with the regulated community, developed new limits. The primary purpose of these changes was to improve the protection of public health and the environment.

Data must be reported to the laboratory specific method detection limits and must be quantifiable at or below the SWSLs. The SWSLs must be used for both groundwater and surface water data reported to the North Carolina Solid Waste Section. The PQLs will no longer be used.

In June 2007, we received new information regarding changes to the Groundwater Protection Standards. If a North Carolina 2L Groundwater Standard does not exist, then a designated Groundwater Protection Standard is used pursuant to 15A NCAC 13B .1634. Toxicologists with the North Carolina Department of Health and Human Services calculated these new Groundwater Protection Standards. Questions regarding how the standards were calculated can be directed to the North Carolina Department of Health and Human Services.

We have reviewed the new results from the North Carolina Department of Public Health and have updated our webpage accordingly. The list of Groundwater Protection Standards, North Carolina 2L Standards and SWSLs are subject to change and will be reviewed every year or sooner if new scientific and toxicological data become available. Please review our website periodically for any changes to the 2L NC Standards, Groundwater Protection Standards, or SWSLs. Specific updates will be noted on our website.

<http://www.wastenotnc.org/sw/swenvmonitoringlist.asp>

In addition, the following should be included with environmental monitoring data submittals:

1. Environmental Monitoring Data Form as a cover sheet:

<http://www.wastenotnc.org/swhome/EnvMonitoring/NCEnvMonRptForm.pdf>

2. Copy of original laboratory results.

3. Table of detections and discussion of 2L exceedances.

4. Electronic files on CD or sent by email. These files should include the written report as a Portable Document Format (PDF) file and the laboratory data as an excel file following the format of the updated Electronic Data Deliverable (EDD) template on our website:

http://www.wastenotnc.org/swhome/enviro_monitoring.asp

If you have any questions or concerns, please feel free to contact Donald Herndon (919-508-8502), Ervin Lane (919-508-8520) or Jaclynne Drummond (919-508-8500).

Thank you for your continued cooperation with these matters.



North Carolina Department of Environment and Natural Resources

Dexter R. Matthews, Director

Division of Waste Management

Michael F. Easley, Governor
William G. Ross Jr., Secretary

October 27, 2006

To: SW Director/County Manager/Consultant/Laboratory

From: NC DENR-DWM, Solid Waste Section

Re: New Guidelines for Electronic Submittal of Environmental Monitoring Data

The Solid Waste Section receives and reviews a wide variety of environmental monitoring data from permitted solid waste management facilities, including the results from groundwater and surface water analyses, leachate samples, methane gas readings, potentiometric measurements, and corrective action data. We are in the process of developing a database to capture the large volume of data submitted by facilities.

To maintain the integrity of the database, it is critical that facilities, consultants, and laboratories work with the Solid Waste Section to ensure that environmental samples are collected and analyzed properly with the resulting data transferred to the Solid Waste Section in an accurate manner.

In order to better serve the public and to expedite our review process, the Solid Waste Section is requesting specific formatting for environmental monitoring data submittals for all solid waste management facilities.

Effective, December 1, 2006, please submit a Solid Waste Environmental Monitoring Data Form in addition to your environmental monitoring data report. This form will be sent in lieu of your current cover letter to the Solid Waste Section. The Solid Waste Environmental Monitoring Data Form must be filled out completely, signed, and stamped with a Board Certified North Carolina Geologist License Seal.

The solid waste environmental monitoring data form will include the following:

1. Contact Information
2. Facility Name
3. Facility Permit Number
4. Facility Address
5. Monitoring Event Date (MM/DD/YYYY)
6. Water Quality Status: Monitoring, Detection Monitoring, or Assessment Monitoring
7. Type of Data Submitted: Groundwater Monitoring Wells, Groundwater Potable Wells, Leachate, Methane Gas, or Corrective Action Data
8. Notification of Exceedance of Groundwater, Surface Water, or Methane Gas (in table form)
9. Signature
10. North Carolina Geologist Seal

Most of these criteria are already being included or can be added with little effort. The Solid Waste Environmental Monitoring Data Form can be downloaded from our website:

http://www.wastenotnc.org/swhome/enviro_monitoring.asp.

The Solid Waste Section is also requesting a new format for monitoring wells, potable wells, surface water sampling locations, and methane probes. This format is essential in the development and maintenance of the database. The Solid Waste Section is requesting that each sampling location at all North Carolina solid waste management facilities have its own unique identification number. We are simply asking for the permit number to be placed directly in front of the sampling location number (example: 9901-MW1 = Permit Number 99-01 and Monitoring Well MW-1). No changes will need to be made to the well tags, etc. This unique identification system will enable us to accurately report data not only to NCDENR, but to the public as well. We understand that this new identification system will take some time to implement, but we feel that this will be beneficial to everyone involved in the long term.

Additionally, effective December 1, 2006, the Practical Quantitation Limits (PQLs) established in 1994 will change. The Solid Waste Section is requiring that all solid waste management facilities use the new Solid Waste Reporting Limits (SWRL) for all groundwater analyses by a North Carolina Certified Laboratory. Laboratories must also report any detection of a constituent even it is detected below the new SWRL (e.g., J values where the constituent was detected above the detection limit, but below the quantitation limit).

PQLs are technology-based analytical levels that are considered achievable using the referenced analytical method. The PQL is considered the lowest concentration of a contaminant that the lab can accurately detect and quantify. PQLs provided consistency and available numbers that were achievable by the given analytical method. However, PQLs are not health-based, and analytical instruments have improved over the years resulting in lower achievable PQLs for many of the constituents. As a result, the Solid Waste Section has established the SWRLs as the new reporting limits eliminating the use of the PQLs.

We would also like to take this opportunity to encourage electronic submittal of the reports. This option is intended to save resources for both the public and private sectors. The Solid Waste Section will accept the entire report including narrative text, figures, tables, and maps on CD-ROM. The CD-ROM submittal shall contain a CD-ROM case and both CD-ROM and the case shall be labeled with the site name, site address, permit number, and the monitoring event date (MM/DD/YYYY). The files may be a .pdf, .txt, .csv, .xls, or .doc type. Also, analytical lab data should be reported in an .xls file. We have a template for analytical lab data available on the web at the address listed above.

If you have any questions or concerns, please call (919) 508-8400. Thank you for your anticipated cooperation in this matter.



North Carolina Department of Environment and Natural Resources

Dexter R. Matthews, Director

Division of Waste Management

Michael F. Easley, Governor
William G. Ross Jr., Secretary

February 23, 2007

MEMORANDUM

To: Solid Waste Directors, Landfill Operators, North Carolina Certified Laboratories, and Consultants

From: North Carolina Division of Waste Management, Solid Waste Section

Re: Addendum to October 27, 2006, North Carolina Solid Waste Section Memorandum Regarding New Guidelines for Electronic Submittal of Environmental Data.

The purpose of this addendum memorandum is to provide further clarification to the October 27, 2006, North Carolina Solid Waste Section memo titled, "New Guidelines for Electronic Submittal of Environmental Data."

The updated guidelines is in large part due to questions and concerns from laboratories, consultants, and the regulated community regarding the detection of constituents in groundwater at levels below the previous practical quantitation limits (PQLs). The North Carolina Solid Waste Section solicited feedback from the regulated community, and, in conjunction with the regulated community, developed new limits. The primary purpose of these changes was to improve the protection of public health and the environment. The North Carolina Solid Waste Section is concerned about analytical data at these low levels because the earliest possible detection of toxic or potentially carcinogenic chemicals in the environment is paramount in the North Carolina Solid Waste Section's mission to protect human health and the environment. Low level analytical data are critical for making the correct choices when designing site remediation strategies, alerting the public to health threats, and protecting the environment from toxic contaminants. The revised limits were updated based on readily available laboratory analytical methodology and current health-based groundwater protection standards.

Definitions

Many definitions relating to detection limits and quantitation limits are used in the literature and by government agencies, and commonly accepted procedures for calculating these limits exist. Except for the Solid Waste Section Limit and the North Carolina 2L Standards, the definitions listed below are referenced from the Environmental Protection Agency (EPA). The definitions are also an attempt to clarify the meaning of these terms as used by the North Carolina Solid Waste Section.

Method Detection Limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.

Method Reporting Limit or Method Quantitation Limit (MRL or MQL) is the minimum concentration of a target analyte that can be accurately determined by the referenced method.

Practical Quantitation Limit (PQL) is a quantitation limit that represents a practical and routinely achievable quantitation limit with a high degree of certainty (>99.9% confidence) in the results. Per EPA Publication Number SW-846, the PQL is the lowest concentration that can be reliably measured within specified limits of precision and accuracy for a specific laboratory analytical method during routine laboratory operating conditions in accordance with "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods. The PQL appears in older NCDENR literature; however, it is no longer being used by the North Carolina Solid Waste Section.

Solid Waste Section Limit (SWSL) is the lowest amount of analyte in a sample that can be quantitatively determined with suitable precision and accuracy. The SWSL is the concentration below which reported analytical results must be qualified as estimated. *The SWSL is the updated version of the PQL that appears in older North Carolina Solid Waste Section literature. The SWSL is the limit established by the laboratory survey conducted by the North Carolina Solid Waste Section. The nomenclature of the SWRL described in the October 27, 2006, memorandum has changed to the SWSL.*

North Carolina 2L Standards (2L) are water quality standards for the protection of groundwaters of North Carolina as specified in 15A NCAC 2L .0200, Classifications and Water Quality Standards Applicable to the Groundwaters of North Carolina.

Method Detection Limits (MDLs)

Clarification of detection limits referenced in the October 27, 2006, memorandum needed to be addressed because of concerns raised by the regulated community. The North Carolina Solid Waste Section is now requiring laboratories to report to the method detection limit.

Method detection limits are statistically determined values that define the concentration at which measurements of a substance by a specific analytical protocol can be distinguished from measurements of a blank (background noise). Method detection limits are matrix-specific and require a well defined analytical method. In the course of routine operations, laboratories generally report the highest method detection limit for all the instruments used for a specific method.

In many instances, the North Carolina Solid Waste Section gathers data from many sources prior to evaluating the data or making a compliance decision. Standardization in data reporting significantly enhances the ability to interpret and review data because the reporting formats are comparable. Reporting a method detection limit alerts data users of the known uncertainties and limitations associated with using the data. Data users must understand these limitations in order to minimize the risk of making poor environmental decisions. Censoring data below unspecified or non-statistical reporting limits severely biases data sets and restricts their usefulness.

Solid Waste Section Limits (SWSLs)

Due to comments from the regulated community, the North Carolina Solid Waste Section has changed the nomenclature of the new limits referenced on Page 2 of the October 27, 2006, memorandum, from the North Carolina Solid Waste Reporting Limits (SWRL) to the Solid Waste Section Limits (SWSL). Data must be reported to the laboratory specific method detection limits and must be quantifiable at or below the SWSL. The SWSLs must be used for both groundwater and surface water data reported to the North Carolina Solid Waste Section. The PQLs will no longer be used.

The North Carolina Solid Waste Section has considered further feedback from laboratories and the regulated community and has made some additional changes to the values of the SWSLs. These changes may be viewed on our webpage:

<http://www.wastenotnc.org/sw/swenvmonitoringlist.asp>

Analytical Data Reporting Requirements

The strategy for implementing the new analytical data reporting requirements involves reporting the actual laboratory method detection limit with all analytical laboratory results along with the following requirements:

1) Any analyte detected at a concentration greater than the MDL but less than the SWSL is known to be present, but the uncertainty in the value is higher than a value reported above the SWSL. As a result, the actual concentration is estimated. The estimated concentration is reported along with a qualifier (“J” flag) to alert data users that the result is between the MDL and the SWSL. Any analytical data below quantifiable levels should be examined closely to evaluate whether the analytical data should be included in any statistical analysis. A statistician should make this determination. If an analyte is detected below the North Carolina 2L Standards, even if it is a quantifiable concentration, compliance action may not be taken unless it is statistically significant increase over background.

These analytical results may require additional confirmation.

2) Any analyte detected at a concentration greater than the SWSL is present, and the quantitated value can be reported with a high degree of confidence. These analytes are reported without estimated qualification. The laboratory’s MDL and SWSL must be included in the analytical laboratory report. Any reported concentration of an organic or inorganic constituent at or above the North Carolina 2L Standards will be used for compliance purposes, unless the inorganic constituent is not statistically significant). Exceedance of the North Carolina 2L Standards or a statistically significant increase over background concentrations define when a violation has occurred. Any reported concentration of an organic or inorganic constituent at or above the SWSL that is not above an North Carolina 2L Standard will be used as a tool to assess the integrity of the landfill system and predict the possibility that a constituent concentration may exceed the North Carolina 2L Standards in the future.

These analytical results may be used for compliance without further confirmation.

Failure to comply with the requirements described in the October 27, 2006, memorandum and this addendum to the October 27, 2006, memorandum will constitute a violation of 15A NCAC 13B .0601, .0602, or .1632(b), and the analytical data will be returned and deemed unacceptable. Submittal of unacceptable data may lead to enforcement action.

Electronic Data Deliverable (EDD) Submittal

The North Carolina Solid Waste Section would also like to take this opportunity to encourage electronic submittal of the reports in addition to the analytical laboratory data. This option is intended to save resources for both the public and private sectors.

The North Carolina Solid Waste Section will accept the entire report including narrative text, figures, tables, and maps on CD-ROM. Please separate the figures and tables from the report when saving in order to keep the

APPENDIX C

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Solid Waste Management



James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
William L. Meyer, Director

September 13, 1994

D. Wayne Sullivan
Municipal Engineering Services
P. O. Box 97
Garner, NC 27529

RE: Permanent Methane Monitoring Plan, Greene County
Landfill Transition Plan, Permit No. 40-02

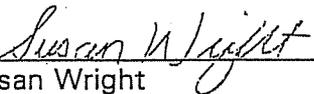
Mr. Sullivan:

In accordance with 15A NCAC 13B .1626(4), owners or operators of all municipal solid waste landfill (MSWLF) units must implement a permanent methane monitoring program on or before October 9, 1994. The permanent methane monitoring plan in the referenced transition plan includes the frequency of testing, test procedure, and a response plan for situations in which methane gas levels are exceeded, in addition to, proposed well locations, depth, and construction.

In accordance with North Carolina General Statute §130A-294 and North Carolina Solid Waste Management Rules, 15A NCAC 13B .1603(d)(2)(B), partial transition plan approval of Section VII - Operational Requirement #4 is hereby approved. This partial approval is valid only until such time as the full transition plan is approved by the Division of Solid Waste Management.

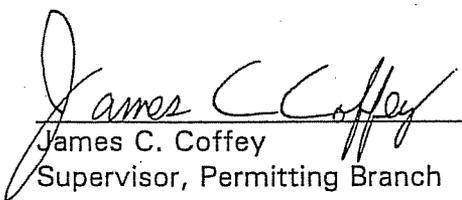
If you have any questions regarding this matter, please contact Susan Wright at (919) 733-0692.

Thank you,



Susan Wright
Environmental Engineer

Approved:



James C. Coffey
Supervisor, Permitting Branch
Solid Waste Section

OPERATION/CONSTRUCTION MANAGERS

**Municipal
Services**

P.O. Box 97, Garner, North Carolina 27529 (919)772-5393



CIVIL/SANITARY ENGINEERS

**Engineering
Company, P.A.**

P.O. Box 349, Boone, North Carolina 28607 (704)262-1767

September 22, 1994

Mr. Jesse Tyndall
Public Works Supervisor
County of Greene
229 Kingold Blvd.
Snow Hill, NC 28580

Re: Permanent Methane Monitoring Plan Approval
Greene County Transition Plan
Permit No. 40-02

Dear Mr. Tyndall:

Enclosed you will find a revised operation plan detailing a methane response plan, revised Appendix III with the GP-204 instruction manual detailing monitoring procedures including calibration, and a detail for the construction and depth of permanent wells.

Please replace Section VII of your transition plan with the enclosed written operation plan.

If you have any questions, please advise.

Very truly yours,
MUNICIPAL ENGINEERING SERVICES CO., PA

D. Wayne Sullivan

D. Wayne Sullivan
Project Manager

DWS:cd

Enclosures

APPENDIX III

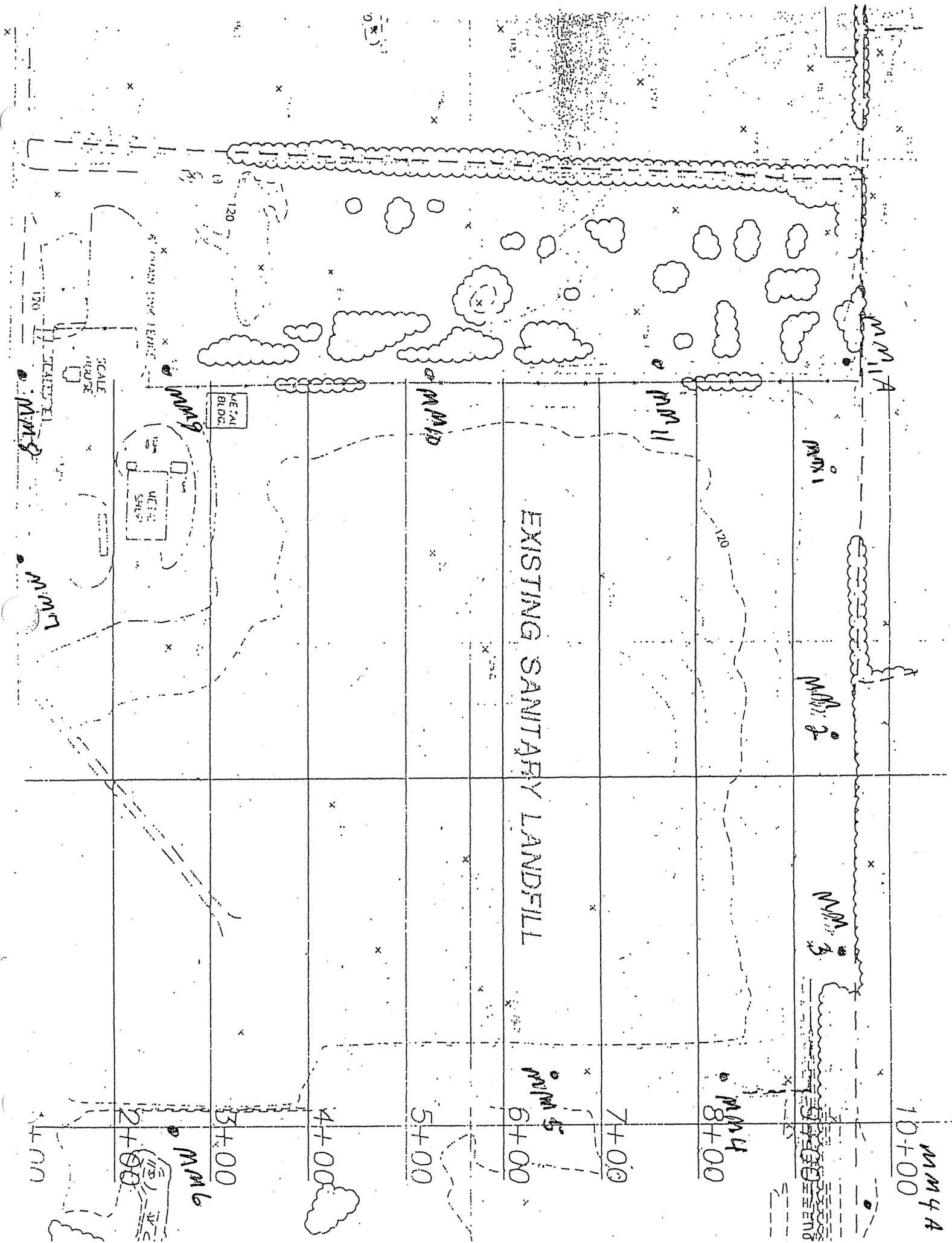
EXPLOSIVE GAS CONTROL PLAN FOR - GREENE COUNTY

Quarterly the Greene County 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 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 will consist of a plastic stand pipe similar to a piezometer used for groundwater detection. A typical permanent methane probe is detailed in the operation drawings. The permanent probes will be installed by October 9, 1994.

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.

Quarterly, a County employee will visit each monitoring point either the temporary or permanent. 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, 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 Greene County.

Other points of monitoring will be the landfill structures. If methane gas is detected beyond 25% of its lower explosive limit, then a remediation plan is stated in the operational requirements.



EXISTING SANITARY LANDFILL

METAL BLDG.

SCALE HOUSE

STAIRS

6' MAIN ENG. ELEC.

MM4A
10+00

MM1

MM2

MM3

MM4
8+00

MM11

7+00

MM5
6+00

5+00

4+00

3+00

2+00

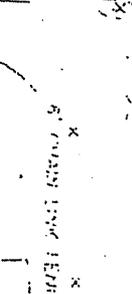
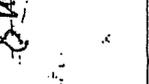
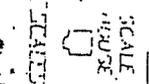
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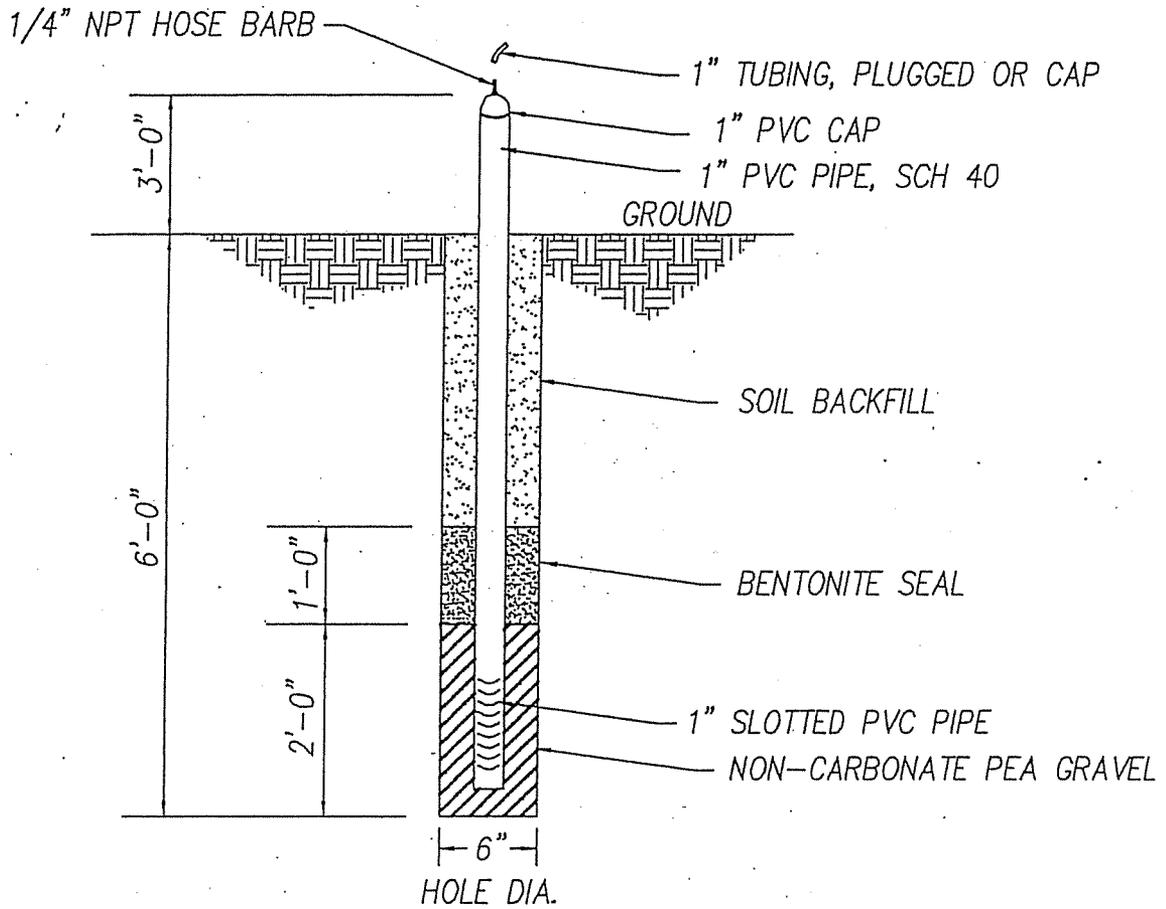
MM8

MM7

MM9

MM11A





METHANE GAS MONITORING PROBE

N.T.S.

GREENE COUNTY LANDFILL
Methane Gas Monitoring Report

Date: Jan-30-09

Well #1 0 %

Well #2 0 %

Well #3 0 %

Well #4 OL-100% % 19.9% OX. 4A

Well #5 0 %

Well #6 0 %

Well #7 0 %

Well #8 0 %

Well #9 0 %

Well #10 0 %

Well #11 OL-100% % OX 16.9 11A

Shelter 0 %

Shop Building 0 %

Scale House 0 %

Testing Done By : Dal Jan

Bio system
multivision

GREENE COUNTY LANDFILL
Methane Gas Monitoring Report

Date: 5-21-09

Well #1 0 %

Well #2 0 %

Well #3 0 %

Well #4 100 %

4A 0%

Well #5 0 %

Well #6 0 %

Well #7 0 %

Well #8 0 %

Well #9 0 %

Well #10 0 %

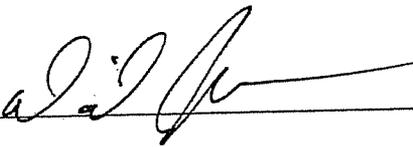
Well #11 100 %

11A 0%

Shelter 0 %

Shop Building 0 %

Scale House 0 %

Testing Done By : 

Bio systems
Multiusion

size of the files smaller. The CD-ROM submittal shall contain a CD-ROM case and both CD-ROM and the case shall be labeled with the site name, site address, permit number, and the monitoring event date (MM/DD/YYYY). The reporting files may be submitted as a .pdf, .txt, .csv, .xls, or .doc type.

Also, analytical lab data and field data should be reported in .xls files. The North Carolina Solid Waste Section has a template for analytical lab data and field data. This template is available on our webpage: http://www.wastenotnc.org/swhome/enviro_monitoring.asp. Methane monitoring data may also be submitted electronically in this format.

Pursuant to the October 27, 2006, memorandum, please remember to submit a Solid Waste Section Environmental Monitoring Reporting Form in addition to your environmental monitoring data report. This form should be sealed by a geologist or engineer licensed in North Carolina if hydrogeologic or geologic calculations, maps, or interpretations are included with the report. Otherwise, any representative that the facility owner chooses may sign and submit the form. Also, if the concentration of methane generated by the facility exceeds 100% of the lower explosive limits (LEL) at the property boundary or exceeds 25% of the LEL in facility structures (excluding gas control or recovery system components), include the exceedance(s) on the North Carolina Solid Waste Section Environmental Monitoring Reporting Form.

If you have any questions or concerns, please feel free to contact Jaclynne Drummond (919-508-8500) or Ervin Lane (919-508-8520).

Thank you for your continued cooperation with this matter.