

PREPARED FOR:

TOWN OF KERNERSVILLE
PUBLIC WORKS DEPARTMENT
P.O. Box 728
KERNERSVILLE, NORTH CAROLINA 27285-0728



**TOWN OF KERNERSVILLE LANDFILL
PERMIT No. 34-04**

CORRECTIVE ACTION EVALUATION REPORT

OCTOBER 2016

PREPARED BY:

JOYCE
ENGINEERING

2211 WEST MEADOWVIEW ROAD, SUITE 101
GREENSBORO, NORTH CAROLINA 27407
NC LICENSE NUMBER C-0782
PHONE: (336) 323-0092
FAX: (336) 323-0093
JOYCE PROJECT No. 838.1601.12

CORRECTIVE ACTION EVALUATION REPORT

Town of Kernersville Landfill, Permit No. 34-04

EXECUTIVE SUMMARY

On behalf of the Town of Kernersville, North Carolina, Joyce Engineering (JOYCE) prepared this Corrective Action Evaluation Report (CAER) for the Town of Kernersville Landfill. The Kernersville Landfill is regulated under §.0500 of the NCSWMR. This CAER has been prepared in accordance with the North Carolina Solid Waste Management Rules (NCSWMR) in response to the Groundwater Protection Standard (GPS) exceedances of volatile organic compounds (VOCs) in groundwater monitoring wells at the facility.

In November 2012, the Town received notification from then North Carolina Department of Environment and Natural Resources (NCDENR), now the Department of Environmental Quality (NCDEQ), that the Town needed to submit a Phased Groundwater Assessment Plan and complete groundwater assessment. A Groundwater Assessment Plan was submitted in January 2013 and a Groundwater Assessment Report was submitted in May 2013. In a letter dated July 16, 2013, the NCDEQ called for the Town to select a remedy and submit a Corrective Action Application. In July 2014, the Town submitted the Corrective Action Application, selecting Monitored Natural Attenuation (MNA) plus Phytoremediation as the remedy. The remedy was approved by DEQ in a letter dated July 23, 2014. The Town submitted a Corrective Action Plan (CAP) in October 2014 and NCDEQ approved the CAP in a letter dated November 4, 2014.

The constituents of concern (COCs) for the facility include the following VOCs: benzene, 1,1-dichloroethane, 1,2-dichloroethane, cis-1,2-dichloroethylene, 1,2-dichloropropane (1,2-DCP), tetrachloroethylene, trichloroethylene, and vinyl chloride. This CAER presents plume maps, cross section, and trend charts for each of the COCs. There is no evidence that the plume is expanding horizontally or vertically, and constituent concentrations are generally decreasing. This CAER recommends that cis-1,2-dichloroethylene be removed from the COC list since it has not been detected in exceedance of its GPS since November 2012.

In accordance with the CAP, MNA baseline sampling was initiated with the November 2014 sampling event; therefore, the June 2016 sampling event was the fourth baseline sampling event for MNA. The MNA baseline data are presented in this CAER, and recommendation are made for eliminating or reducing the frequency for several of the MNA parameters.

Tree surveys to evaluate phytoremediation at the facility were conducted in June 2015 and April 2016, and they determined that the existing flora was healthy and sufficient to sustain phytoremediation. This CAER concludes that the current remedy is sufficient for remediating the groundwater at the Kernersville Landfill facility and recommends no changes to the CAP or the active remedy.

CORRECTIVE ACTION EVALUATION REPORT
Town of Kernersville Landfill, Permit No. 34-04

TABLE OF CONTENTS

EXECUTIVE SUMMARY i

1.0 INTRODUCTION 1

 1.1 Site Background..... 1

 1.2 Aquifer Characteristics 2

 1.2.1 Groundwater Flow 3

 1.2.2 Vertical Gradient..... 3

 1.3 Contaminant Distribution..... 4

 1.4 Site Conceptual Model..... 6

 1.4.1 Site Geology..... 6

 1.4.2 Site Hydrogeology 6

 1.5 Regulatory Status 7

2.0 CORRECTIVE ACTION SUMMARY 7

 2.1 Physical and Chemical Changes in Aquifer Conditions 7

 2.2 Physical and Chemical Changes in Plume Characteristics 8

 2.3 Refining the Site Conceptual Model..... 8

 2.4 Evaluation of the Impact of Corrective Actions 9

 2.4.1 Contaminant Levels 9

 2.4.2 Evaluation of MNA Parameters..... 9

 2.4.3 MNA Matrix Evaluation 14

 2.4.4 Evaluation of Phytoremediation 14

 2.4.5 Impacts on Hydraulic Gradients 16

 2.4.6 Contaminant Removal Efficiencies and Mass of Contaminants Removed 17

 2.5 Migration of the Contaminant Plume 17

 2.5.1 Status of Impacts at the Compliance Boundary 17

 2.5.2 Off-Site Migration Concerns 18

3.0 CONCLUSIONS AND RECOMMENDATIONS..... 18

 3.1 Changes to the COC List 18

 3.2 Assessment of MNA Indicator Parameters..... 18

 3.3 Modifications Needed to Selected Remedy 19

 3.4 Contingency Plan 20

 3.5 Land Use Restrictions 20

4.0 REFERENCES..... 20

5.0 ACRONYMS..... 22

CORRECTIVE ACTION EVALUATION REPORT
Town of Kernersville Landfill, Permit No. 34-04

TABLES

Table 1	Monitoring Well Construction Data
Table 2	Historical Groundwater Elevations
Table 3	Estimated Hydraulic Gradient and Groundwater Flow Velocity
Table 4	Exceedances of Groundwater Standards for Organic Constituents
Table 5	Exceedances of Groundwater Standards for Inorganic Constituents
Table 6	Recent and Historical MNA Parameters
Table 7	MNA Biodegradation Screening Matrix

CHARTS

Chart 1	Benzene Concentration vs. Time
Chart 2	1,1-Dichloroethane Concentration vs. Time
Chart 3	1,2-Dichloroethane Concentration vs. Time
Chart 4	cis-1,2-Dichloroethene Concentrations vs. Time
Chart 5	1,2-Dichloropropane Concentrations vs. Time
Chart 6	Tetrachloroethene Concentrations vs. Time
Chart 7	Trichloroethene Concentrations vs. Time
Chart 8	Vinyl Chloride Concentrations vs. Time
Chart 9	Total VOC Concentrations vs. Time

FIGURES

Figure 1	Site Location Map
Figure 2	Geologic Map

DRAWINGS

Drawing 1	Groundwater Potentiometric Surface Map (June 2016)
Drawing 2	Benzene Isoconcentration Map (June 2016)
Drawing 3	1,1-Dichloroethane Isoconcentration Map (June 2016)
Drawing 4	1,2-Dichloroethane Isoconcentration Map (June 2016)
Drawing 5	cis-1,2-Dichloroethene Isoconcentration Map (June 2016)
Drawing 6	1,2-Dichloropropane Isoconcentration Map (June 2016)
Drawing 7	Tetrachloroethene Isoconcentration Map (June 2016)
Drawing 8	Trichloroethene Isoconcentration Map (June 2016)
Drawing 9	Vinyl Chloride Isoconcentration Map (June 2016)
Drawing 10	Total VOCs Isoconcentration Map (June 2016)
Drawing 11	Total VOCs Cross-Section (June 2016)
Drawing 12	Tree Survey (June 2015)
Drawing 13	Tree Survey (April 2016)

CORRECTIVE ACTION EVALUATION REPORT
Town of Kernersville Landfill, Permit No. 34-04

APPENDICES

- Appendix A Historical Detected Groundwater Constituents
- Appendix B Historical Detected Surface Water Constituents
- Appendix C BIOCHLOR Modeling Input & Output

1.0 INTRODUCTION

On behalf of the Town of Kernersville, Joyce Engineering (JOYCE) prepared this *Corrective Action Evaluation Report* (CAER) for the Town of Kernersville Landfill (facility). This CAER has been prepared in accordance with 15A NCAC 13B.1636 of the North Carolina Solid Waste Management Rules (NCSWMR) and in response to the Groundwater Protection Standard (GPS) exceedances of several volatile organic compounds (VOCs) in groundwater monitoring wells at the facility.

1.1 Site Background

The Town of Kernersville Landfill is a closed, unlined municipal solid waste (MSW) landfill located on approximately 58.2 acres in Forsyth and Guilford Counties, NC, approximately 10 miles north of the City of Kernersville. The waste disposal area comprises approximately 13.8 acres. The property boundary is indicated on an excerpt from the 7.5 minutes USGS topographic map for Belews Creek, North Carolina (Figure 1). The facility was issued a Permit to Operate on May 15, 1985, and a letter of closure was issued on December 10, 1991.

The area surrounding the landfill is zoned residential/agricultural and contains open fields and woodlands. The landfill is separated to the North from the Waste Management Piedmont Landfill and Recycling Center Facility by Freeman Road. The landfill is bounded to the south by an unnamed tributary of East Belews Creek. Groundwater at the site flows to the southwest toward the unnamed tributary. Drawing 1 presents a site map showing the layout of the facility.

The Town of Kernersville Landfill is currently monitoring groundwater in accordance with criteria set forth in Title 15A Subchapter 13B .0500 of the North Carolina Solid Waste Management Rules (NCSWMR) for municipal solid waste landfills (MSWLF) closed prior to October 9, 1993. The current groundwater compliance monitoring network includes six monitoring wells, including one upgradient well and five downgradient wells. Existing monitoring well MW-6 serves as the background well for the facility. Monitoring well MW-6 replaced MW-1 as the facility's background well due to infrequent opportunities to sample the well as a result of low well volumes or the well-being dry; however, MW-6 has also been dry during the last several sampling events. Downgradient monitoring wells MW-2, MW-3S, MW-3D, MW-4, and MW-5 are monitored as part of the compliance network for the facility. MW-1 is monitored for water levels only, as conditions permit. Monitoring well construction details are summarized in Table 1, and the well locations are shown on Drawing 1. These wells are summarized below, along with their current monitoring program status.

Monitoring Well	Classification	Monitoring Program	Total Depth from TOC (feet)
MW-1	Former Background	Water Levels Only	34.69
MW-2	Compliance/MNA	Detection (.0500)/CAP	13.18
MW-3S	Compliance/MNA	Detection (.0500)/CAP	24.00
MW-3D	Compliance/MNA	Detection (.0500)/CAP	56.96
MW-4	Compliance/MNA	Detection (.0500)/CAP	14.40
MW-5	Compliance	Detection (.0500)	11.36
MW-6	Background/MNA	Detection (.0500)/CAP	20.46

TOC = Top of casing. CAP = Corrective Action Plan.

Groundwater samples are collected semiannually during the second and fourth quarters. Samples are analyzed for all constituents in the NCSWMR Appendix I list. As a condition of the CAP, monitoring wells MW-2, MW-3S, MW-3D, MW-4 and MW-6 are also monitored for MNA laboratory constituents, including nitrate, sulfate, chloride, alkalinity, total organic carbon, methane, ethane, ethene, volatile fatty acids, dissolved hydrogen, biological oxygen demand, and chemical oxygen demand, as well several MNA field parameters, during both the first and second semiannual events.

Based on the presence of constituents above NC2L standards that could potentially be crossing the facility boundary, the North Carolina Department of Environment and Natural Resources (NC DENR), now known as the Department of Environmental Quality (NC DEQ), requested that Kernersville submit a Groundwater Assessment Plan to evaluate site conditions as they relate to groundwater quality. The Groundwater Assessment Report was submitted to NC DENR on May 13, 2013. The Groundwater Assessment Report concluded that, based on site hydrogeology, it is unlikely that the site impacts above NC2L standards are crossing the boundary.

In a July 16, 2013, response to the Groundwater Assessment Report, NC DEQ determined that the detection of VOCs at concentrations that exceed NC2L standards constitutes a violation of Solid Waste Section regulations. As required by NC DEQ, JOYCE submitted a Corrective Action Plan (CAP) on behalf of the Town of Kernersville Landfill in October 2014. NC DENR approved the Corrective Action Plan in a letter dated November 4, 2014.

This report represents the first CAER for the facility and is being submitted in accordance with the reporting schedule presented in the CAP. Subsequent CAERs will be submitted to NC DEQ every five years.

1.2 Aquifer Characteristics

The water table under the area of investigation was encountered in the unconfined aquifer that is mostly in saprolite, but is believed to grade into highly fractured bedrock with depth. Groundwater in the saprolite feeds the fractures in the bedrock and is discharged into creeks south and southwest of the landfill. Groundwater flow at deeper levels within the fractured

bedrock is controlled by fracture orientation and connectivity. This unconfined aquifer is pervasive across the site and the water table generally mimics the surface topography.

Depth to groundwater at the site ranges from approximately 2-5 feet below ground surface (ft-bgs) on the downgradient (southwest) side of the site, to about 28-33 ft-bgs near the northeast corner of the waste unit. Groundwater elevation ranges from approximately 785 feet above mean sea level (ft-amsl) on the upgradient side of the site to approximately 755 ft-amsl on the down gradient side of the site. Groundwater flow direction at the site is from the northeast to the southwest. Historical groundwater elevation data for the facility are presented in Table 2. The groundwater elevations and flow direction based on the June 28, 2016, water level data are shown on Drawing 1.

1.2.1 Groundwater Flow

Aquifer hydraulic properties and groundwater flow velocity calculations are included in Table 3. The horizontal gradient for the flow path shown on Drawing 1 was 0.0311 ft/ft. This value is consistent with previous estimates.

The linear groundwater flow velocities were computed using the modified Darcy equation: $V = Ki/n_e$, where V = average linear velocity (feet/day), K = hydraulic conductivity (feet/day), i = horizontal hydraulic gradient, and n_e = effective porosity. The hydraulic conductivity ($K = 1.73$ feet/day) from slug-tests conducted by JOYCE in April 2013 was used in this calculation (see Table 3). The effective porosity ($n_e = 30\%$) was estimated based on typical values for saprolite in the North Carolina Piedmont. Although the regolith and bedrock are hydraulically connected, the effective porosity generally decreases with depth into the underlying fractured bedrock. The calculated linear groundwater velocity is approximately 65 feet/year.

Because of our conservative estimate of effective porosity, actual groundwater velocities may be significantly less than those calculated. Also, the modified Darcy equation makes the simplified assumptions of a homogeneous and isotropic aquifer. Actual velocities may vary significantly in the heterogeneous, anisotropic conditions believed to exist at this site.

1.2.2 Vertical Gradient

Monitoring wells MW-3S and MW-3D represent a nested pair of wells with different screened intervals. The estimated vertical gradient based on the water levels measured during the June 28, 2016, sampling event is calculated below. The calculated upward gradient is -0.025 feet/foot between these two wells, indicating a weak upward component to groundwater flow. Since these wells are located near the creek southwest of the landfill, these data support the contention that the creek is a groundwater discharge feature.

Vertical Gradient Calculation

Well ID	Ground Surface (Ft-AMSL)	TOC (Ft-AMSL)	Screened Interval Elevation (Ft-AMSL)			Groundwater Elevation (Ft-AMSL)	Vertical Gradient (Feet/Foot)
			Top	Bottom	Midpoint		
MW-3S	761.98	764.57	748.0	738.0	743.0	750.32	-0.025
MW-3D	762.02	764.56	725.1	705.1	715.1	751.01	

Ft-AMSL = Feet above mean sea level. TOC = Top of PVC well casing.

1.3 Contaminant Distribution

Based on recent groundwater sampling at the facility, there appears to be one VOC plume and associated area of concern (AOC) for the facility. The AOC is located hydraulically downgradient of the waste disposal area in the vicinity of MW-2, MW-3S, MW-3D, and MW-4. The groundwater surface contours shown on Drawing 1 indicate that groundwater flow is generally from the northeast to the southeast towards the creek, which is an unnamed tributary to East Belews Creek. This is consistent with the observed plume. The creek, which flows toward the northwest, is believed to be a groundwater discharge features and therefore should exert some hydraulic control over the migration of the VOC plume. There have been no quantified detections of VOCs in the surface water and there have been no exceedances of NC2B surface water standards.

Since 2009, several VOCs have been detected at concentrations that exceed their respective Groundwater Standards, promulgated under 15A NCAC 2L.0202 (NC2L) or the NC Solid Waste Section Groundwater Protection Standards (GWPS - established for constituents with no NC2L). The constituents of concern (COCs) for the facility include the VOCs that have been detected in exceedance of NC2L standards in one or more downgradient well at least once in the 3 years preceding submittal of the CAP. These COCs include benzene, 1,1-dichloroethane, 1,2-dichloroethane, cis-1,2-dichloroethylene, 1,2-dichloropropane (1,2-DCP), tetrachloroethylene, trichloroethylene, and vinyl chloride. Monitoring wells impacted by VOCs include MW-2, MW-3S, MW-3D and MW-4, which are located southwest of the waste unit approximately 130 feet to 450 feet from the western boundary of the facility.

Tables 4 and 5 present summaries of NC Appendix I and II organic and inorganic constituents that have been detected above the NC2L or the GWPS. Complete historical data for detected constituents in groundwater and surface water are presented in Appendices A and B, respectively. The laboratory analytical reports and field data logs have been submitted in the corresponding Semiannual Water Quality Monitoring Reports (WQMRs) for the facility. The laboratory reports and field logs for the June 2016 sampling event are presented in the First Semiannual WQMR of 2016, which was submitted in August 2016.

Seven VOCs (all of the COCs except cis-1,2-dichloroethylene) have been detected at concentrations greater than the regulatory Groundwater Protection Standard (GPS) as defined in NCSWMR §.1634.g in the last several years. For the COCs, the GPS are the NC2L standards. Since 2009, the GPS for benzene; 1,1-dichloroethane; tetrachloroethene; and trichloroethene have been exceeded only in monitoring well MW-2. The GPS for 1,2-dichloroethane is sporadically exceeded only in MW-3D. Cis-1,2-dichloroethylene is considered to be a COC at this facility; however, it has exceeded the GPS only one time in one monitoring well (MW-3D in November 2012). The GPS for 1,2-dichloropropane has historically been exceeded in MW-2 and MW-3D. The GPS for vinyl chloride has historically been exceeded in each of the downgradient compliance wells except MW-5. Table 4 presents the historical data for these constituents. Drawings 2 through 10 present isoconcentration maps for the individual COC plumes and for total VOCs using the June 2016 sample event data. Based on the lack of detections of any COCs in the surface water samples SW-2 and SW-3, immediately downgradient of the impacted monitoring wells, the plume appears to be limited and contained within the facility boundary.

Drawing 11 shows a cross-section through the total VOC plume. The downgradient horizontal extent of the plume is controlled by the surface water monitoring points, which have exhibited only sporadic detections of cis-1,2-dichloroethene at estimated concentrations at least an order of magnitude below the NC2L groundwater standard. As previously discussed, nested wells MW-3S and MW-3D, which are located adjacent to the creek, exhibit a slight upward hydraulic gradient, indicating that the creek is a groundwater discharge feature. The deep-screened well MW-3D has higher concentrations of VOCs than the shallower MW-3S, indicating that the vertical extent of the total VOC plume is not delineated.

Charts 1 through 9 present plots of the COCs and total VOCs versus time in all monitoring wells where they have been detected (MW-2R, MW-3R, and MW-4). The concentrations of most of the COCs in most wells show downward or stable trends. 1,1-dichloroethane concentrations have shown sporadic variations with no clear trend. Vinyl chloride concentrations show slightly increasing trends in MW-2 and MW-3D, which could be related to degradation of the higher-order chlorinated VOCs. A review of Chart 9 appears to show a downward trend in total VOCs in all of the wells, although the trend in MW-3D is less clear than the others. The trends indicate that the geometric distribution of the plume and the concentrations in the plume are generally stable or decreasing.

In addition to the VOCs, there have been isolated occurrences of inorganic constituents (metals) detected above the NC2L or the groundwater protection standards (GWPS) in both upgradient and downgradient monitoring wells at the site; however, in the last three years the only metal with consistent exceedances has been cobalt in MW-5. MW-5 is located on the east side of the landfill, in a cross-gradient location relative to waste and is unlikely to have been impacted by the landfill. The metals exceedances do not appear to coincide with the VOC plume; therefore, they do not appear to be related to a release from the landfill. The metals are believed to represent naturally occurring variations in groundwater chemistry due to the site geology;

therefore, they are not considered COCs. The historic exceedances of inorganic constituents are summarized in Table 5.

1.4 Site Conceptual Model

1.4.1 Site Geology

The Town of Kernersville Landfill is located in the Piedmont physiographic province of North Carolina and is underlain by intrusive granitic rocks of Pennsylvanian to Permian age which are part of the Charlotte Belt Geologic Unit. A geologic map of the area has been included as Figure 2 (Espenshade, et al, 1975). The geologic map shows that rock underlying the site is primarily quartz monzonite and granodiorite, typically containing large microcline phenocrysts as well as biotite, muscovite, epidote, and hornblende. It is generally nonfoliated, and may contain thin layers of mafic rock. Just south of the site is an area mapped as a mafic intrusive body, mainly composed of gneissic metagabbro and metadiorite. The geologic map does not show any diabase dikes mapped near the site location.

There is relatively limited geological data available for the Kernersville landfill. JOYCE could not locate drilling records or boring logs for wells on the property through a review of both the Town of Kernersville records and NCDEQ records. In 2012, JOYCE installed a number of gas probes at the site and boring records were prepared for those probe installations. In most cases, the borings for the gas probes encountered uniform red clayey sands that appeared saprolitic. Depths of borings for the probes ranged from 8 feet to 34 ft-bgs. Bedrock was not encountered in any of those borings.

1.4.2 Site Hydrogeology

The uppermost aquifer is unconfined and includes both saprolite and the uppermost fractured bedrock, which are well connected and act as a single aquifer. Typically in the Piedmont, the saprolite grades into weathered bedrock which grades into fractured competent bedrock, resulting in an aquifer in which porosity and permeability decrease significantly with depth. Groundwater can occur in substantial volumes where soils and saprolite are very thick; but typically, groundwater is found in minimal volumes in bedrock, primarily restricted to fractures. Groundwater in the saprolite feeds the fractures in the bedrock and is discharged into creeks south and southwest of the landfill. Although the regolith and bedrock are hydraulically connected, the effective porosity generally decreases with depth into the underlying fractured bedrock. Groundwater flow at deeper levels within the fractured bedrock is controlled by fracture orientation and connectivity. This unconfined aquifer is pervasive across the site.

Historical water level data are presented in Table 2, and aquifer hydraulic properties and groundwater flow velocity calculations are presented in Table 3. A groundwater potentiometric surface map based on water levels obtained during the June 2016 sampling event is presented in Drawing 1. The water table beneath the facility generally mimics the surface topography, ranging in depth from 3 to 30 ft-bgs. Groundwater flow is to the southwest, and discharges to

the creeks south and southwest of the landfill. The creeks form a hydrologic divide, so that groundwater from the site is not expected to migrate beyond them. The calculated linear groundwater velocity is approximately 65 feet/year (see Section 1.2 for a more detailed discussion).

Based on the above-described geologic and hydrogeologic information, the groundwater flow regime on this site is well-constrained and predictable. Migration of groundwater contaminants are expected to follow the general groundwater flow paths shown on Drawing 1. The unnamed tributary present along the south and southwestern border of the waste unit, downgradient of the plume, is a groundwater discharge feature and, therefore, a hydrologic divide that should prevent migration of the plume beyond it. There are no known preferred pathways that could significantly affect plume migration or the effectiveness of the groundwater/surface water monitoring network to monitoring plume migration.

1.5 Regulatory Status

The Kernersville Landfill is regulated under §.0500 of the NCSWMR, and is monitored in accordance with the requirements of §.0600 of the NCSWMR. On November 1, 2012, the Town of Kernersville received notification from NCDEQ that because of the detection of groundwater impacts at the site that could potentially be crossing the property boundary, the Town needed to submit a Phased Groundwater Assessment Plan and complete the described groundwater assessment. In January 2013, JOYCE, on behalf of the Town, submitted a Groundwater Assessment Plan, which was approved by DEQ on February 14, 2013. In May 2013, JOYCE submitted a Groundwater Assessment Report for the facility. In a letter dated July 16, 2013, DEQ approved the Groundwater Assessment Report and called for the Town to select a remedy and submit a Corrective Action Application within 1 year of the date of that letter. In July 2014, on behalf of the Town, JOYCE submitted the Corrective Action Application selecting Monitored Natural Attenuation (MNA) plus Phytoremediation as the remedy. The remedy was approved by DEQ in a letter dated July 23, 2014. As required by NCDEQ, JOYCE submitted a Corrective Action Plan (CAP) on behalf of the Town of Kernersville Landfill in October 2014. NCDEQ approved the CAP in a letter dated November 4, 2014.

2.0 CORRECTIVE ACTION SUMMARY

2.1 Physical and Chemical Changes in Aquifer Conditions

Data obtained from the June 2016 semiannual sampling event, including groundwater elevation and flow, groundwater field parameters, MNA parameters, and constituent concentrations have been evaluated with regard to the physical and chemical conditions in the uppermost aquifer at the site. Table 6 presents the recent and historical MNA data for the facility. The laboratory analytical reports for the MNA data have been submitted in the corresponding Semiannual WQMRs for the facility. The laboratory report for the June 2016 MNA data are presented in the First Semiannual WQMR of 2016, which was submitted in August 2016.

Temperature, pH, conductivity, ORP, turbidity, dissolved oxygen, dissolved carbon dioxide, and ferrous iron fluctuate within normal ranges for groundwater in saprolite of the Piedmont physiographic province. Conductivity, ORP, alkalinity and chloride concentrations are significantly higher and sulfate concentrations are lower in the vicinity of the plume than in the upgradient well. These differences are attributed to the presence of the plume and the natural attenuation process. Although some MNA parameters have fluctuated or had sporadic results, we see no major or systematic differences in groundwater chemistry between June 2014 and June 2016. In addition, we have observed no significant change or variation in groundwater elevation and flow or constituent concentrations since the CAP was implemented. These data do not indicate any significant changes in the physical or chemical characteristics of the aquifer since the ACM and CAP.

2.2 Physical and Chemical Changes in Plume Characteristics

Table 4 presents the historical data for the constituents of concern. Drawings 2 through 10 present isoconcentration maps for the individual COC plumes and for total VOCs using the June 2016 sample event data. Based on the lack of detections of any COCs in the surface water samples SW-2 and SW-3, immediately downgradient of the impacted monitoring wells, the plume appears to be limited and contained within the facility boundary. There is no evidence of the plume either increasing or decreasing in horizontal or vertical extent since the CAP was prepared in 2014.

Charts 1 through 9 present plots of the COCs and total VOCs versus time in monitoring wells MW-2R, MW-3R, and MW-4. The concentrations of most of the COCs in most wells show downward or stable trends. 1,1-dichloroethane concentrations have shown sporadic variations with no clear trend. Vinyl chloride concentrations show slightly increasing trends in MW-2 and MW-3D, which could be related to degradation of the higher-order chlorinated VOCs. A review of Chart 9 appears to show a downward trend in total VOCs in all of the wells, although the trend in MW-3D is less clear than the others. The trends indicate that the geometric distribution of the plume and the concentrations in the plume are generally stable or decreasing. These data indicate that there have been no significant changes in the chemical or physical characteristics of the contaminant plume since 2014.

2.3 Refining the Site Conceptual Model

Any new information that comes to the attention of the facility, either from the data collected on site or other sources, which impact the site conceptual model will be reported and evaluated. This includes data on site or regional geology, hydrogeology, or other aspects of the site conceptual model. The site conceptual model will be refined in response to the new information as needed and appropriate.

The landfill is bound to the south and southwest by an unnamed tributary of East Belews Creek, and to the east by a drainage feature that flows south into the unnamed tributary. The unnamed

tributary flows to a confluence with East Belews Creek more than 2000 feet northwest of the facility property.

Historically, three surface water points [SW-1 (upstream), SW-2 (downstream), and SW-3 (midpoint)] have been sampled semiannually in conjunction with the groundwater sampling at the facility. Historical surface water sampling data indicate that groundwater discharge into the creek has not impacted the surface water; therefore, the surface water does not constitute a sensitive receptor pathway risk. If the plume migrated to impact the surface water, dilution would likely reduce the concentrations to below detectable levels with a short distance downstream.

Flora and fauna on or above the ground surface are at minimal risk, because there have been no confirmed detections of the COCs in the downstream surface water samples. Organisms suspected to be living in the subsurface at the site are at potential risk; however, soil microorganisms are known to use the organic acids and by-products of the degradation process of the groundwater plumes as a food source; therefore, the potential risk to the environment from the impacted groundwater is considered to be low. JOYCE conducted a tree surveys in June 2015 and April 2016 and no evidence of distressed vegetation or obvious impacts to wildlife were observed as a result of exposure to the contaminant plume.

As noted above, the VOC plume remains relatively unchanged, and there is no data indicating a need to modify the site conceptual model at this time.

2.4 Evaluation of the Impact of Corrective Actions

2.4.1 Contaminant Levels

Charts 1 through 9 present plots of the COCs and total VOCs versus time in monitoring wells MW-2R, MW-3R, and MW-4. The concentrations of most of the COCs in most wells show downward or stable trends. 1,1-dichloroethane concentrations have shown sporadic variations with no clear trend. Vinyl chloride concentrations show slightly increasing trends in MW-2 and MW-3D, which could be related to degradation of the higher-order chlorinated VOCs. A review of Chart 9 appears to show a downward trend in total VOCs in all of the wells, although the trend in MW-3D is less clear than the others. The trends indicate that the concentrations in the plume are generally stable or decreasing.

2.4.2 Evaluation of MNA Parameters

In accordance with the CAP for the facility, MNA baseline sampling was initiated with the November 2014 sampling event; therefore, the June 2016 sampling event was the fourth and final baseline sampling event for MNA; however, we also have MNA data from June 2014, so we have data from five events to evaluate. During the June 2016 sampling event, the full list of MNA parameters, except for sulfide, were obtained for the following wells: MW-2, MW-3S, MW-3D, and MW-4. Monitoring well MW-6 has been dry and has not been sampled since June

2014, so data that needs to be compared to background values will be compared to the June 2014 results from MW-6.

The MNA performance parameters provide insight into the microbial and biogeochemical reactions and processes that are occurring within the subsurface. In accordance with the CAP, the baseline sampling has included the following MNA performance parameters. Some of these parameters will be analyzed in the field at the time of sampling while others will be collected for laboratory analysis, as indicated in parentheses below.

- Nitrate (lab)
- Sulfate (lab)
- Sulfide (lab)
- Methane (lab)
- Ethene, Ethane (lab)
- TOC (lab)
- Alkalinity (lab)
- Chloride (lab)
- Dissolved Hydrogen (lab)
- Volatile Fatty Acids (lab)
- pH (field)
- Temperature (field)
- Conductivity (field)
- Turbidity (field)
- ORP (field)
- Ferrous Iron (field)
- Dissolved CO₂ (field)
- Dissolved Oxygen (field)

In addition, the MNA samples have been analyzed for Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). Table 6 presents a summary of all MNA parameter results between June 2014 and June 2016.

Standard MNA Parameters:

- Temperature of groundwater is used to help assess the representativeness of water samples, and to correct temperature sensitive parameters/measuring devices. Microorganisms are active over a wide temperature range, although some may become more active with increasing temperature. Temperature measurements for groundwater samples have fluctuated between 12.6 °C and 18.7 °C.
- pH is an indication of the suitability of environment to support wide range of microbial species. Activity tends to be reduced outside of pH range of 5 to 9, and anaerobic microorganisms are typically more sensitive to pH extremes. pH is also used to help assess the representativeness of the water sample taken during purging of wells. All pH measurements of groundwater at the site have been between 5.5 and 6.5.
- Conductivity of groundwater is a measure of its ability to conduct electricity. The standard unit of conductivity is micro-Siemens per centimeter (µS/cm). Conductivity measurements are used in environmental applications as a way of measuring the ionic content in water. Conductivity in downgradient wells has been fairly consistent with time, ranging from 235.5 to 347.5 µS/cm. These values are significantly higher than the 43.9 µS/cm observed in the

background well, MW-6, in June 2014. This is an indication on increased ionic content in the vicinity of the plume.

- Oxidation-Reduction Potential (ORP), also referred at as redox potential or Eh, measures whether the environment is reducing or oxidizing. Ranges from 0 to +500 mV indicate oxidizing (aerobic) environments, and ranges from -500 mV to 0 indicate reducing (anaerobic) environments. The ORP measurements have fluctuated between 18.1 and 100.3 mV in downgradient wells, and have been generally lower than the 99.1 mV observed in MW-6 in June 2014. The ORP data indicate a weakly aerobic environment in the plume, but less aerobic than the upgradient environment. Biological activity associated with natural attenuation is expected to reduce the ORP, so these data indicate ongoing biodegradation.
- Dissolved Oxygen (DO) is an indicator of aerobic versus anaerobic environments. The availability of oxygen is essential for aerobic microbes to metabolize organic contaminants, but DO > 5 mg/L is detrimental to the ability of anaerobic microbes to metabolize organic contaminants. Groundwater from downgradient wells showed fluctuations in DO concentrations over time, ranging from 0.81 to 3.92 mg/l; however, the DO concentrations were generally lower than the 3.04 mg/l observed in MW-6 in June 2014. The key observation is that there is sufficient oxygen in the plume area to facilitate biodegradation of constituents like benzene which require an anaerobic environment, but not too much oxygen to shut down anaerobic biodegradation required for most chlorinated VOCs. The decreased DO in the plume indicates ongoing aerobic biodegradation.
- Chloride is an ultimate daughter product of reductive dehalogenation, and is usually an indicator of anaerobic degradation of chlorinated hydrocarbons; however, chloride production has been documented to occur also in association with biodegradation of benzene. Chloride concentrations within the plume have consistently been an order of magnitude greater than in background well MW-6 (2.22 mg/l in June 2014), with concentrations ranging from 10-30 mg/l during this CAER period. This is a strong indication that natural attenuation is occurring.
- Nitrate and Sulfate compounds can be used as electron acceptors by reducing bacteria. Changes in concentrations may provide evidence of biological activity. At high concentrations, they may interfere with reductive pathways. In general, one would expect concentrations of nitrate and sulfate to decrease if active biodegradation is occurring. Concentrations of sulfate have been consistently lower in the wells within the plume than in the upgradient well, ranging from 1190-1870 µg/l. Concentrations of nitrate have generally been slightly lower in the wells within the plume than in the upgradient well, ranging from below the detection limit to 75 µg/l.

Extended MNA Parameters:

- Dissolved Hydrogen (DH) concentrations in anaerobic environments can be correlated with types of anaerobic activities. DH may be the limiting factor for complete dechlorination of chlorinated hydrocarbons. A concentration greater than 1 nM is considered necessary for effective reductive dehalogenation. Concentrations of DH have little impact on the aerobic degradation, such as is expected for benzene. In general, the measured DH concentrations have been between 1.1-15.0 nM in most wells; however, there have been a few anomalously high concentrations (120-320 nM). The 3600 nM detected in MW-3D in June 2016 is suspected to be erroneous. The primary conclusion is that there is more than sufficient hydrogen to support anaerobic dehalogenation of chlorinated VOCs.
- Sulfide presence may provide evidence of sulfate reduction; however, it may not be detected even if sulfate-reducing bacteria are active because it can react with various oxygenated chemical species and metals. We have no sulfide data from this site at this time.
- Alkalinity level increase may be indicative of carbon dioxide production and mineralization of organic compounds. Alkalinity has ranged from 134 to 186 mg/l in the wells within the plume, compared to only 4.6 mg/l in the upgradient well MW-6 in June 2014. This is a strong sign that natural attenuation is occurring.
- Total Organic Carbon (TOC) in significant concentrations indicates the availability of general growth substrates for microorganisms. One would expect TOC to also be higher inside the plume than outside of it. The TOC concentrations inside the plume have ranged from 0.81-10.6 mg/l, with significant fluctuations. The fluctuations make it hard to compare the results to the one datum we have for TOC in MW-6 (3.1 mg/l in June 2014); however, these data indicate that there is less organic matter in the plume area than is considered conducive to sustain biological activity.
- BTEX (the sum of benzene, toluene, ethylbenzene, and xylenes) in significant concentrations indicate the availability of general growth substrates for microorganisms. There have been no detections of toluene, ethylbenzene, or xylenes in any well in recent years, so the BTEX is simply the benzene concentration, which has ranged from ND to 6.4 µg/l. This is lower than the concentrations considered conducive to sustain biological activity.
- Biological Oxygen Demand (BOD) is based on the activities of bacteria and aerobic microorganisms which feed on organic matter in presence of oxygen. The result of a BOD test indicates the amount of water-dissolved oxygen (mg/l) consumed by microbes. In general, the higher the BOD, the higher the amount of pollution in the test sample. Typical values for pristine rivers will have BOD below 1 mg/L. Moderately polluted rivers may have a BOD value in the range of 2 to 8 mg/L. The BOD value in the background well, MW-6, was below the detection limit (ND) in June 2014. In MW-2, the BOD values ranged from ND to 5.67 mg/L; and in MW-3S, the BOD values ranged from ND to 2.00 mg/L. The BOD

values in MW-3D and MW-4 have been consistently ND. The higher values indicate heightened biological activity within the plume, which implies significant biodegradation of the BOD is occurring; however, these results have not been consistent.

- Chemical Oxygen Demand (COD) tells how much oxygen is needed to fully oxidize compounds containing carbon, hydrogen or both. As an indicator of the amount of organic pollutants found in groundwater, COD indicates the mass of oxygen consumed per liter (mg/l). The COD was ND in MW-6, and has been ND in most of the samples from within the plume; however, there have been a few higher detections (16-431 mg/l). The higher values indicate heightened biological activity within the plume, which implies significant biodegradation of the COD is occurring; however, these results have not been consistent.
- Dissolved Methane, Ethane, Ethene in groundwater can provide evidence of dechlorination of chlorinated hydrocarbons; however, methane may also indicate activity of methanogenic bacteria. Methane produced by methanogenic bacteria decomposing organic waste is common and expected in an MSW landfill. Dissolved methane has been detected consistently in MW-2 at 3.19-6.01 mg/l, and at lower concentrations (0.1-0.5 mg/l) in MW-3S, MW-3D, and MW-4. We have no methane data from the upgradient well MW-6. The higher methane in MW-2 probably indicates impact by landfill gas. Low but detectable concentrations of ethane and ethene have been detected in the plume area sporadically, but most have been ND.
- Volatile Fatty Acids (VFAs) include pyruvic acid, lactic acid, acetic acid, propionic acid, and butyric acid. Analysis of VFAs can provide insight into the types of microbial activity that are occurring. VFAs can also serve as electron donors. A few low-concentration VFAs have been detected sporadically, but they have not been consistent enough to evaluate natural attenuation processes at the facility.
- Carbon Dioxide (CO₂) is an ultimate oxidative daughter product of the biodegradation of hydrocarbons; however, carbon dioxide is also a principal constituent of landfill gas, and when landfill gas is in contact with the water table CO₂ will partition into the groundwater. CO₂ concentrations have been ranged between 35 and 125 mg/l within the plume, compared to 60 mg/l in MW-6 in June 2014. The lack of a significant difference between upgradient concentrations and concentrations in the plume indicate that this parameter is a poor indicator of natural attenuation at this site.
- Ferrous Iron (Fe²⁺) (the soluble reduced form of iron) is a nutrient and indicates the activity of iron reducing bacteria. Fe²⁺ is used as electron acceptor. Fe²⁺ has been detected in the range of ND to 0.90 mg/l during the CAER period, but was not detected in the background well MW-6 in June 2014. The weaknesses of these data show that this parameter is a poor indicator of natural attenuation at this site.

2.4.3 MNA Matrix Evaluation

The MNA parameter data were evaluated in general accordance with the United States Environmental Protection Agency's (EPA's) *Technical Protocol Manual* (EPA, 1998) to determine whether the conditions are conducive to, or whether there is evidence for anaerobic degradation of the chlorinated hydrocarbons. Specifically, the results were evaluated according to the weighted system presented in Table 2.3 of the *Technical Protocol Manual*, referred to hereafter as the Biodegradation Screening Matrix. According to this manual, a score less than 5 indicates that there is inadequate evidence for anaerobic natural attenuation, a score of 6 to 14 indicates that there is limited evidence for anaerobic natural attenuation, a score of 15 to 20 indicates that there is adequate evidence for anaerobic natural attenuation, and a score greater than 20 indicates that there is strong evidence that anaerobic natural attenuation is occurring.

The MNA evaluation was performed based on the results from the June 2016 sampling event for downgradient wells within the contaminant plume, compared where appropriate to the background well (MW-6). The Biodegradation Screening Matrix is presented in Table 7 of this report.

One difficulty in evaluation of the Screening Matrix is that the matrix assumes some compounds (such as, but not limited to methane and vinyl chloride) are daughter products of biodegradation within the plume; however, at a landfill we cannot eliminate the possibility that they may be contaminants released directly from the landfill. If we include the scores for these potential daughter products, our total score could be artificially high; on the other hand, if we exclude them, the score might be artificially low. Table 7 presents scoring results both with and without the questionable daughter product scores. The following table summarizes the scoring results from Table 7 for both options for interpreting the data.

	Points Awarded including DP	Points Awarded excluding DP
Points Awarded excluding HD	24	15

DP = Points for possible daughter products.

The scores ranged from 15 (adequate evidence of natural attenuation) to 24 (strong evidence of natural attenuation). In reality, the best score is probably in the middle of this range, indicating good evidence of natural attenuation.

2.4.4 Evaluation of Phytoremediation

Phytoremediation is the use of plants to remove, transfer or stabilize contaminants in soil or groundwater. Plants may remove contaminants from groundwater through either direct plant uptake and metabolization or by microbial degradation in the root zone. Contaminants in groundwater can be removed when plant-produced enzymes break down contaminants that enter the plant during transpiration (phytodegradation). Another method by which plants can enhance

groundwater quality is by phytoaccumulation, which is the process of uptake and storage of contaminants in the root systems. Plants may also uptake contaminants and transpire them through the leaves (phytovolatilization). Finally, plants can provide secretions that enhance microbial activity in the root zone that aid in the breakdown of contaminants (ITRC, 1999). Phytoremediation via direct uptake of groundwater contaminants has been demonstrated to be a very efficient removal mechanism for aromatic and chlorinated VOCs, such as those observed at the site.

Generally the octanol-water partition coefficient ($\log K_{ow}$) of organic contaminants must be between 1.0 and 3.5 (moderately hydrophobic organic chemicals) to be susceptible to uptake by plants. Hydrophobic chemicals ($\log K_{ow} > 3.5$) are bound too strongly to roots and soil to be translocated within the plants. Water-soluble chemicals ($\log K_{ow} < 1.0$) are neither sufficiently sorbed to roots nor actively transported through plant membranes (Briggs, et. al., 1982). The $\log K_{ow}$ of the facility's COCs are summarized below. They are all within the range to be susceptible to phytoremediation.

Constituent of Concern	Log K_{ow}
Benzene	2.13
1,1-Dichloroethane (1,1-DCA)	1.79
1,2-Dichloroethane (1,2-DCA)	1.47
cis-1,2-Dichloroethylene (c-1,2-DCE)	1.86
1,2-Dichloropropane	1.97
Tetrachloroethylene (PCE)	2.67
Trichloroethylene (TCE)	2.17
Vinyl chloride	1.50

(Compounds with $\log(K_{ow}) < 1.0$ are considered very hydrophilic; and compounds with $\log(K_{ow}) > 3.5$ are considered very hydrophobic.)

Root contact is a primary limitation on phytoremediation applicability. Remediation via plants requires that the contaminants be in contact with the root zone of the plants. Either the plants must be able to extend roots to the contaminants, or the contaminated media must be moved to within range of the plants. Rhizodegradation, which is the breakdown of an organic contaminant in soil through microbial activity that is enhanced by the presence of the root zone, is the most effective mode of phytoremediation for petroleum hydrocarbons (US-EPA, 2000).

The groundwater is extremely shallow in the vicinity of the plume, ranging from an average of 1-2 feet below ground surface in MW-2 to 8-10 feet below ground surface in MW-3S. This puts most of the plume within reach of the root systems of large trees, like poplars and sweet gums, and the shallower parts of the plume will be within reach of even the shallower root systems of small trees and shrubs. Typically, phytoremediation as a remedial technology includes selection of a plant species, planting the selected species, and possibly harvesting the plants at some time in the future; however, at this site, we believe that phytoremediation is already taking place with existing flora and site conditions.

A survey of tree species, health, and maturity present within the plume area has been conducted annually since the CAP was approved. The most recent tree surveys were conducted on June 18, 2015, and April 15, 2016. Drawings 12 and 13 show the results of the 2015 and 2016 tree surveys, respectively.

The tree surveys covered the western, southern, and eastern sides of the landfill from the edge of waste to about 20-50 feet beyond the creek. The tree surveys were divided into three areas based on similar flora assemblages. Area 1 was the east side of the landfill, Area 2 was the south side from the eastern corner to a point between MW-2 and MW-3S&D, and Area 3 was from that point westward, and partly up the west side of the landfill. All three areas are heavily wooded with abundant mature trees, young trees, and undergrowth. Area 1 is predominantly sweetgum (*Liquidambar styraciflua*), yellowwood (*Cladrastis kentukea*), and tulip poplar (*Liriodendron tulipifera*). There also were several areas of apparent wetlands observed in Area 1. Area 2 is predominantly American sycamore (*Platanus occidentalis*), with lesser amounts of tulip poplar, black willow, and sweetgum. Area 3 is predominantly tulip poplar with smaller amounts of sweetgum and black maple.

The trees and other plants present on site are expected to effectively metabolize and/or transpire observed groundwater contamination, and rhizodegradation in the root zone is expected to further remediate the groundwater. Poplars have been well-studied in phytoremediation applications (Landmeyer, 2001; Gordon, et al, 1997; Ferro, et al, 1999), and are one of the most commonly recommended trees for phytoremediation of VOCs, metals, and radionuclides. American sycamore, sweetgum, and willows have less documentation; however, they have also been used successfully in similar phytoremediation applications (McCutcheon and Schnoor, 2004; Negri and Hinchman, 2000). Other trees and herbaceous plants in and downgradient of the plume are also likely to contribute to phytoremediation. Furthermore, wetlands are among the most biologically active ecosystems, and are considered to have high potential for phytoremediation of VOCs and other contaminants (Williams, 2002). The presence of wetlands downgradient of the plume is expected to enhance phytoremediation at this site. No changes or augmentation to the phytoremediation remedy are needed at this time.

2.4.5 Impacts on Hydraulic Gradients

Based on historic groundwater elevations at this site, the average hydraulic gradient is 0.0311 ft/ft toward the southwest, with an estimated horizontal flow velocity of approximately 65 feet per year. The most recent estimate of hydraulic gradients and groundwater flow velocities are provided in Table 3 of this report and are discussed in Section 1.2.1. There is no pumping or injection associated with the corrective action at this facility; therefore, there is no impact on hydraulic gradients.

2.4.6 Contaminant Removal Efficiencies and Mass of Contaminants Removed

The CAP specifies that the EPA's BIOCHLOR Natural Attenuation Decision Support System (Version 2.2) will be used as a screening model to evaluate MNA at the Town of Kernersville Landfill facility. BIOCHLOR is an easy-to-use screening model which simulates remediation by natural attenuation of dissolved solvents at chlorinated solvent release sites (USEPA, 2002). BIOCHLOR includes three different model types:

- Solute transport without decay;
- Solute transport with biotransformation modeled as a sequential first-order decay process; and
- Solute transport with biotransformation modeled as a sequential first-order decay process with two different reaction zones (i.e., each zone has a different set of rate coefficient values).

The software, programmed in the Microsoft Excel spreadsheet environment and based on the Domenico analytical solute transport model, has the ability to simulate one-dimensional advection, three-dimensional dispersion, linear adsorption, and biotransformation via reductive dechlorination (the dominant biotransformation process at most chlorinated solvent sites). Reductive dechlorination is assumed to occur under anaerobic conditions and dissolved solvent degradation is assumed to follow a sequential first-order decay process.

BIOCHLOR modeling was run for the Town of Kernersville Landfill for the chlorinated ethylenes (PCE, TCE, DCE, & VC) based on the June 2016 concentrations in MW-2 for a simulated 10 years of biodegradation. The input and output of the BIOCHLOR modeling are presented in Appendix C and the results of the modeling are summarized below.

Constituent	Mass Removed	% Biotransformed	% Change in Mass Rate
Tetrachloroethylene (PCE)	0.043 Kg	70.9%	98.0%
Trichloroethylene (TCE)	0.198 Kg	63.3%	96.6%
Dichloroethylenes (DCE)	1.424 Kg	55.1%	90.7%
Vinyl Chloride (VC)	-1.065 Kg	-380%	-375.8%

2.5 Migration of the Contaminant Plume

2.5.1 Status of Impacts at the Compliance Boundary

No quantified detections of VOCs have been recorded in the surface water samples collected from the monitoring point SW-3, which is immediately downgradient of MW-2, nor in the upstream or downstream surface water samples (SW-1 and SW-2, respectively). Since this creek is believed to be a groundwater discharge feature, this indicates that the plume in the uppermost aquifer has not migrated beyond the creek, nor has it migrated beyond the facility boundary west of the plume. Since there are GPS exceedances in the deep well, MW-3D, the vertical extent of the plume is not fully delineated; therefore, it is possible that the plume extends into the fractured

bedrock. Groundwater flow in fractured bedrock is less predictable than in the unconsolidated regolith and saprolite, therefore, we cannot determine whether or not the plume may have migrated farther at depth in the bedrock fractures.

2.5.2 Off-Site Migration Concerns

The nearest property boundary to the plume is located approximately 135 feet west of MW-4; however, the direction of groundwater flow and therefore, plume migration is to the southwest, and the creek lies between MW-4 and the property boundary in this direction. The only COC with GPS exceedances in MW-4 is vinyl chloride, and vinyl chloride has never been detected in surface water samples from SW-2, which is near the property boundary west of MW-4. Furthermore, there have never been any quantified detections of VOCs in SW-2. This supports the contention that the plume has not migrated off site. As discussed above, we cannot determine whether or not the plume may have migrated farther at depth in the fractured bedrock; however, since there are no receptors for the bedrock aquifer, there is no significant risk. Since there is no evidence that the plume is expanding, there is no reason to expect the plume to migrate off site in the foreseeable future.

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 Changes to the COC List

Cis-1,2-dichloroethylene has not been detected in exceedance of its GPS in any monitoring well since November 2012, and the concentrations of cis-1,2-dichloroethylene appear to be stable or decreasing in all wells. On behalf of the Town of Kernersville, JOYCE recommends that cis-1,2-dichloroethylene be removed from the facility's COC list. No other changes to the COC list are recommended at this time.

3.2 Assessment of MNA Indicator Parameters

Several of the extended MNA parameters described above show limited usefulness in evaluating natural attenuation at this site. On behalf of the Town of Kernersville, JOYCE recommends and requests that the following parameters be removed from the MNA analytical requirements for this facility:

- BOD and COD – These parameters were not required by the CAP for the facility, and the results have been too inconsistent to draw any significant conclusions regarding natural attenuation at the facility. We recommend discontinuing BOD and COD analyses.
- Methane, ethane, and ethene – Dissolved ethane and ethene have been detected only sporadically. Methane has been detected consistently, but is likely from landfill gas migration rather than biodegradation of the VOCs in the groundwater. We recommend reducing the frequency of monitoring for dissolve methane, ethane, and

- ethene to twice per CAER period, during the two semiannual events immediately prior to the next and subsequent CAERs.
- Dissolved CO₂ – The lack of a significant difference between upgradient and downgradient CO₂ concentrations indicate that this parameter is a poor indicator of natural attenuation at this site. Also, the CO₂ is likely from landfill gas migration rather than biodegradation of the VOCs in the groundwater. We recommend reducing the frequency of monitoring for dissolve CO₂ to twice per CAER period, during the two semiannual events immediately prior to the next and subsequent CAERs.
 - Volatile Fatty Acids – There have been a few sporadic detections of volatile fatty acids, insufficient to assess natural attenuation. We recommend reducing the frequency of monitoring for volatile fatty acids to twice per CAER period, during the two semiannual events immediately prior to the next and subsequent CAERs.
 - Ferrous Iron (Fe²⁺) – The low, infrequent detections of ferrous iron show that this parameter is a poor indicator of natural attenuation at this site. We recommend reducing the frequency of monitoring for ferrous iron to twice per CAER period, during the two semiannual events immediately prior to the next and subsequent CAERs.

For the parameters that we are recommending a reduction in frequency to twice per CAER period, the next time these parameters will be sampled for will be the fourth quarter of 2020 and the second quarter of 2021 and the result will be reported in the 2021 CAER. Subsequently, they will be sampled for during the corresponding two semiannual events in fiscal years 2025-2026, 2030-2031, and so forth, to be reported in the corresponding CAERs.

3.3 Modifications Needed to Selected Remedy

Natural attenuation and phytoremediation will not prevent further releases of COCs from the waste unit; however, natural attenuation and phytoremediation appear to be occurring beneath the facility at a rate sufficient to keep up with migration of the plume. Evaluation of indicator parameter data and historical observations of the plume indicate that biodegradation is occurring beneath the facility at a rate that will prevent migration of contaminants beyond the property line and will reduce concentrations of constituents-of-concern within the delineated plume with time.

An evaluation of the risks posed to human health and the environment suggests that there is low risk due to the fact that groundwater contamination is contained within the facility property boundary, the adjoining property downgradient of the plume is undeveloped land, and there are no known human receptors. We conclude that MNA plus phytoremediation remains an appropriate and effective remedy for the Town of Kernersville Landfill. No changes to the CAP are recommended.

3.4 Contingency Plan

The CAP included a contingency plan in the event that MNA plus phytoremediation is shown to be ineffective at controlling migration of the contaminant plume. The contingency plan includes implementation of one of two contingency remedies:

1. Control of landfill gas through installation of passive or active gas vents or an intercept trench; or
2. Installation of a reactive barrier trench to intercept and filter the shallow groundwater plume.

At this time, MNA plus phytoremediation remains an appropriate and effective remedy for the Town of Kernersville Landfill. No contingency remedies are recommended.

3.5 Land Use Restrictions

Groundwater beneath the landfill property appears to have been impacted by leachate that originates from the unlined landfill and/or by the migration of landfill gas as evidenced by the fact that several VOCs have been detected in downgradient wells in exceedance of their respective GPS. There is no evidence that the contaminant plume has impacted the surface water in the creek or that the plume has migrated off site. The current COC plume is stable and concentrations of most COCs appear to be decreasing. Based on the data presented and discussed in this CAER, there is no need to impose land use restrictions on the landfill or adjoining property at this time.

4.0 REFERENCES

The references cited herein were used to prepare this document and may or may not be cited in the text of this report.

Briggs, G.C., Brownmilow, R.H., and Evans, A.A., “*Relationship between Lipohicity and Root Uptake and Translocation of Non-ionized Chemicals by Barley*”, Pesticide Science, Volume 13, 1982.

Espenshade, G.H., D.W. Rankin, K.Weir Shaw, and R.B. Newman, 1975. *Geologic Map of the East Half of the Winston-Salem Quadrangle, North Carolina-Virginia*. Dept. of the Interior, United States Geological Survey, Miscellaneous Investigations Series, Map I-7090B. 1975.

Ferro, A., Kennedy, J., Kjelgren, R., Rieder, J., and S. Perrin. 1999. “*Toxicity Assessment of Volatile Organic Compounds in Poplar Trees*”. International Journal of Phytoremediation. 1(1): 9-17.

- Fritsche, Wolfgang, and Hofrichter, Martin, 2008. *Aerobic Degradation by Microorganisms*, in Biotechnology: Environmental Processes II, Volume 11b, Second Edition, H. J. Rehm & G. Reed, eds. WILEY-VCH Verlag GmbH. Published Online: 20 MAR 2008.
- Gordon, M., N. Choe, J. Duffy, G. Ekuan, P. Heilman, I. Muiznieks, L. Newman, M. Ruszaj, B.B. Shurtleff, S. Strand, and J. Wilmoth. 1997. *Phytoremediation of Trichloroethylene with Hybrid Poplars*. p. 177-185. In E.L. Kruger et al. (ed.) Phytoremediation of Soil and Water Contaminants. ACS symposium series 664. American Chemical Society, Washington, DC.
- Interstate Technology and Regulatory Cooperation Work Group (ITRC). ***Phytoremediation Decision Tree***. Prepared by: ITRC Phytoremediation Work Team. November 1999. Available at <http://www.itrcweb.org>.
- Jindrová, E., M. Chocová, K. Demnerová, and V. Brenner, 2002. *Bacterial Aerobic Degradation of Benzene, Toluene, Ethylbenzene and Xylene*. Folia Microbiologica, Volume 47, Issue 2, pp 83-93, April 2002.
- Joyce Engineering, Inc. (JOYCE), 2010. *Water Quality Monitoring Plan, Town of Kernersville Landfill, Permit No. 34-04*. December 2010.
- JOYCE, 2013a. *Groundwater Assessment Plan, Town of Kernersville Landfill, Permit #34-04*. January 2013.
- JOYCE, 2013b. *Groundwater Assessment Report, Town of Kernersville Landfill, Permit #34-04*. May 2013.
- JOYCE, 2013c. *Landfill Gas Corrective Action Plan, Town of Kernersville Landfill, Permit #34-04*. September 2013.
- JOYCE, 2014. *Corrective Action Plan, Town of Kernersville Landfill, Permit #34-04*. October 2014.
- Miller, R. ***Phytoremediation, Technology Overview Report***. Ground-Water Remediation Technologies Analysis Center (GWRTAC), available at <http://ww.gwrtac.org>
- North Carolina Department of Environment, Health, and Natural Resources (NCDENR), 2011. North Carolina Solid Waste Management Rules. 15 NCAC 13B. Amended April 2011.
- NCDENR, 2007. North Carolina Solid Waste Section Guidelines for Corrective Action at Solid Waste Management Facilities. March 2007.

NRC, 2000. *Natural Attenuation for Groundwater Remediation*. National Academy Press, Washington, D.C. pp. 108-111.

Schnoor, J. *Phytoremediation, Technology Evaluation Report*. GWRTAC. Available at <http://ww.gwrtac.org>.

United States Environmental Protection Agency (US-EPA), 1992. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance*. July 1992.

US-EPA, 1998. *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*. ORD, EPA/600/R-98/128. September 1998.

USEPA and U.S. Air Force (USAF), 1993. *Remediation Technologies Screening Matrix Reference Guide, Version I*. Joint Project of OSWER and Envirionics Directorate, PB93-2118212. July 1993.

USEPA, 1999. *Phytoremediation Resource Guide*, EPA 542-B-99-003. June 1999. Available at <http://www.epa.gov/tio>.

USEPA, 2000. *Introduction to Phytoremediation*, EPA 600-R-99-107. February 2000. Available at <http://www.epa.gov/tio>.

USEPA, 2002. *BIOCHLOR Natural Attenuation Decision Support System, Version 2.2, User's Manual*. (Carol E. Aziz, Charles J. Newell, and James R. Gonzales.) March 2002.

USEPA, 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance*. March 2009.

Williams, John B., 2002. *Phytoremediation in Wetland Ecosystems: Progress, Problems, and Potential*. Critical Reviews in Plant Sciences, Volume 21, Issue 6, 2002.

5.0 ACRONYMS

ACM	Assessment of Corrective Measures (report)
AOC	Area of Concern
C&D	Construction and Demolition Waste
CAP	Corrective Action Plan (report)
CAER	Corrective Action Evaluation Report (report)
COC	Contaminant of Concern
DENR	See NCDENR
DEQ	See NCDEQ
DL	Detection Limit (for laboratory data)

DO	Dissolved Oxygen
EPA	(or USEPA) United States Environmental Protection Agency
GPS	Groundwater Protection Standards (per 15A NCAC 13B.1634.g)
GWPS	SWS Groundwater protection Standards (for constituents with noNC2L)
HASP	Site-specific Health and Safety Plan
JOYCE	Joyce Engineering, Inc.
LFG	Landfill Gas
LEL	Lower Explosive Limit
MNA	Monitored Natural Attenuation
MSW	Municipal Solid Waste
MW	Monitoring Well
NC2B	North Carolina Surface Water Standards found in 15A NCAC 2B.0101
NC2L	North Carolina Groundwater Standards found in 15A NCAC 2L.0202
NCAC	North Carolina Administrative Code
NCDENR	North Carolina Department of Environment and Natural Resources (now NCDEQ)
NCDEQ	North Carolina Department of Environmental Quality (formerly NCDENR)
NCSWMR	North Carolina Solid Waste Management Regulations (15A NCAC 13B.1600)
ND	Not detected (for laboratory data)
NES	Nature and Extent Study (report)
O&M	Operations and Maintenance
OSHA	Occupational Health and Safety Association
PVC	Poly Vinyl Chloride
QL	Quantitation Limit (for laboratory data)
QRA	Quantitative Risk Assessment (report)
RA	Risk Assessment (report)
RL	Reporting Limit (for laboratory data)
SWQS	Surface Water Quality Standards
SWS	NCDENR/NCDEQ Division of Waste Management, Solid Waste Section
SWSL	North Carolina Solid Waste Section Reporting Limits (for laboratory data)
VOC	Volatile Organic Compound
WQMP	Water Quality Monitoring Plan (report)

TABLES

TABLE 1: Monitoirng Well Construction Data

WELL ID	CASING DIAMETER inches	WELL ELEVATIONS		TOTAL DEPTH		SCREENED INTERVAL*				LITHOLOGY OF SCREENED INTERVAL*
		GROUND SURFACE	TOC	Feet-BGS	Feet-BTOC	DEPTH (Feet-BTOC)		ELEV. (Feet-AMSL)		
						from	to	from	to	
		Feet-AMSL								
MW-1	2	803.89	806.42	32.16	34.69	24.69	34.69	779.2	769.2	SAPROLITE
MW-2	2	760.07	762.19	11.06	13.18	3.18	13.18	756.9	746.9	SAPROLITE
MW-3S	2	761.98	764.57	21.41	24.00	14.00	24.00	748.0	738.0	SAPROLITE
MW-3D	2	762.02	764.56	54.42	56.96	36.96	56.96	725.1	705.1	SAPROLITE
MW-4	2	757.00	760.26	11.14	14.40	4.40	14.40	752.6	742.6	SAPROLITE
MW-5	2	771.00	773.32	9.04	11.36	6.36	11.36	764.6	759.6	SAPROLITE
MW-6	2	801.77	804.87	17.36	20.46	10.46	20.46	791.3	781.3	SAPROLITE

NOTES:

- TOC Top of PVC Well Casing
- Feet-BGS Feet Below Ground Surface
- Feet-TOC Feet Below Top of Casing
- Feet-AMSL Feet Above Mean Sea Level

* Due to limited information, this data is assumed based on field conditions.

TABLE 2: Historical Groundwater Elevations

Well ID:	Background		Downgradient				
	MW-1	MW-6	MW-2	MW-3S	MW-3D	MW-4	MW-5
TOC Elevation:	806.42	804.87	762.19	764.57	764.56	760.26	773.32
Well Depth:	34.69	20.46	13.18	24.00	56.96	14.40	11.36
30-Dec-09	772.45	786.66	759.16	751.54	752.79	754.33	769.21
01-Jun-10	773.45	788.32	758.90	750.76	752.63	753.90	769.69
16-Nov-10	773.55	787.93	759.14	750.98	752.59	753.74	769.81
29-Dec-10	773.29	787.37	758.83	749.82	752.45	753.68	769.56
29-Jun-11	773.10	786.81	758.38	750.54	752.16	753.41	769.73
01-Nov-11	771.92	785.10	758.49	754.73	751.90	753.08	769.63
01-May-12	771.88	785.32	758.54	750.86	752.34	753.55	769.55
07-Nov-12	771.65	DRY	758.20	750.30	751.61	752.87	768.57
09-May-13	769.95	787.56	759.20	752.52	753.24	754.44	-
07-Nov-13	771.46	DRY	758.09	750.12	751.50	752.79	768.13
05-Jun-14	772.22	785.84	758.45	750.67	752.14	753.36	768.57
20-Nov-14	771.73	784.41	758.08	750.24	751.53	752.81	769.23
27-Apr-15	-	784.66	758.49	751.11	752.34	753.61	769.62
19-Nov-15	-	784.62	757.18	747.60	750.53	750.66	768.69
28-Jun-16	-	784.55	757.34	750.32	751.01	753.33	768.69

Notes:

TOC = Top of PVC well casing.

Elevations in feet above mean sea level. Well depths in feet below TOC.

TABLE 3: Estimated Hydraulic Gradient and Flow Velocity

Date of Water Table Measurements:		June 28, 2016					
FLOW LINE SEGMENT	SEGMENT LENGTH (feet)	FLOW DIRECTION	SEGMENT BEGIN & END GW ELEVATION (feet-AMSL)	HORIZ. GRADIENT i (ft/ft)	HYDRAULIC CONDUCTIVITY K (ft/day)	EFFECTIVE POROSITY n_e	LINEAR VELOCITY V (ft/year)
i_1	805	SW	785	0.0311	1.73E+00	0.30	65.4
			760				

Notes:

For Flow Line Segment, see Drawing 1.

Linear flow velocity: $V = Ki/n_e$ (modified Darcy equation).

Hydraulic conductivity (K) was estimated from slug tests completed by JOYCE in April 2013

Effective porosity (n_e) estimated based on typical values for saprolite in the North Carolina Piedmont.

Assumes a homogeneous, isotropic, porous aquifer

TABLE 4: Historical Exceedances of Groundwater Standards for Organic Constituents

Analyte	Sample Date	Background MW-6	Downgradient							
			MW-2	MW-3S	MW-3D	MW-4	MW-5			
Benzene NC 2L = 1 µg/L (10/23/07)	30-Dec-09	ND	8.4	0.3	J	0.4	J	0.3	J	---
	01-Jun-10	ND	2.9	ND	ND	ND	ND	ND	---	---
	29-Dec-10	ND	8.1	ND	ND	ND	ND	ND	---	ND
	29-Jun-11	ND	7.2	0.38	J	0.45	J	0.42	J	ND
	01-Nov-11	ND	8.6	ND	ND	ND	ND	ND	---	ND
	01-May-12	ND	6.7	0.36	J	0.45	J	0.42	J	ND
	07-Nov-12	---	8.63	0.430	J	0.504	J	0.478	J	---
	09-May-13	ND	5.2	0.27	J	0.32	J	0.30	J	---
	07-Nov-13	---	6.9	0.33	J	0.38	J	0.39	J	---
	05-Jun-14	ND	6.0	ND	0.42	J	0.40	J	ND	ND
	20-Nov-14	---	6.2	0.30	J	ND	0.32	J	ND	ND
	27-Apr-15	---	6.4	0.38	J	0.48	J	0.45	J	ND
	19-Nov-15	---	6.0	ND	0.37	J	ND	ND	ND	ND
	28-Jun-16	---	4.9	ND	ND	ND	ND	ND	ND	ND
	1,1-Dichloroethane NC 2L = 6 µg/L (1/11/10)	30-Dec-09	ND	22.8	1.9	J	4.0	J	2.4	J
01-Jun-10		ND	11.0	1.1	J	ND	ND	1.2	J	---
29-Dec-10		ND	28.2	2.4	J	4.1	J	2.6	J	ND
29-Jun-11		ND	25.0	2.5	J	3.9	J	2.6	J	ND
01-Nov-11		ND	27.2	2.3	J	4.0	J	2.3	J	ND
01-May-12		ND	22.6	2.0	J	3.8	J	2.0	J	ND
07-Nov-12		---	28.1	2.06	J	4.08	J	ND	---	---
09-May-13		ND	18.7	1.4	J	3.0	J	1.6	J	---
07-Nov-13		---	26.6	1.7	J	4.2	J	2.2	J	---
05-Jun-14		ND	21.9	1.4	J	3.9	J	1.9	J	ND
20-Nov-14		---	21.5	1.3	J	3.2	J	1.8	J	ND
27-Apr-15		---	24.2	1.4	J	4.3	J	2.4	J	ND
19-Nov-15		---	20.7	0.82	J	3.1	J	1.8	J	ND
28-Jun-16		---	19.1	0.90	J	3.3	J	1.9	J	ND
1,2-Dichloroethane NC 2L = 0.4 µg/L (1/11/10)		30-Dec-09	ND	1.2	0.7	J	1.2	ND	ND	---
	01-Jun-10	ND	ND	ND	ND	ND	ND	ND	---	---
	29-Dec-10	ND	ND	0.82	J	1.1	ND	ND	---	ND
	29-Jun-11	ND	0.76	J	0.86	J	1.3	ND	---	ND
	01-Nov-11	ND	0.95	J	ND	1.3	ND	ND	---	ND
	01-May-12	ND	0.71	J	0.70	J	1.1	ND	---	ND
	07-Nov-12	---	ND	ND	ND	ND	ND	ND	---	---
	09-May-13	ND	0.50	J	0.49	J	0.81	J	ND	---
	07-Nov-13	---	0.93	J	0.66	J	1.3	ND	---	---
	05-Jun-14	ND	0.76	J	0.52	J	0.99	J	ND	ND
	20-Nov-14	---	0.68	J	0.47	J	0.81	J	ND	ND
	27-Apr-15	---	ND	0.56	J	1.2	0.15	J	ND	ND
	19-Nov-15	---	0.86	J	0.40	J	1.1	ND	ND	ND
	28-Jun-16	---	0.76	J	0.29	J	0.89	J	ND	ND
	cis-1,2-Dichloroethene NC 2L = 70 µg/L (10/23/07)	30-Dec-09	ND	68.2	11.0	51.0	21.8	---	---	---
01-Jun-10		ND	23.0	7.6	ND	10.2	---	---	---	
29-Dec-10		ND	66.7	16.8	56.7	24.1	---	---	ND	
29-Jun-11		ND	55.1	16.5	62.7	25.1	---	---	ND	
01-Nov-11		ND	59.4	15.2	59.3	23.2	---	---	ND	
01-May-12		ND	{48.7}	14.2	59.5	22.1	---	---	ND	
07-Nov-12		---	59.7	13.6	71.3	26.4	---	---	---	
09-May-13		ND	39.9	10.9	49.7	17.4	---	---	---	
07-Nov-13		---	53.9	10.7	67.1	21.8	---	---	---	
05-Jun-14		ND	47.0	11.2	58.1	20.0	---	---	ND	
20-Nov-14		---	44.9	9.6	55.4	19.3	---	---	ND	
27-Apr-15		---	51.8	9.7	65.3	24.0	---	---	ND	
19-Nov-15		---	44.4	5.6	51.2	18.8	---	---	ND	
28-Jun-16		---	42.4	7.5	53.2	19.5	---	---	ND	

TABLE 4: Historical Exceedances of Groundwater Standards for Organic Constituents

1,2-Dichloropropane NC 2L = 0.6 µg/L (1/11/10)	30-Dec-09	ND	5.7	0.6	J	1.1	0.7	J	---	
	01-Jun-10	ND	1.9	ND		ND	ND		---	
	29-Dec-10	ND	5.3	ND		ND	ND		ND	
	29-Jun-11	ND	4.8	0.90	J	1.3	0.73	J	ND	
	01-Nov-11	ND	4.9	0.76	J	1.3	ND		ND	
	01-May-12	ND	4.4	0.76	J	1.4	0.62	J	ND	
	07-Nov-12	---	4.93	ND		1.66	ND		---	
	09-May-13	ND	3.3	0.51	J	0.96	J	0.45	J	---
	07-Nov-13	---	4.4	0.63	J	1.3	0.57	J	---	
	05-Jun-14	ND	4.0	0.51	J	ND	0.41	J	ND	
	20-Nov-14	---	4.1	0.56	J	1.2	0.36	J	ND	
	27-Apr-15	---	4.8	0.59	J	1.6	0.57	J	ND	
	19-Nov-15	---	4.3	ND		1.1	ND		ND	
	28-Jun-16	---	4.3	ND		1.2	ND		ND	
	Tetrachloroethene NC 2L = 0.7 µg/L (10/23/07)	30-Dec-09	ND	1.2	ND		ND	ND		---
01-Jun-10		ND	1.4	ND		ND	ND		---	
29-Dec-10		ND	2.8	ND		ND	ND		ND	
29-Jun-11		ND	3.6	ND		ND	ND		ND	
01-Nov-11		ND	2.9	ND		ND	ND		ND	
01-May-12		ND	3.0	ND		ND	ND		ND	
07-Nov-12		---	2.52	ND		ND	ND		---	
09-May-13		ND	1.9	ND		ND	ND		---	
07-Nov-13		---	1.8	ND		ND	ND		---	
05-Jun-14		ND	2.3	ND		ND	ND		ND	
20-Nov-14		---	1.1	ND		ND	ND		ND	
27-Apr-15		---	1.4	ND		ND	ND		ND	
19-Nov-15		---	0.90	J	ND	ND	ND		ND	
28-Jun-16		---	1.0		ND	ND	ND		ND	
Trichloroethene NC 2L = 3 µg/L (1/11/10)		30-Dec-09	ND	8.0	ND		ND	0.2	J	---
	01-Jun-10	ND	6.4	ND		ND	ND		---	
	29-Dec-10	ND	10.1	ND		ND	ND		ND	
	29-Jun-11	ND	14.6	ND		ND	ND		ND	
	01-Nov-11	ND	10.2	ND		ND	ND		ND	
	01-May-12	ND	11.6	ND		ND	ND		ND	
	07-Nov-12	---	9.97	ND		ND	ND		---	
	09-May-13	ND	8.4	ND		ND	ND		---	
	07-Nov-13	---	8.0	ND		ND	ND		---	
	05-Jun-14	ND	8.9	ND		ND	ND		ND	
	20-Nov-14	---	5.1	ND		ND	ND		ND	
	27-Apr-15	---	7.1	ND		ND	ND		ND	
	19-Nov-15	---	4.7	ND		ND	ND		ND	
	28-Jun-16	---	4.9	ND		ND	ND		ND	
	Vinyl chloride NC 2L = 0.03 µg/L (1/11/10)	30-Dec-09	ND	4.0	2.8		4.1	26.2		---
01-Jun-10		ND	2.2	3.0		ND	26.7		---	
29-Dec-10		ND	3.5	2.4		4.7	25.6		ND	
29-Jun-11		ND	2.8	2.8		4.6	28.7		ND	
01-Nov-11		ND	5.1	2.6		6.9	24.0		ND	
01-May-12		ND	3.5	2.0		4.8	21.8		ND	
07-Nov-12		---	7.94	2.73		6.99	29.9		---	
09-May-13		ND	2.8	1.9		4.2	18.6		---	
07-Nov-13		---	6.3	2.1		6.0	21.9		---	
05-Jun-14		ND	7.1	5.6		8.9	21.9		ND	
20-Nov-14		---	5.2	2.1		5.3	16.2		ND	
27-Apr-15		---	5.3	2.4		7.1	21.4		ND	
19-Nov-15		---	7.7	2.0		6.7	17.3		ND	
28-Jun-16		---	4.6	2.3		6.1	17.0		ND	

Notes:

All concentrations are in micrograms per liter (µg/l)

NC 2L Standard is the groundwater quality standard established under 15A NCAC 2L

GWPS = Groundwater Protection Standard (GWPS is used when the NC 2L Standard has not been established.

ND = Not detected at the laboratory's detection limit

J = Estimated value - concentration is less than the reporting limit but greater than the detection limit

B = Blank-qualified data - the concentration is within five times the concentration reported in associated quality control blank

--- = Monitoring well was not sampled

Bold values are greater than the NC 2L Standard or GWPS

TABLE 5: Histroic GPS Exceedancnes for Inorganic Constituents

Analyte	Sample Date	MW-6	MW-2	MW-3S	MW-3D	MW-4	MW-5
Cadmium NC 2L = 2 µg/L (1/11/10)	30-Dec-09	ND	0.5 J	5.6	ND	ND	---
	01-Jun-10	2.9	1.0 B	5.3	0.4 B	0.4 B	---
	29-Dec-10	ND	ND	ND	ND	ND	ND
	29-Jun-11	ND	ND	ND	ND	ND	ND
	01-Nov-11	ND	ND	ND	ND	ND	ND
	01-May-12	ND	ND	ND	ND	ND	ND
	07-Nov-12	---	0.15 J	ND	ND	0.043 J	---
	09-May-13	ND	ND	ND	ND	ND	---
	07-Nov-13	---	ND	ND	ND	ND	---
	05-Jun-14	ND	ND	ND	ND	ND	ND
	20-Nov-14	---	ND	ND	ND	ND	ND
	27-Apr-15	---	ND	ND	ND	ND	ND
	19-Nov-15	---	ND	ND	ND	ND	ND
	28-Jun-16	---	ND	2.6	ND	ND	ND
Chromium NC 2L = 10 µg/L (1/11/10)	30-Dec-09	ND	2.7 J	9.7 J	ND	3.1 J	---
	01-Jun-10	3.5 J	1.6 J	12.4	1.2 J	3.2 J	---
	29-Dec-10	0.48 J	1.3 J	0.57 J	ND	5.5 J	3.8 J
	29-Jun-11	ND	ND	ND	ND	ND	ND
	01-Nov-11	ND	ND	ND	ND	10.3	ND
	01-May-12	ND	ND	ND	ND	5.8 J	ND
	07-Nov-12	---	0.71 J	0.12 B	0.094 B	7.31 J	---
	09-May-13	ND	ND	ND	ND	ND	---
	07-Nov-13	---	ND	ND	ND	ND	---
	05-Jun-14	ND	ND	ND	ND	ND	ND
	20-Nov-14	---	ND	ND	ND	ND	ND
	27-Apr-15	---	ND	ND	ND	7.2 J	ND
	19-Nov-15	---	ND	ND	ND	3.0 J	ND
	28-Jun-16	---	ND	11.9	ND	5.0 J	ND
Cobalt GWPS = 70 µg/L (10/23/07) GWPS = 1 µg/L (10/1/10)	30-Dec-09	ND	6.4 J	11.2	ND	1.8 J	---
	01-Jun-10	1.8 J	2.5 J	8.5 J	ND	1.7 J	---
	29-Dec-10	ND	4.9 J	1.7 J	ND	1.6 J	10.2
	29-Jun-11	ND	ND	ND	ND	ND	9.9 J
	01-Nov-11	ND	ND	ND	ND	ND	5.2 J
	01-May-12	ND	ND	ND	ND	ND	13.9
	07-Nov-12	---	1.98 J	3.89 J	0.43 B	2.02 J	---
	09-May-13	ND	ND	ND	ND	ND	---
	07-Nov-13	---	ND	ND	ND	ND	---
	05-Jun-14	ND	ND	ND	ND	ND	12.0
	20-Nov-14	---	ND	2.5 J	ND	ND	10.2
	27-Apr-15	---	ND	2.7 J	ND	ND	10.7
	19-Nov-15	---	ND	3.9 J	ND	ND	3.5 J
	28-Jun-16	---	ND	8.7 J	ND	2.6 J	23.0
Lead NC 2L = 15 µg/L (10/23/07)	30-Dec-09	ND	ND	10.2	ND	ND	---
	01-Jun-10	9.1 B	8.2 B	8.7 B	3.0 B	3.9 B	---
	29-Dec-10	ND	ND	ND	ND	ND	6.5 J
	29-Jun-11	ND	ND	ND	ND	ND	19.9
	01-Nov-11	5.5 J	ND	ND	ND	ND	ND
	01-May-12	ND	ND	ND	ND	ND	ND
	07-Nov-12	---	1.00 B	0.091 B	0.066 B	1.12 B	---
	09-May-13	ND	ND	ND	ND	ND	---
	07-Nov-13	---	ND	ND	ND	ND	---
	05-Jun-14	ND	ND	ND	ND	ND	ND
	20-Nov-14	---	ND	ND	ND	ND	4.2 J
	27-Apr-15	---	ND	ND	ND	ND	ND
	19-Nov-15	---	ND	ND	ND	ND	ND
	28-Jun-16	---	ND	6.3 J	ND	3.7 J	ND

TABLE 5: Histroic GPS Exceedancnes for Inorganic Constituents

Analyte	Sample Date	MW-6	MW-2	MW-3S	MW-3D	MW-4	MW-5						
Thallium GWPS = 0.28 µg/L (10/23/07) GWPS = 0.2 µg/L (10/1/10)	30-Dec-09	ND	ND	ND	ND	ND	---						
	01-Jun-10	ND	ND	ND	ND	ND	---						
	29-Dec-10	ND	3.2	J	ND	ND	4.8 J ND						
	29-Jun-11	ND	ND	ND	ND	ND	ND						
	01-Nov-11	ND	ND	ND	ND	ND	ND						
	01-May-12	ND	ND	ND	ND	ND	ND						
	07-Nov-12	---	0.16	J	ND	ND	0.76 J ---						
	09-May-13	ND	ND	ND	ND	ND	---						
	07-Nov-13	---	ND	ND	ND	ND	---						
	05-Jun-14	ND	ND	ND	ND	ND	ND						
	20-Nov-14	---	ND	ND	ND	ND	ND						
	27-Apr-15	---	ND	ND	ND	ND	ND						
	19-Nov-15	---	ND	ND	8.8	8.8	ND						
	28-Jun-16	---	ND	ND	ND	ND	ND						
Vanadium GWPS = 3.5 µg/L (10/23/07) GWPS = 0.3 µg/L (10/1/10)	30-Dec-09	ND	1.4	J	37.4	1.5	J	4.3	J	---			
	01-Jun-10	1.2	J	3.4	J	84.2	1.4	J	4.8	J	---		
	29-Dec-10	1.2	B	2.8	J	2.3	J	1.6	J	5.5	J	14.5	J
	29-Jun-11	ND		ND		ND		ND		ND		22.0	J
	01-Nov-11	7.2	J	ND		ND		ND		12.0	J	7.2	J
	01-May-12	ND		ND		ND		ND		7.2	J	7.6	J
	07-Nov-12	---		2.48	J	2.02	J	2.35	J	4.55	J	---	
	09-May-13	ND		ND		ND		ND		ND		---	
	07-Nov-13	---		ND		ND		ND		ND		---	
	05-Jun-14	ND		ND		11.4	J	ND		ND		ND	
	20-Nov-14	---		ND		3.2	J	ND		ND		9.4	J
	27-Apr-15	---		ND		ND		ND		8.9	J	5.6	J
	19-Nov-15	---		3.1	J	4.3	J	ND		6.5	J	3.9	J
	28-Jun-16	---		ND		45.2		ND		6.8	J	7.6	J

Notes:

All concentrations are in micrograms per liter (µg/l).

NC 2L Standard is the groundwater quality standard established under 15A NCAC 2L.

GWPS = Groundwater Protection Standard (GWPS is used when the NC 2L Standard has not been established.)

ND = Not detected at the laboratory's detection limit.

J = Estimated value - concentration is less than the reporting limit but greater than the detection limit.

B = Blank-qualified data - the concentration is within five times the concentration reported in associated quality control blanks.

--- = Monitoring well was not sampled.

Bold values are greater than the NC 2L Standard or GWPS.

TABLE 6: Recent and Historical MNA Parameters

Analyte	Sample Date	DL	RL	Background		Downgradient				
				MW-6		MW-2	MW-3S	MW-3D	MW-4	
Alkalinity, Total as CaCO ₃ (µg/l)	5-Jun-14	1,000	5,000	4,600	J	148,000	147,000	160,000	186,000	
	20-Nov-14	1,000	5,000	---		159,000	151,000	159,000	181,000	
	15-Apr-15	1,000	5,000	---		141,000	134,000	146,000	166,000	
	19-Nov-15	1,000	5,000	---		158,000	147,000	158,000	185,000	
	29-Jun-16	1,000	5,000	---		135,000	142,000	148,000	165,000	
Sulfate (µg/l)	5-Jun-14	2,000	250,000	6,500	J	ND	ND	ND	ND	
	20-Nov-14	1,000	250,000	---		1760	J 1730	J 1870	J 1560	J
	15-Apr-15	1,000	250,000	---		ND	ND	ND	ND	
	19-Nov-15	1,000	250,000	---		1190	J 1360	J 1520	J 1240	J
	29-Jun-16	1,000	250,000	---		1390	J 1750	J 1740	J 1400	J
Nitrogen, Nitrate (µg/l)	5-Jun-14	20.0	1,000	72.0	J	56	J ND	ND	ND	
	20-Nov-14	10.0	1,000	---		45	J ND	ND	ND	
	15-Apr-15	10.0	1,000	---		ND	ND	ND	ND	
	19-Nov-15	10.0	1,000	---		69.4	J 15.8	J 13.1	J 19.1	J
	29-Jun-16	10.0	10,000	---		74.9	J ND	ND	ND	
Ethene (µg/l)	14-Jun-14	0.47	10	ND		ND	ND	ND	ND	
	14-Nov-14	0.47	10	---		ND	ND	ND	ND	
	15-Apr-15	0.47	10	---		ND	ND	ND	4.1	J
	15-Nov-15	0.47	10	---		ND	ND	ND	ND	
	29-Jun-16	0.77	10	---		ND	ND	ND	2.6	J
Ethane (µg/l)	14-Jun-14	5.0	10	ND		ND	ND	ND	ND	
	14-Nov-14	5.0	10	---		ND	ND	ND	ND	
	15-Apr-15	5.0	10	---		ND	ND	ND	ND	
	15-Nov-15	5.0	10	---		ND	ND	ND	ND	
	29-Jun-16	0.87	10	---		ND	1.7	J ND	ND	
Methane (µg/l)	5-Jun-14	3.3	6.6	ND		5,530	254	242	515	
	20-Nov-14	3.3	6.6	---		4,980	159	182	186	
	15-Apr-15	3.3	6.6	---		4,160	178	188	536	
	19-Nov-15	3.3	6.0	---		6,010	220	160	3	J
	29-Jun-16	0.5	10	---		3,190	164	128	376	
Chloride (µg/l)	5-Jun-14	1,000	1,000	2,220		11,200	25,900	16,800	15,600	
	20-Nov-14	500	1,000	---		17,100	27,900	17,300	17,100	
	15-Apr-15	500	1,000	---		12,200	26,900	17,200	17,000	
	19-Nov-15	500	1,000	---		16,300	27,800	17,400	16,900	
	29-Jun-16	500	1,000	---		10,600	30,700	18,900	18,400	
Total Organic Carbon (µg/l)	5-Jun-14	1,000	1,000	3,100		10,600	8,300	1,500	8,200	
	20-Nov-14	500	1,000	---		2,150	1,750	1,370	1,100	
	15-Apr-15	500	1,000	---		1,510	1,720	1,380	1,630	
	19-Nov-15	500	1,000	---		889	J 1,210	ND	1,900	
	29-Jun-16	500	1,000	---		1,080	2,870	810	J 1,480	
BTEX (µg/l)	5-Jun-14	---	---	ND		6.0	ND	0.42	0.40	
	20-Nov-14	---	---	---		6.2	0.30	ND	0.32	
	15-Apr-15	---	---	---		6.4	0.38	0.48	0.45	
	19-Nov-15	---	---	---		6.0	ND	0.37	ND	
	29-Jun-16	---	---	---		4.9	ND	ND	ND	
Dissolved Hydrogen (nM)	5-Jun-14	0.13	0.6	---		1.5	1.2	120	3.5	
	20-Nov-14	0.13	0.6	---		2.0	1.1	4.4	1.4	
	15-Apr-15	0.13	0.6	---		2.3	1.4	320	4.4	
	19-Nov-15	0.13	0.6	---		1.9	1.4	7.4	1.4	
	29-Jun-16	0.08	0.6	---		8.8	280	3,600	15	

TABLE 6: Recent and Historical MNA Parameters

Analyte	Sample Date	DL	RL	Background	Downgradient			
				MW-6	MW-2	MW-3S	MW-3D	MW-4
Biological Oxygen Demand (BOD, 5 day) (µg/l)	5-Jun-14	2,000	2,000	ND	ND	ND	ND	ND
	20-Nov-14	2,000	2,000	---	4,900	ND	ND	ND
	15-Apr-15	2,000	2,000	---	5,670	ND	ND	ND
	19-Nov-15	2,000	2,000	---	5,000	ND	ND	ND
	29-Jun-16	2,000	2,000	---	ND	2,000	ND	ND
Chemical Oxygen Demand (COD) (µg/l)	5-Jun-14	12,500	25,000	ND	ND	ND	ND	ND
	20-Nov-14	12,500	25,000	---	ND	ND	431,000	ND
	15-Apr-15	12,500	25,000	---	ND	ND	ND	ND
	19-Nov-15	12,500	25,000	---	ND	ND	ND	16,000 J
	29-Jun-16	12,500	25,000	---	ND	17,000 J	ND	17,000 J
Acetic Acid (µg/l)	14-Jun-14	890	5,000	ND	ND	ND	ND	ND
	14-Nov-14	890	5,000	---	ND	ND	ND	ND
	15-Apr-15	890	5,000	---	2,500 J	ND	1,700 J	ND
	19-Nov-15	160	200	---	ND	ND	ND	ND
	29-Jun-16	330	5,000	---	ND	ND	ND	500 J
Propionic Acid (µg/l)	14-Jun-14	730	5,000	ND	ND	ND	ND	ND
	14-Nov-14	730	5,000	---	ND	ND	ND	ND
	15-Apr-15	730	5,000	---	750 J	ND	ND	ND
	19-Nov-15	65	100	---	ND	ND	ND	ND
	29-Jun-16	52	5,000	---	ND	ND	ND	ND
Total Volatile Fatty Acids (µg/l) <i>(Sum of above two acids)</i>	14-Jun-14	---	---	ND	ND	ND	ND	ND
	14-Nov-14	---	---	---	ND	ND	ND	ND
	15-Apr-15	---	---	---	3,250 J	ND	1,700 J	ND
	19-Nov-15	---	---	---	ND	ND	ND	ND
	29-Jun-16	---	---	---	ND	ND	ND	500 J
Ferrous Iron (mg/l)	14-Jun-14	---	---	ND	---	ND	ND	0.90
	14-Nov-14	---	---	---	0.50	ND	ND	0.50
	15-Apr-15	---	---	---	0.50	0.20	ND	0.70
	19-Nov-15	---	---	---	0.50	ND	ND	0.50
	28-Jun-16	---	---	---	ND	ND	ND	0.50
Oxidation Reduction Potential (mV)	14-Jun-14	---	---	99.1	92.6	65.7	15.4	38.3
	14-Nov-14	---	---	---	53.2	18.1	65.7	59.1
	15-Apr-15	---	---	---	55.9	31.3	43.9	41.5
	19-Nov-15	---	---	---	100.3	57.6	29.4	34.5
	28-Jun-16	---	---	---	51.6	43.4	17.9	38.5
pH (S.U.)	14-Jun-14	---	---	6.46	5.56	6.62	6.05	6.41
	14-Nov-14	---	---	---	6.26	6.37	6.34	6.42
	15-Apr-15	---	---	---	6.12	6.35	6.29	6.46
	19-Nov-15	---	---	---	6.03	6.15	6.06	6.45
	28-Jun-16	---	---	---	5.54	5.80	5.81	5.84
Temperature (°C)	14-Jun-14	---	---	18.1	15.2	18.7	16.5	17.4
	14-Nov-14	---	---	---	15.9	15.0	14.0	14.3
	15-Apr-15	---	---	---	13.6	14.7	15.9	12.6
	19-Nov-15	---	---	---	17.1	16.0	15.8	16.0
	28-Jun-16	---	---	---	16.4	15.4	15.8	15.0

TABLE 6: Recent and Historical MNA Parameters

Analyte	Sample Date	DL	RL	Background	Downgradient			
				MW-6	MW-2	MW-3S	MW-3D	MW-4
Turbidity (NTU)	14-Jun-14	---	---	103.8	13.05	11.5	8.01	4.35
	14-Nov-14	---	---	---	9.78	30.1	20.1	6.71
	15-Apr-15	---	---	---	14.85	6.88	9.55	15.0
	19-Nov-15	---	---	---	4.4	20.7	7.00	7.72
	28-Jun-16	---	---	---	3.23	15.8	5.17	9.68
Conductivity (μ S/cm)	14-Jun-14	---	---	43.9	268.7	335.4	315.4	347.5
	14-Nov-14	---	---	---	296.5	309.6	235.5	315.1
	15-Apr-15	---	---	---	252.1	288.5	289.7	292.2
	19-Nov-15	---	---	---	293.1	301.5	294.7	320.4
	28-Jun-16	---	---	---	256.1	321.4	298.1	319.2
Dissolved Oxygen (mg/l)	14-Jun-14	---	---	3.04	2.11	1.89	1.31	1.84
	14-Nov-14	---	---	---	2.91	1.79	3.35	2.35
	15-Apr-15	---	---	---	2.40	1.38	1.64	2.04
	19-Nov-15	---	---	---	1.85	2.49	0.81	3.92
	28-Jun-16	---	---	---	2.20	2.41	2.81	2.75
Dissolved Carbon Dioxide (mg/l)	14-Jun-14	---	---	60	---	55	80	115
	14-Nov-14	---	---	---	65	45	90	35
	15-Apr-15	---	---	---	55	50	85	80
	19-Nov-15	---	---	---	125	115	90	70
	28-Jun-16	---	---	---	100	65	90	85

Notes:

DL = Detection limit.

RL = Reporting Limit (NC SWSL).

ND = Not detected at the laboratory's detection limit.

J = Estimated value - concentration is less than the reporting limit but greater than the detection limit.

B = Blank-qualified detection - concentration is within five times the concentration reported in the associated quality control blanks.

--- = Monitoring well was not sampled for this parameter.

μ g/l = micrograms per liter.

mg/l = milligrams per liter.

mV = milliVolts.

S.U. = Standard Units.

nM = nanomolars.

μ S/cm = microSeimens per centimeter.

**TABLE 7:
EPA Biodegradation Screening Matrix**

Parameter	Concentration in Plume	Interpretation	Possible Points	Points Awarded with DP points	Points Awarded without DP points
Oxygen	< 0.5 mg/L	Tolerated, suppresses the reductive pathway at higher concentrations	3	0	0
	> 5 mg/L	Not tolerated; however, vinyl chloride may be oxidized aerobically	-3		
Nitrate	< 1 mg/L	At higher concentrations may compete with reductive pathway	2	2	2
Iron II (Ferrous Iron)	> 1 mg/L	Reductive pathway possible; vinyl chloride may be oxidized under Fe (III) - reducing conditions	3	0	0
Sulfate	< 20 mg/L	At higher concentrations may compete with reductive pathway	2	2	2
Sulfide	> 1 mg/L	Reductive pathway possible	3		
Methane	< 0.5 mg/L	Vinyl chloride oxidizes	0		
	> 0.5 mg/L	Ultimate reductive daughter product, vinyl chloride accumulates	3	3	0
Oxidation Reduction Potential	< 50 mV	Reductive pathway possible	1	1	1
	< -100 mV	Reductive pathway likely	2		
pH	5 < pH < 9	Optimal range for reductive pathway	0	0	0
	5 > pH > 9	Outside optimal range for reductive pathway	-2		
TOC	> 20 mg/L	Carbon and energy source; drives dechlorination; can be natural or anthropogenic	2	0	0
Temperature	>20° C	At T > 20°C biochemical process is accelerated	1	0	0
Carbon Dioxide	> 2x background	Ultimate oxidative daughter product	1	0	0
Alkalinity	> 2x background	Results from interaction between CO ₂ and aquifer minerals	1	1	1
Chloride	> 2x background	Daughter product of organic chlorine	2	2	2
Hydrogen	> 1 nM	Reductive pathway possible	3	3	3
	< 1 nM	Vinyl chloride oxidizes	0		
Volatile Fatty Acids	> 0.1 mg/L	Intermediates resulting from biodegradation of more complex compounds; carbon and energy source	2	0	0
BTEX	> 0.1 mg/L	Carbon and energy source; drives dechlorination	2	0	0
Tetrachloroethene (PCE)	---	Material released	0	0	0
Trichloroethene (TCE)	---	Material released	0		2
	---	Daughter product of PCE	2	2	
Dichloroethenes (DCE)	---	Material released	0		0
	---	Daughter product of TCE	2	2	
Dichloroethene, cis-1,2,	---	Material released	0		2
	---	Daughter product of trichloroethene	2	2	
Vinyl Chloride (VC)	---	Material released	0		0
	---	Daughter product of DCE	2	2	
1,1,1-Trichloroethane (TCA)	---	Material released	0	0	0
1,1-Dichloroethane (DCA)	---	Material released	0		0
	---	Daughter product of TCA	2	2	
Chloroethane	---	Daughter product of dichloroethane or vinyl chloride under reducing conditions	2	0	0
Ethene/Ethane	> 0.01 mg/L	Daughter products of vinyl chloride/ethene	2	0	0
	> 0.1 mg/L		3		
Chloroform	---	Material released	0		0
	---	Daughter product of carbon tetrachloride	2	0	
Dichloromethane (MC)	---	Material released	0		0
(Methylene Chloride)	---	Daughter product of chloroform	2	0	
Total Points Awarded :				24	15

Based primarily on data collected on June 29, 2016.

Total Points Awarded :

24

15

mg/L = milligrams per liter
mV = millivolts
nM = Nanometer
C = Celcius
NA = Not Analyzed

BTEX = Sum of Benzene, Toluene, Ethylbenzene, and Total Xylenes

This screening matrix is prepared in general accordance with the United States Environmental Protection Agency's (EPA's) Table 2.3 Analytical Parameters and Weighted for Preliminary Screening for Anaerobic Biodegradation Process presented in the EPA's Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater, September 1988.

NOTE: Chloroethane, Methane, TCE, DCE, cis-1,2-DCE, MC, VC, DCA, and CO₂ may be present in the plume; however, it is uncertain whether these are primary leachate constituents or daughter products (DPs); therefore, we have two calculation columns. The first column assumes all of these are daughter products, and the second column assumes none of them are. The true score is probably between the two.

SCORE:	Evid. of Nat. Atten.
< 5	inadequate
6-14	limited
15-19	adequate
> 20	strong

CHARTS

CHART 1: Benzene Concentration vs. Time

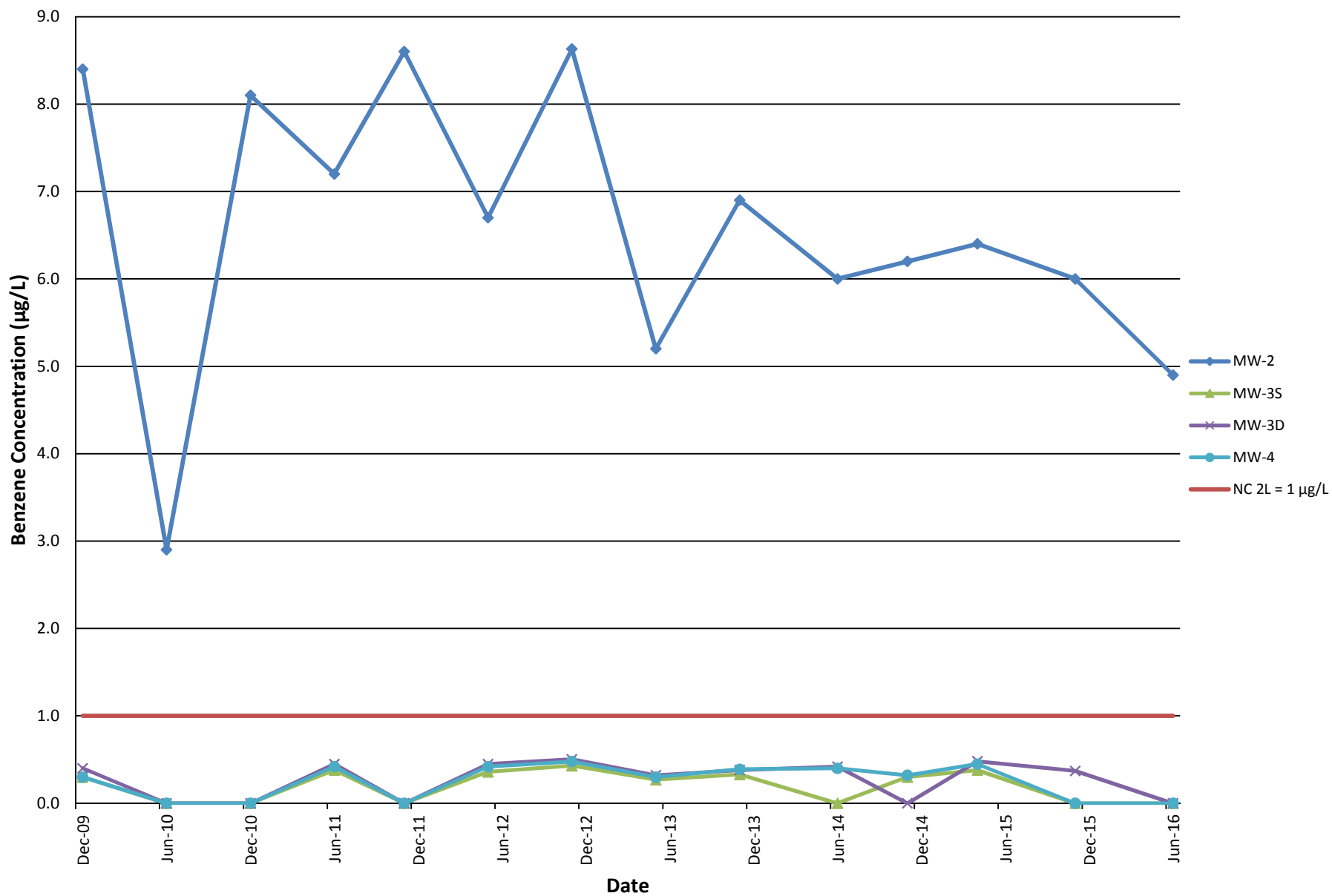


CHART 2: 1,1-Dichloroethane Concentration vs. Time

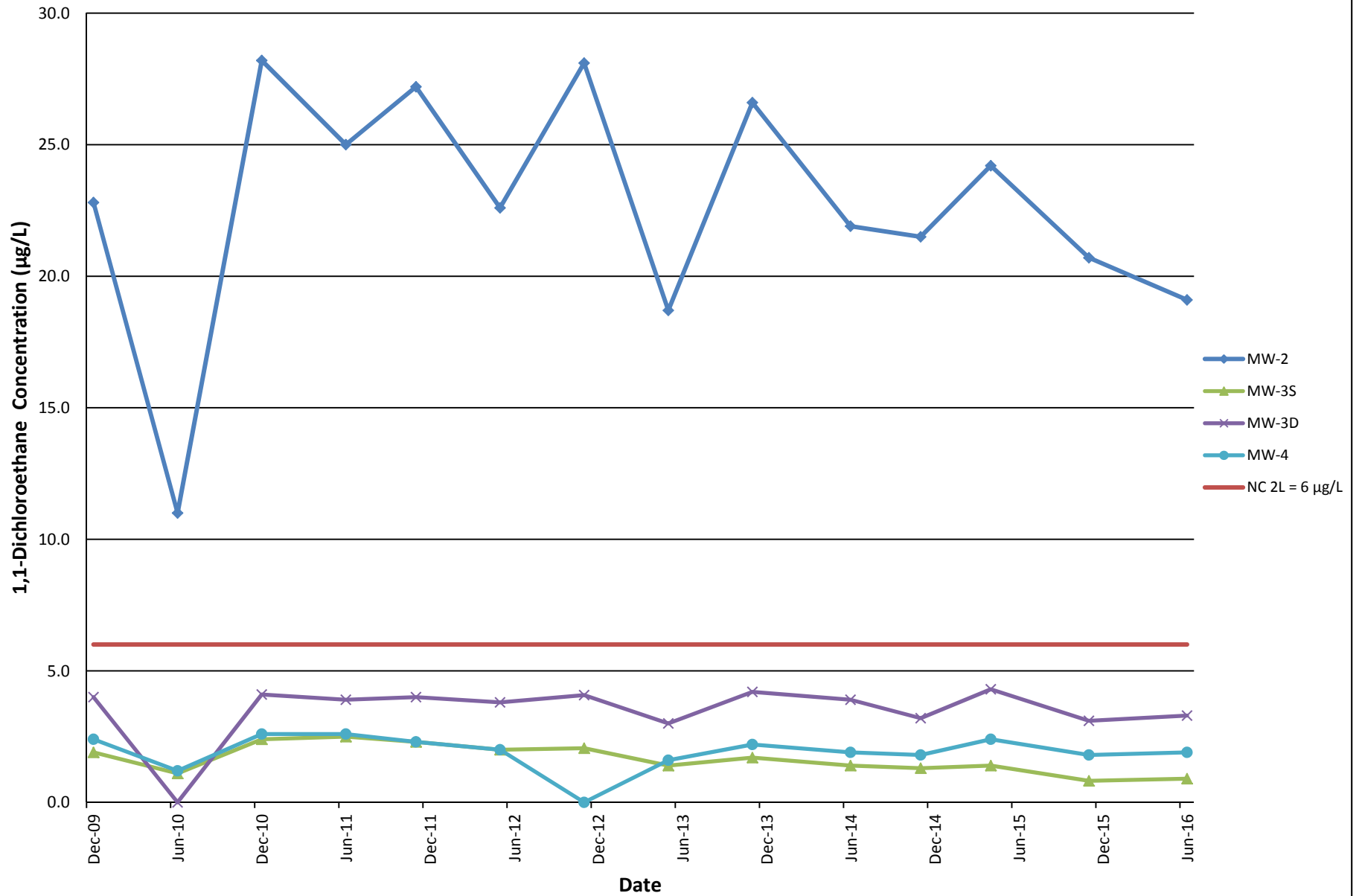


CHART 3: 1,2-Dichloroethane Concentration vs. Time

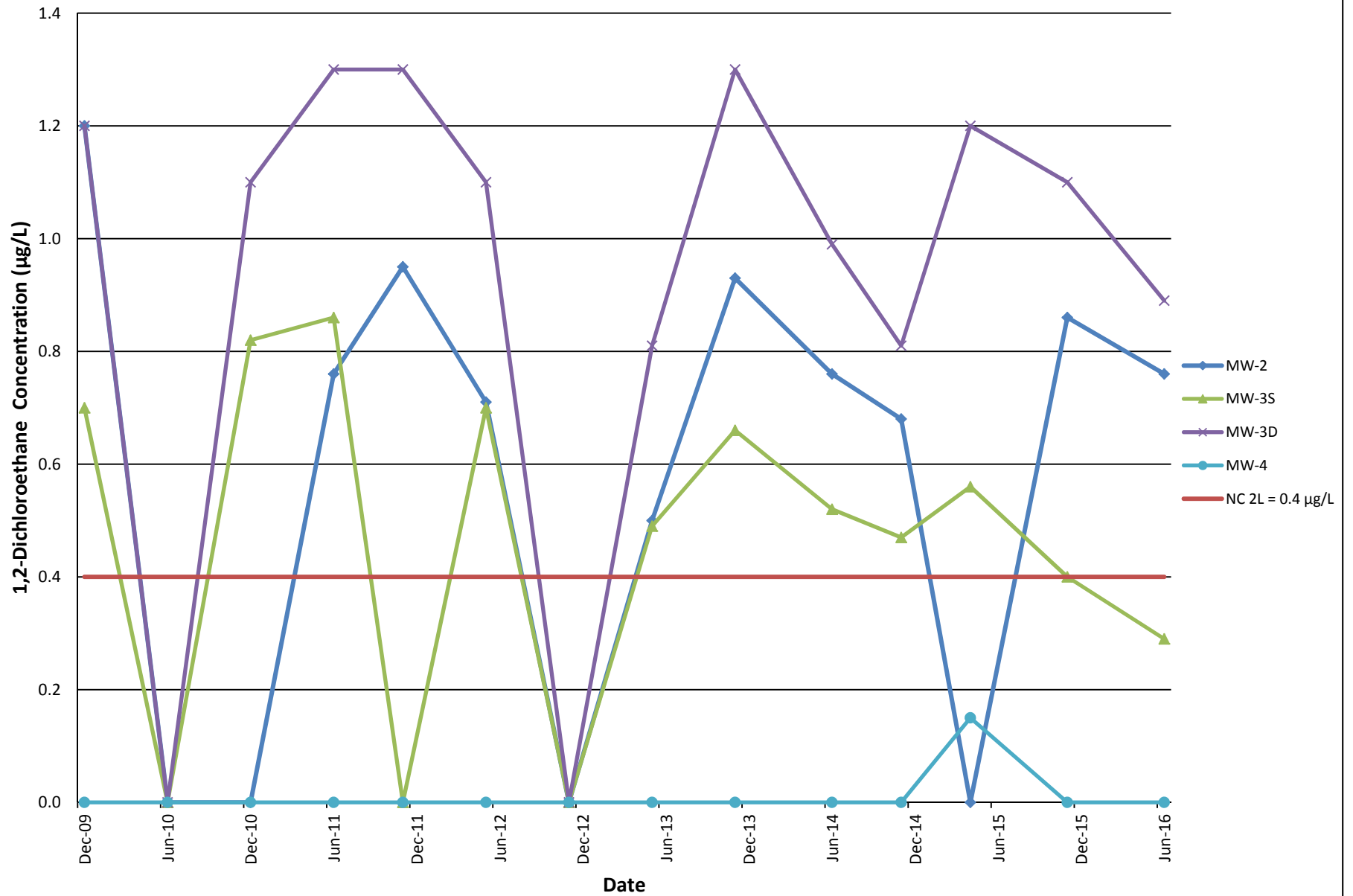


CHART 4: cis-1,2-Dichloroethene Concentration vs. Time

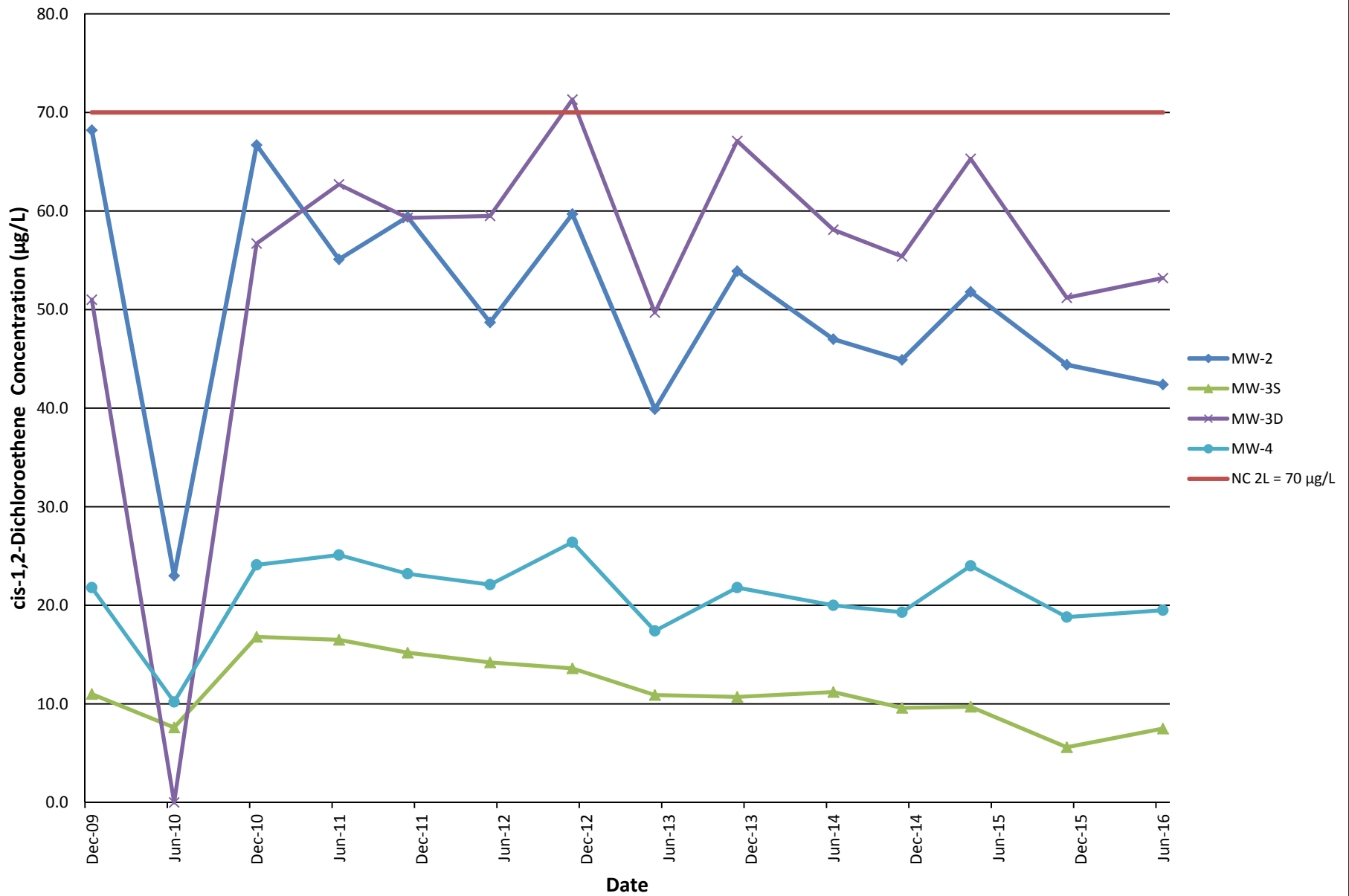


CHART 5: 1,2-Dichloropropane Concentration vs. Time

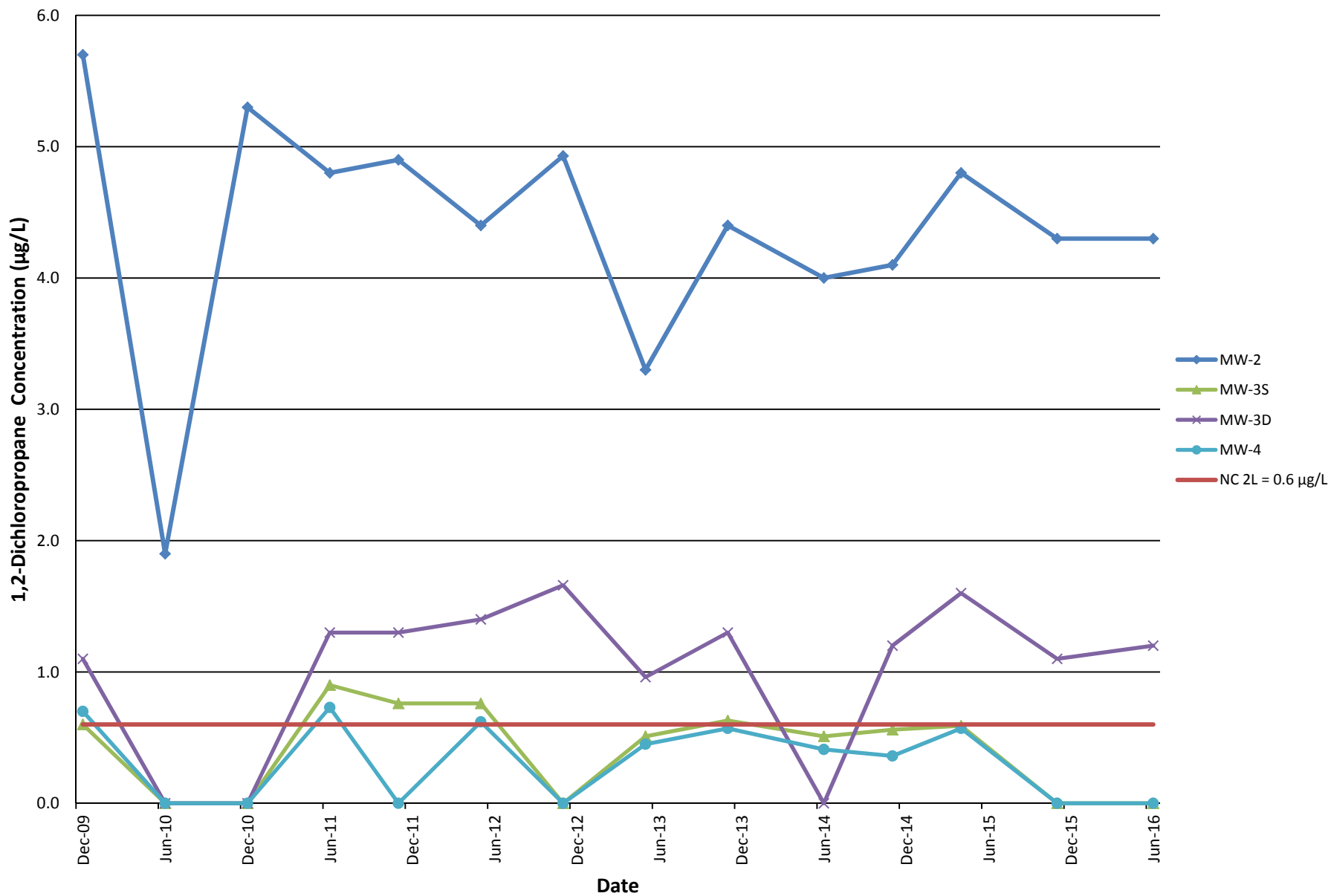


CHART 6: Tetrachloroethene Concentration vs. Time

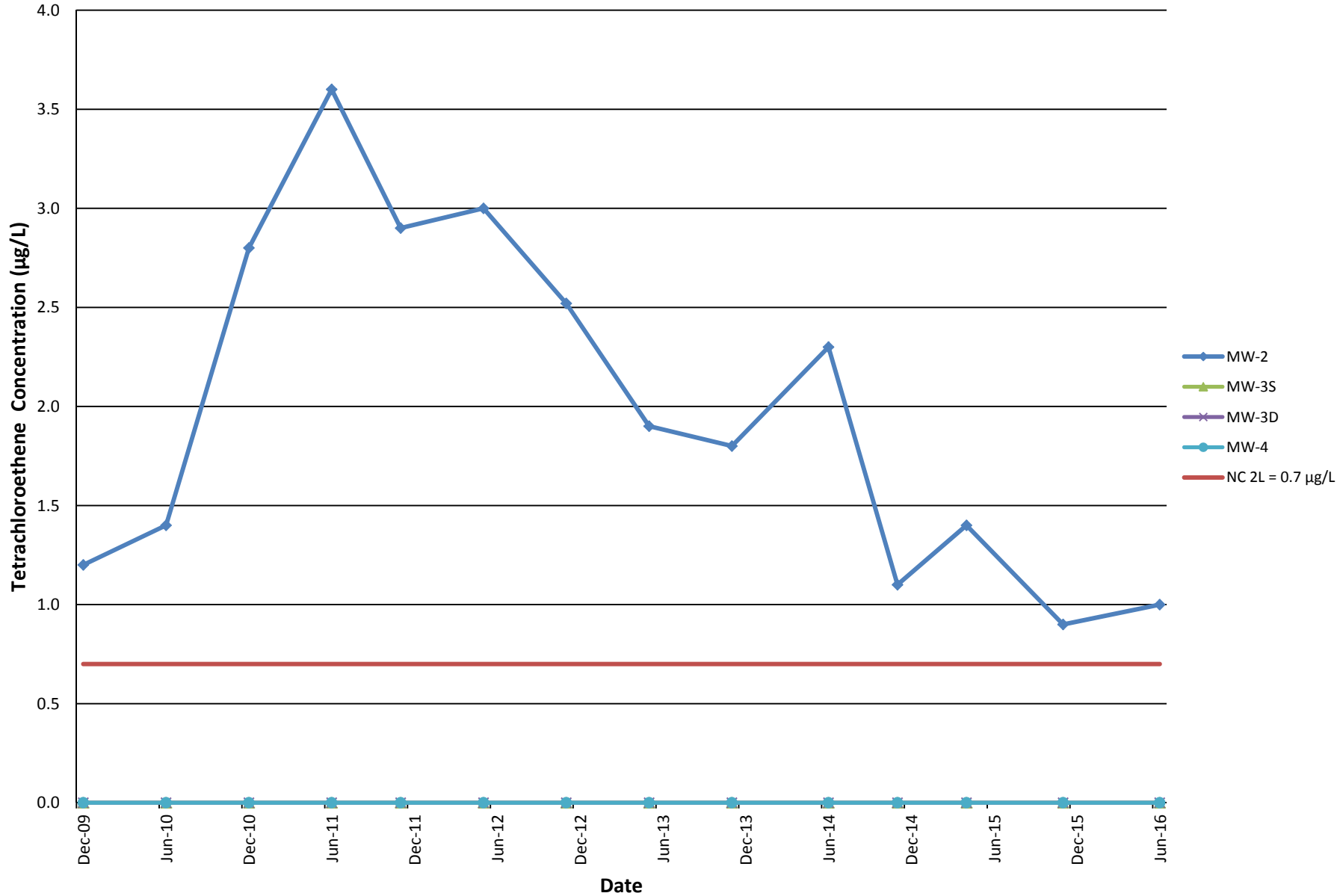


CHART 7: Trichloroethene Concentration vs. Time

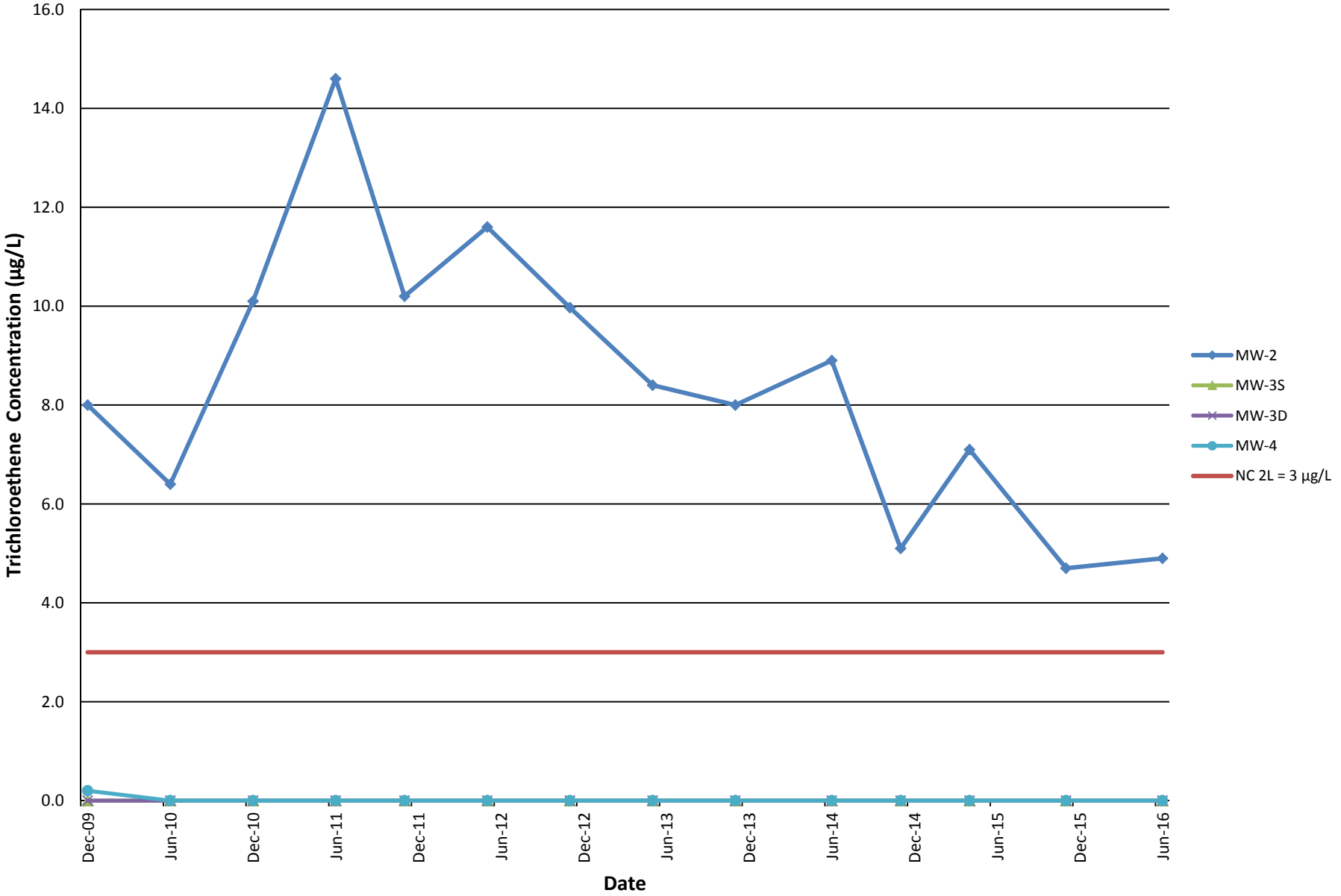


CHART 8: Vinyl Chloride Concentration vs. Time

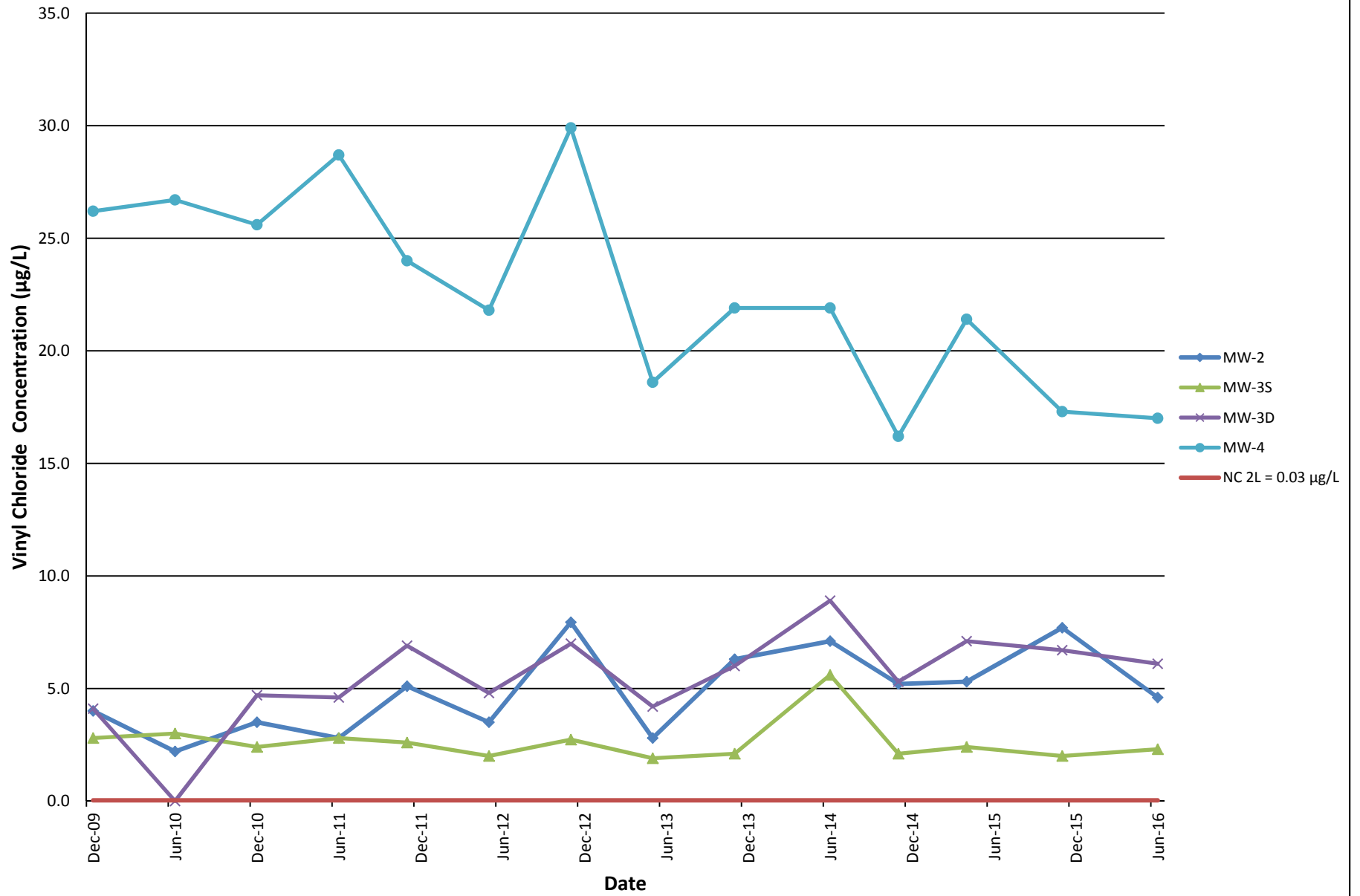
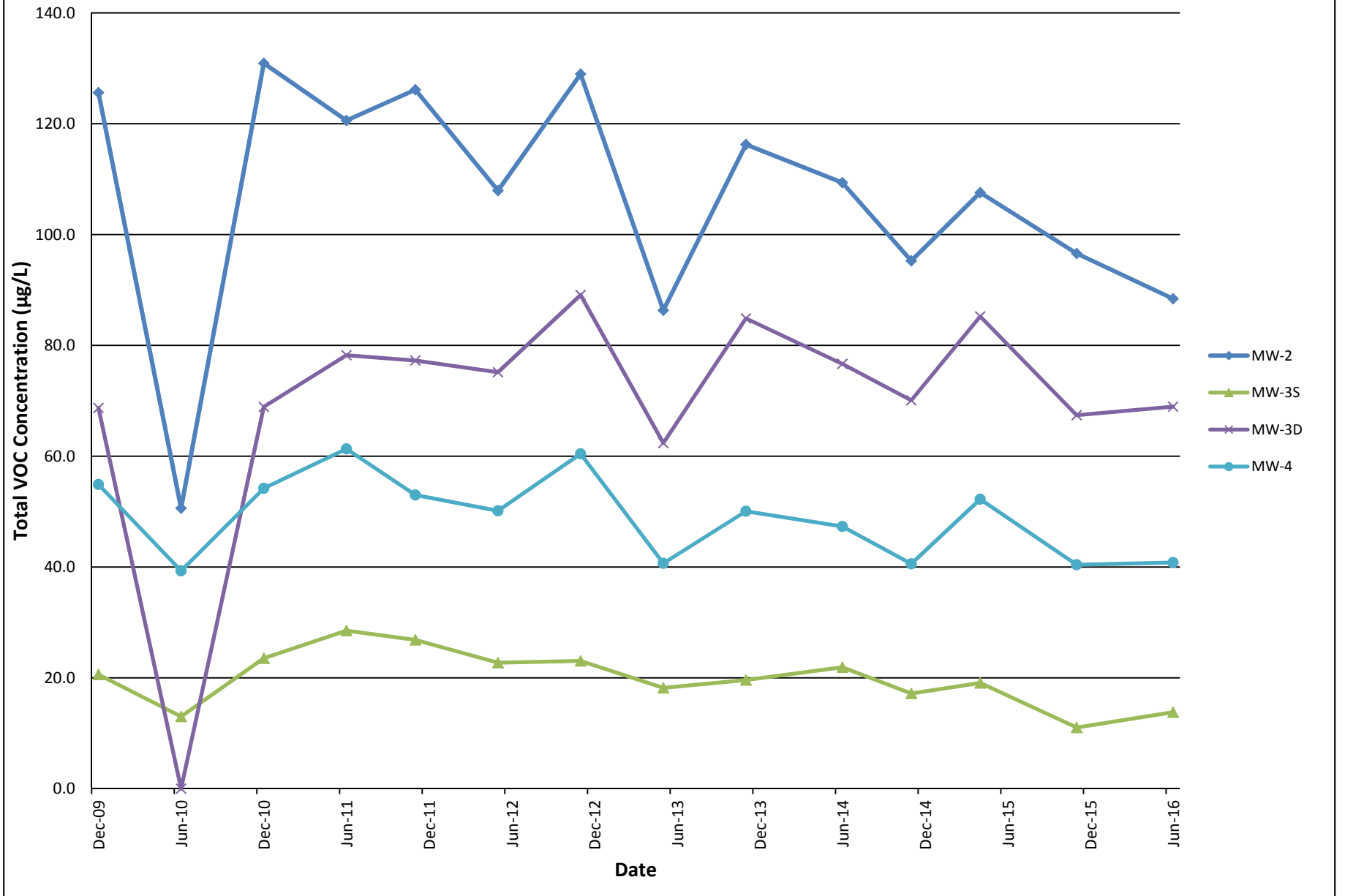
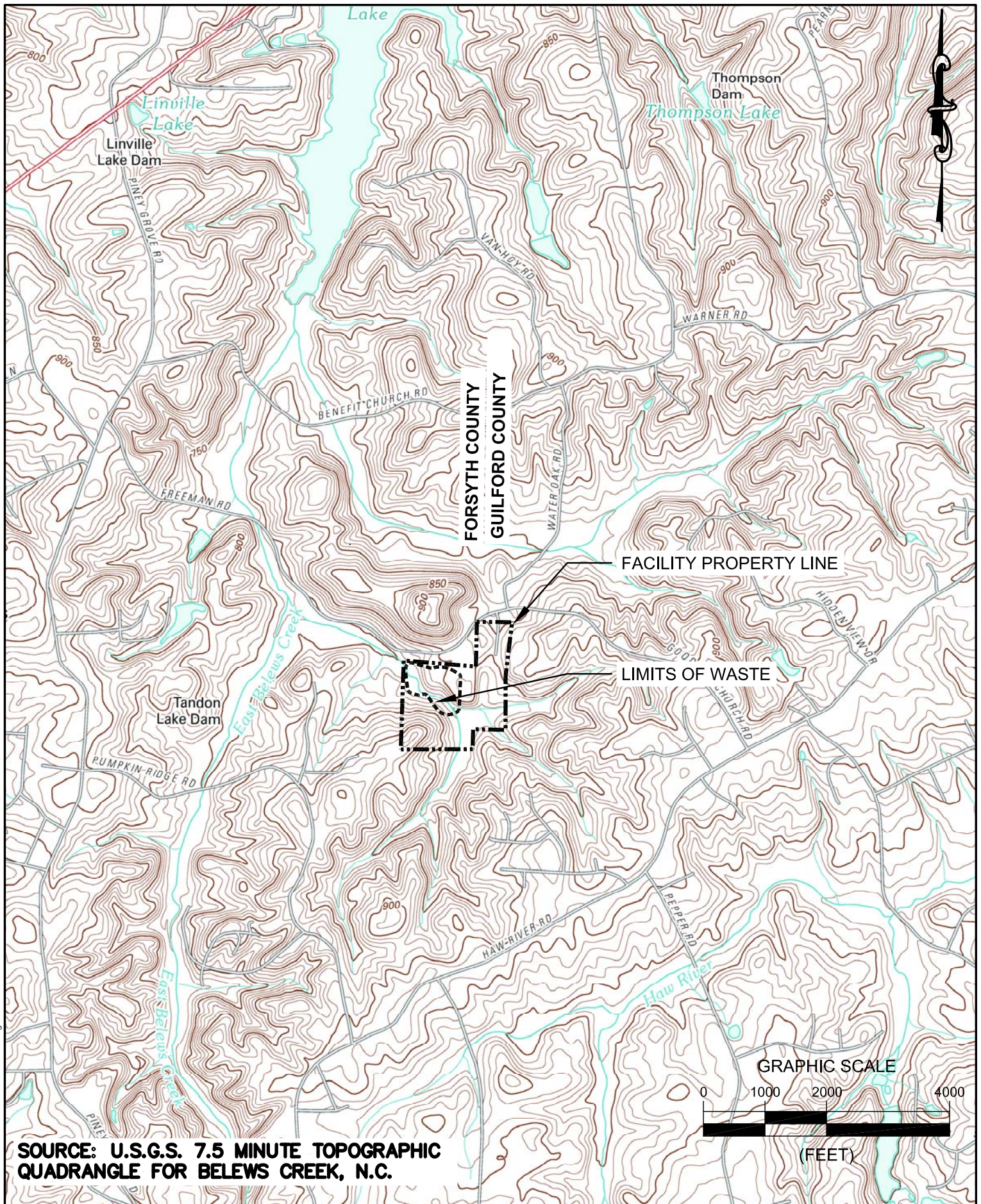


CHART 9: Total VOC Concentration vs. Time



FIGURES



SOURCE: U.S.G.S. 7.5 MINUTE TOPOGRAPHIC QUADRANGLE FOR BELEWS CREEK, N.C.

FIGURE NO. 1

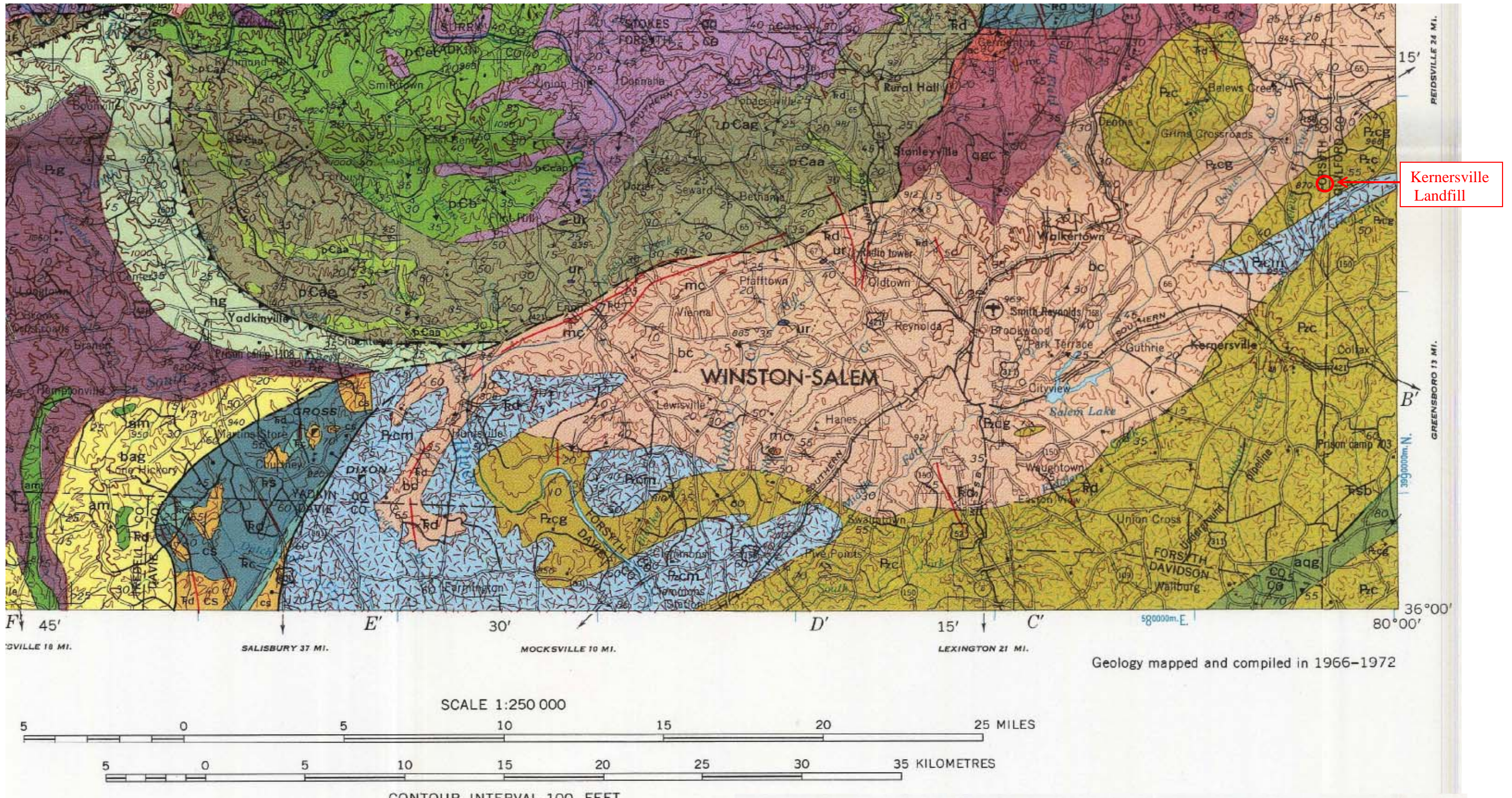
JOYCE ENGINEERING
 2211 WEST MEADOWVIEW ROAD
 GREENSBORO, N.C. 27407
 PHONE: (336) 323-0092
 © 2016, Joyce Engineering
 All rights reserved.

SCALE
 1"=2000'

PROJECT NO.
 838.1101.12

TOWN OF KERNERSVILLE LANDFILL
 FORSYTH COUNTY, NORTH CAROLINA
 SITE LOCATION MAP

L:\KERNERSVILLE\GW EVENT\2011 SITE LOCATION MAP.dwg



**Figure 2: Geologic Map
(Excerpt from Geologic Map of the East Half of the Winston-Salem Quadrangle)**

**GEOLOGIC MAP OF THE EAST HALF OF THE WINSTON-SALEM QUADRANGLE,
NORTH CAROLINA-VIRGINIA**

By
G. H. Espenshade, D. W. Rankin, K. Wier Shaw,
and R. B. Neuman
1975

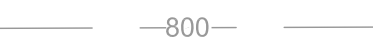

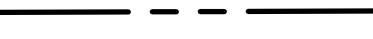


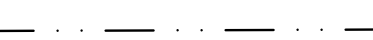
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY


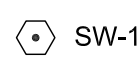
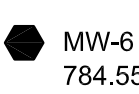







MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-709-B

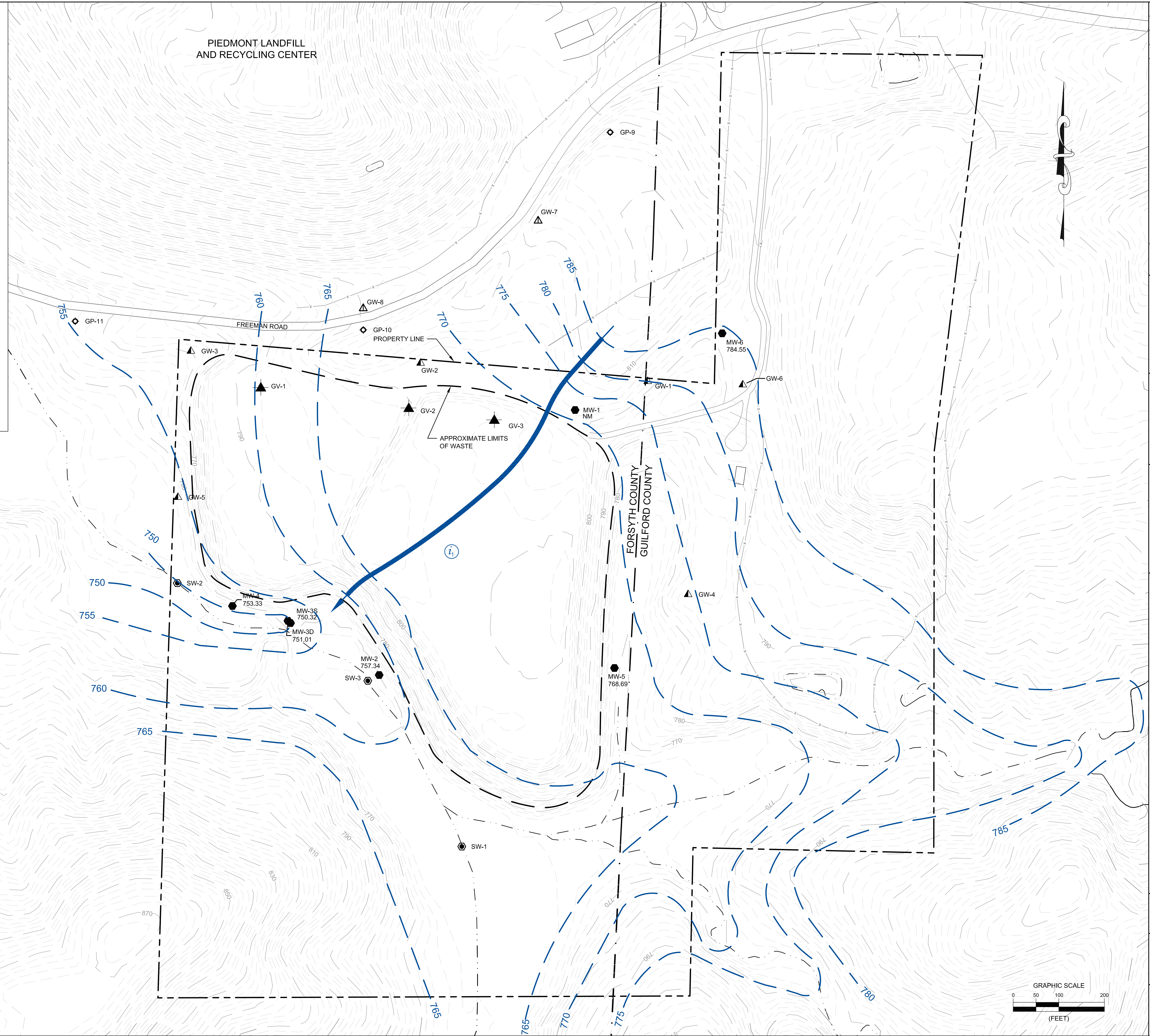
DRAWINGS

PIEDMONT LANDFILL
AND RECYCLING CENTER

LEGEND






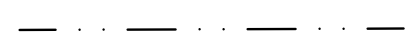

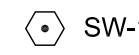






-  EXISTING 10' TOPOGRAPHIC CONTOUR
 -  EXISTING 2' TOPOGRAPHIC CONTOUR
 -  PROPERTY LINE
 -  EXISTING ROAD
 -  APPROXIMATE LIMITS OF WASTE
 -  CENTERLINE OF STREAM

 -  GROUNDWATER CONTOUR AND ELEVATION
 -  APPROXIMATE SURFACE WATER SAMPLING POINT LOCATION AND IDENTIFICATION
 -  MONITORING WELL IDENTIFICATION AND WATER LEVEL READING
 -  GROUNDWATER FLOW DIRECTION WITH GRADIENT CALCULATION SEGMENT
 -  SEGMENT USED FOR GRADIENT CALCULATIONS
 -  LANDFILL GAS WELL - TOWN OF KERNERSVILLE
 -  LANDFILL PASSIVE GAS VENT
 -  LANDFILL GAS PROBE - WM PIEDMONT
 -  NOT MONITORED
 -  SEGMENT FLOW LENGTH
- $i_1 = 805 \text{ LF}$



<p>TOWN OF KERNERSVILLE LANDFILL FORSYTH COUNTY, NORTH CAROLINA</p> <p>POTENTIOMETRIC SURFACE CONTOUR MAP</p> <p>JUNE 28, 2016</p>	<p>PROJECT NO. 838</p> <p>SCALE AS SHOWN</p> <p>DRAWING NO. 1</p>
<p>DESIGNED: GE</p> <p>DRAWN: RWI</p> <p>CHECKED: GVB</p> <p>APPROVED: GVB</p> <p>DATE: 07/07/16</p> <p>© 2016 Joyce Engineering All rights reserved.</p>	<p>NO. BY CK APP</p> <p>REVISIONS AND RECORD OF ISSUE</p> <p>DATE</p>

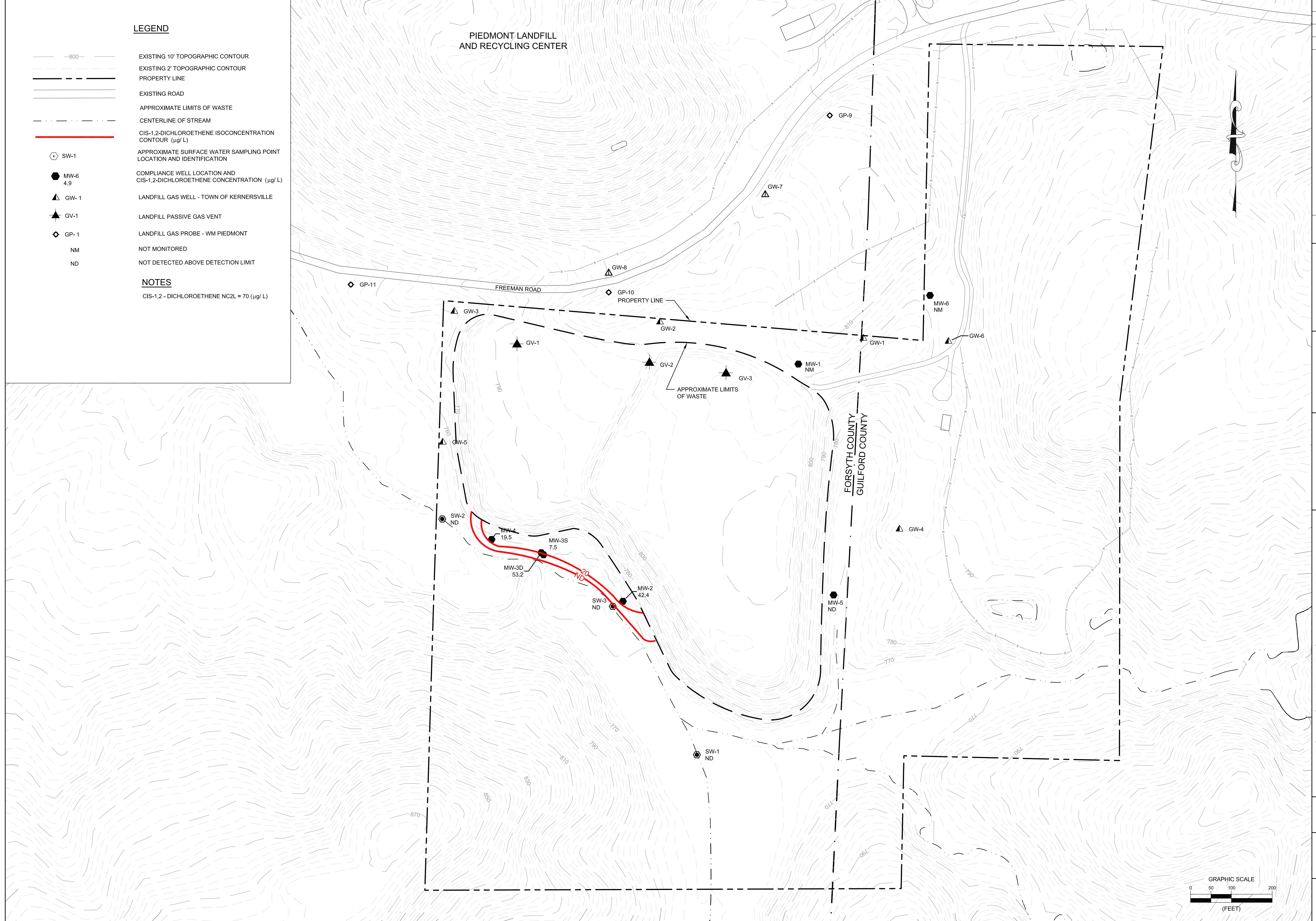
LEGEND

-  EXISTING 10' TOPOGRAPHIC CONTOUR
-  EXISTING 2' TOPOGRAPHIC CONTOUR
-  PROPERTY LINE
-  EXISTING ROAD
-  APPROXIMATE LIMITS OF WASTE
-  CENTERLINE OF STREAM
-  CIS-1,2-DICHLOROETHENE ISOCONCENTRATION CONTOUR (µg/L)
-  SW-1
APPROXIMATE SURFACE WATER SAMPLING POINT LOCATION AND IDENTIFICATION
-  MW-6
4.9
COMPLIANCE WELL LOCATION AND CIS-1,2-DICHLOROETHENE CONCENTRATION (µg/L)
-  GW-1
LANDFILL GAS WELL - TOWN OF KERNERSVILLE
-  GV-1
LANDFILL PASSIVE GAS VENT
-  GP-1
LANDFILL GAS PROBE - WM PIEDMONT
-  NM
NOT MONITORED
-  ND
NOT DETECTED ABOVE DETECTION LIMIT

NOTES

CIS-1,2 - DICHLOROETHENE NC2L = 70 (µg/L)

**PIEDMONT LANDFILL
AND RECYCLING CENTER**



NO	BY	CK	APP

DATE	REVISIONS AND RECORD OF ISSUE

DESIGNED	JL
DRAWN	RWH
CHECKED	GVB
APPROVED	JL
DATE	09/16

© 2016 Joyce Engineering
All rights reserved.

JOYCE ENGINEERING
 2211 W. MEADOWVIEW ROAD
 GREENSBORO, NC 27407
 PHONE: (336) 323-0092
 NC CORP LIC: C-0782

TOWN OF KERNERSVILLE LANDFILL
 FORSYTH COUNTY, NORTH CAROLINA
 CIS 1,2-DICHLOROETHENE
 ISOCONCENTRATION MAP
 JUNE 28, 2016

PROJECT NO.
838

SCALE
AS SHOWN

DRAWING NO.
5

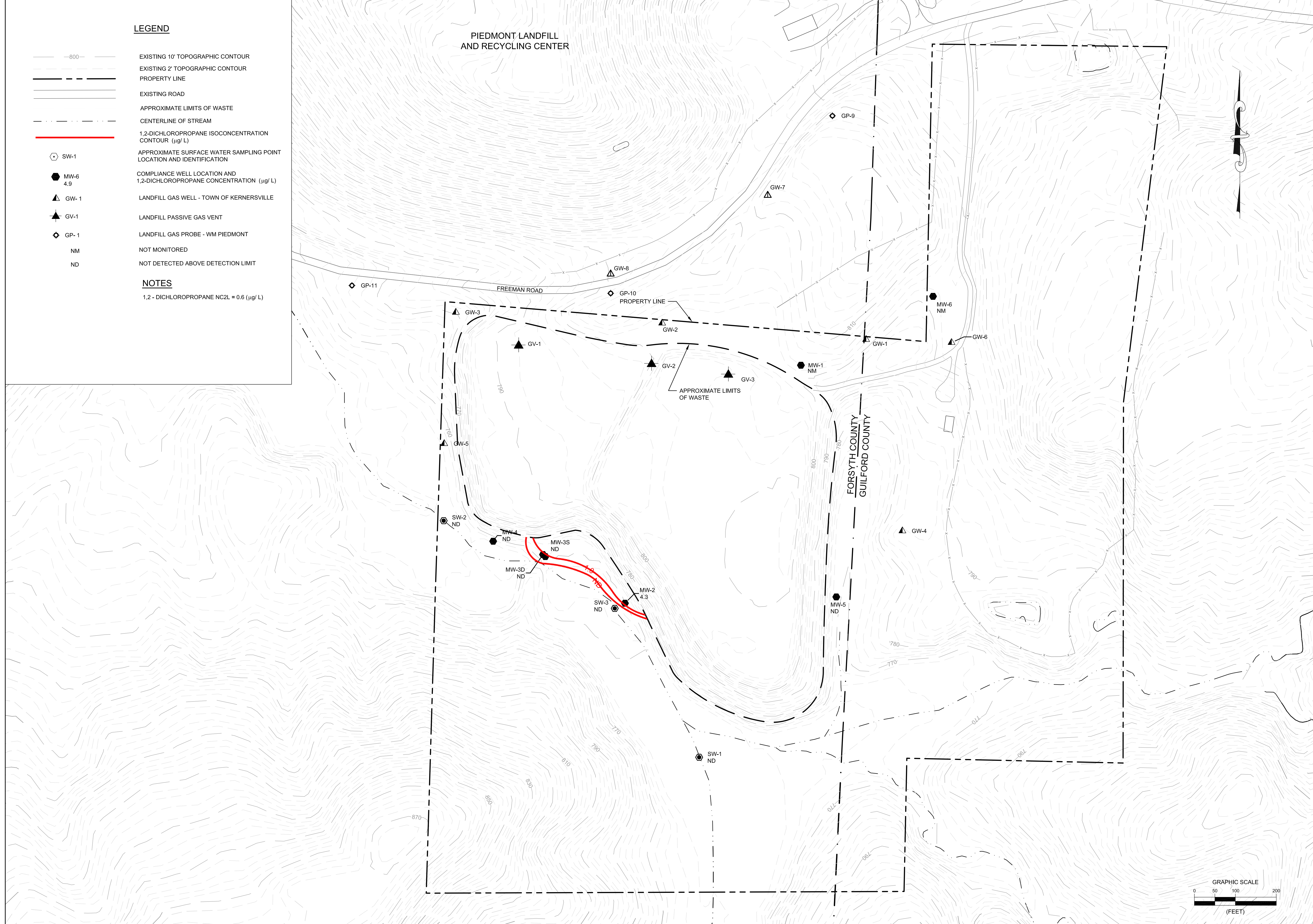
LEGEND

- 800 — EXISTING 10' TOPOGRAPHIC CONTOUR
- EXISTING 2' TOPOGRAPHIC CONTOUR
- - - - - PROPERTY LINE
- ==== EXISTING ROAD
- - - - - APPROXIMATE LIMITS OF WASTE
- — — — — CENTERLINE OF STREAM
- 1,2-DICHLOROPROPANE ISOCONCENTRATION CONTOUR (µg/L)
- SW-1 APPROXIMATE SURFACE WATER SAMPLING POINT LOCATION AND IDENTIFICATION
- MW-6 4.9 COMPLIANCE WELL LOCATION AND 1,2-DICHLOROPROPANE CONCENTRATION (µg/L)
- ▲ GW-1 LANDFILL GAS WELL - TOWN OF KERNERSVILLE
- ▲ GV-1 LANDFILL PASSIVE GAS VENT
- ◇ GP-1 LANDFILL GAS PROBE - WM PIEDMONT
- NM NOT MONITORED
- ND NOT DETECTED ABOVE DETECTION LIMIT

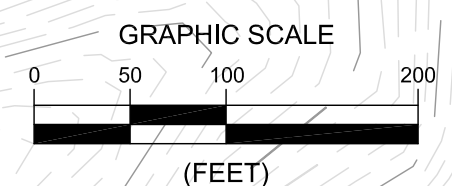
NOTES

1,2 - DICHLOROPROPANE NCZL = 0.6 (µg/L)

PIEDMONT LANDFILL AND RECYCLING CENTER



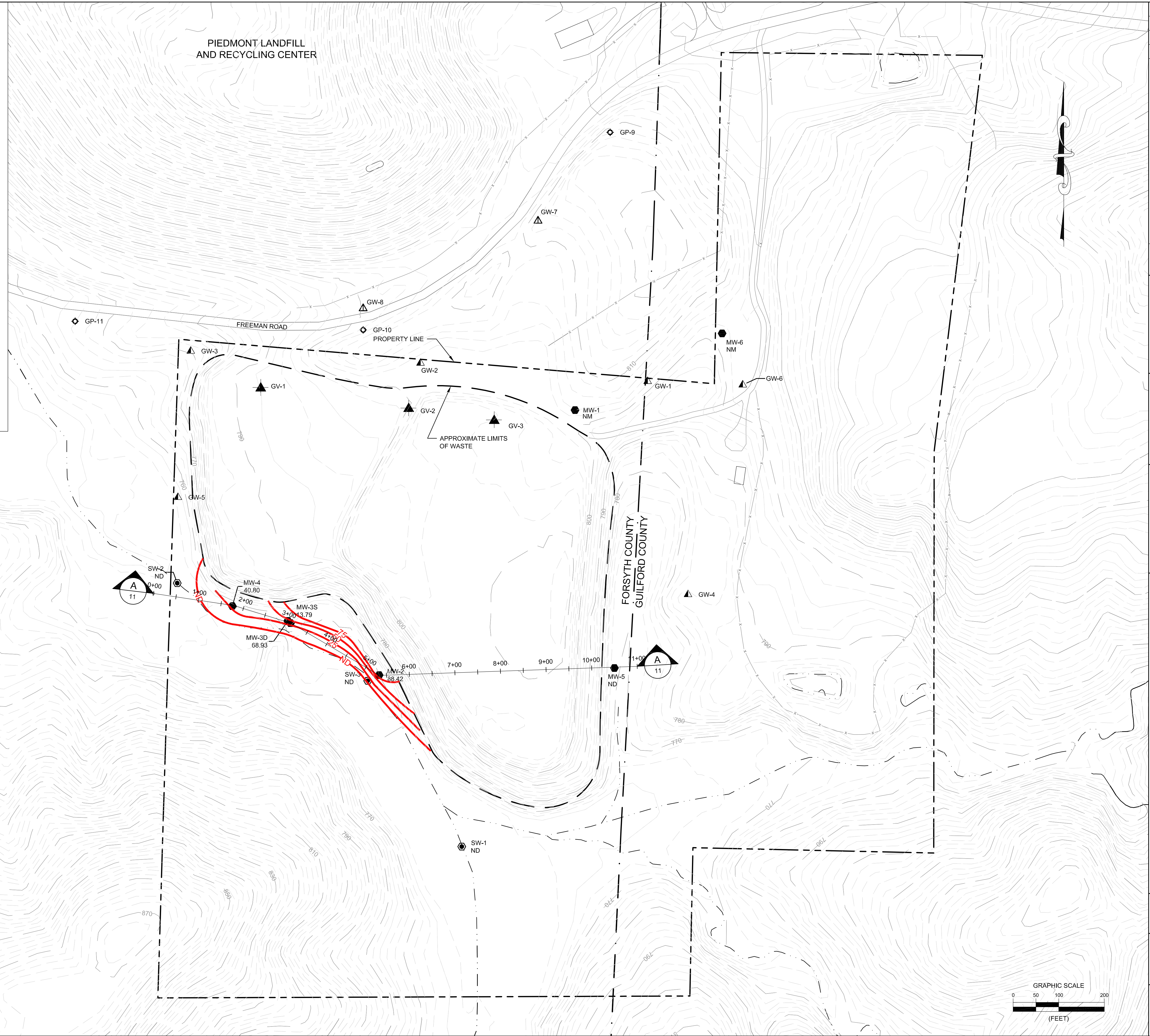
<p>TOWN OF KERNERSVILLE LANDFILL FORSYTH COUNTY, NORTH CAROLINA</p> <p>1,2-DICHLOROPROPANE ISOCONCENTRATION MAP JUNE 28, 2016</p>	<p>PROJECT NO. 838</p> <p>SCALE AS SHOWN</p> <p>DRAWING NO. 6</p>																				
<p>DESIGNED: JL DRAWN: RWH CHECKED: GVB APPROVED: JL DATE: 09/16</p>	<p>REVISIONS AND RECORD OF ISSUE</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>NO</th> <th>BY</th> <th>CK</th> <th>APP</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table>	NO	BY	CK	APP																
NO	BY	CK	APP																		
<p>JOYCE ENGINEERING 2211 W. MEADOWVIEW ROAD GREENSBORO, NC 27407 PHONE: (336) 323-0092 NC CORP LIC: C-0782</p>																					
<p>© 2016 Joyce Engineering All rights reserved.</p>																					



L:\KERNERSVILLE\2016 CORRECTIVE ACTION\6-1,2-DICHLOROPROPANE.dwg Layout/Layout1

LEGEND

- EXISTING 10' TOPOGRAPHIC CONTOUR
- EXISTING 2' TOPOGRAPHIC CONTOUR
- PROPERTY LINE
- EXISTING ROAD
- APPROXIMATE LIMITS OF WASTE
- CENTERLINE OF STREAM
- TOTAL VOCs ISOCONCENTRATION CONTOUR (µg/L)
- SW-1 APPROXIMATE SURFACE WATER SAMPLING POINT LOCATION AND IDENTIFICATION
- MW-6 4.9 COMPLIANCE WELL LOCATION AND TOTAL VOCs CONCENTRATION (µg/L)
- GW-1 LANDFILL GAS WELL - TOWN OF KERNERSVILLE
- GV-1 LANDFILL PASSIVE GAS VENT
- GP-1 LANDFILL GAS PROBE - WM PIEDMONT
- NM NOT MONITORED
- ND NOT DETECTED ABOVE DETECTION LIMIT



<p>TOWN OF KERNERSVILLE LANDFILL FORSYTH COUNTY, NORTH CAROLINA</p> <p>TOTAL VOCs ISOCONCENTRATION MAP</p> <p>JUNE 28, 2016</p>	<p>PROJECT NO. 838</p> <p>SCALE AS SHOWN</p> <p>DRAWING NO. 10</p>
<p>DESIGNED: JL DRAWN: RWH CHECKED: GVB APPROVED: JL DATE: 09/16</p> <p>© 2016 Joyce Engineering All rights reserved.</p>	<p>NO. BY CK APP</p> <p>REVISIONS AND RECORD OF ISSUE</p> <p>DATE</p>

APPENDICES

Appendix A

Historical Detected Groundwater Constituents

APPENDIX A: HISTORICAL DETECTED GROUNDWATER CONSTITUENTS

Analyte	Sample Date	DL	RL	MW-1	MW-6	MW-2	MW-3S	MW-3D	MW-4	MW-5	Blanks		
Inorganic Compounds													
Antimony GWPS = 1.4 µg/L (10/23/07) GWPS = 1 µg/L (8/1/10)	30-Dec-09	1.2	6.0	---	ND	5.4	B	ND	ND	4.5	B	---	
	01-Jun-10	1.2	6.0	---	ND	ND	ND	ND	ND	---	---	1.4	
	29-Dec-10	2.6	6.0	---	ND	ND	ND	ND	ND	ND	---	3.9	
	29-Jun-11	5.0	6.0	---	ND	ND	ND	ND	ND	ND	---	ND	
	01-Nov-11	5.0	6.0	---	ND	ND	ND	ND	ND	ND	---	ND	
	01-May-12	5.0	6.0	---	ND	ND	ND	ND	ND	ND	---	ND	
	07-Nov-12	0.48	6.0	---	---	ND	ND	ND	ND	---	---	ND	
	09-May-13	5.0	6.0	---	ND	ND	ND	ND	ND	---	---	ND	
	07-Nov-13	5.0	6.0	---	---	ND	ND	ND	ND	---	---	ND	
	05-Jun-14	5.0	6.0	---	ND	ND	ND	ND	ND	ND	---	ND	
	20-Nov-14	3.8	6.0	---	---	ND	ND	ND	ND	ND	---	ND	
	27-Apr-15	3.8	6.0	---	---	ND	ND	ND	ND	ND	---	ND	
	19-Nov-15	3.8	6.0	---	---	ND	ND	ND	ND	ND	---	ND	
	28-Jun-16	3.8	6.0	---	---	ND	ND	ND	ND	ND	---	ND	
	Arsenic NC 2L = 10 µg/L (1/11/10)	29-Jun-11	5.0	10.0	---	ND	ND	ND	ND	ND	6.2	J	ND
01-Nov-11		5.0	10.0	---	ND	ND	ND	ND	ND	ND	---	ND	
01-May-12		5.0	10.0	---	ND	ND	ND	ND	ND	ND	---	ND	
07-Nov-12		0.094	10.0	---	---	1.43	B	1.42	B	0.87	B	1	
09-May-13		5.0	10.0	---	ND	ND	ND	ND	ND	---	---	ND	
07-Nov-13		5.0	10.0	---	---	ND	ND	ND	ND	---	---	ND	
05-Jun-14		5.0	10.0	---	ND	ND	ND	ND	ND	ND	---	ND	
20-Nov-14		2.5	10.0	---	---	ND	2.5	J	ND	ND	2.7	J	
27-Apr-15		2.5	10.0	---	---	ND	ND	ND	ND	ND	---	ND	
19-Nov-15		2.5	10.0	---	---	ND	ND	ND	2.7	J	ND	ND	
28-Jun-16		2.5	10.0	---	---	ND	ND	ND	ND	3.7	J	ND	
Barium NC 2L = 700 µg/L (1/11/10)		30-Dec-09	1.1	100	---	74.1	J	496	178	18.2	J	89.0	J
	01-Jun-10	1.1	100	---	58.1	J	326	187	22.2	J	94.9	J	---
	29-Dec-10	0.20	100	---	46.3	B	430	112	38.0	B	92.1	J	72.6
	29-Jun-11	5.0	100	---	77.7	J	370	128	41.2	J	98.4	J	113
	01-Nov-11	5.0	100	---	125	---	413	132	41.7	J	111	---	72.1
	01-May-12	5.0	100	---	78.8	J	323	121	40.0	J	99.7	J	66.1
	07-Nov-12	0.39	100	---	---	---	369	127	41.0	B	98.7	J	---
	09-May-13	5.0	100	---	78.6	J	307	112	40.0	J	85.6	J	---
	07-Nov-13	5.0	100	---	---	---	302	113	38.0	J	89.6	J	---
	05-Jun-14	5.0	100	---	60.3	J	285	117	39.2	J	80.3	J	75.0
	20-Nov-14	2.5	100	---	---	---	301	113	39.5	J	83.3	J	108
	27-Apr-15	2.5	100	---	---	---	268	104	39.0	J	94.8	J	67.4
	19-Nov-15	2.5	100	---	---	---	294	108	42.2	J	101	---	60.3
	28-Jun-16	2.5	100	---	---	---	253	155	37.9	J	90.1	J	70.6
	Beryllium GWPS = 4 µg/L (10/23/07)	30-Dec-09	0.2	1.0	---	ND	0.5	J	ND	ND	ND	---	ND
01-Jun-10		0.2	1.0	---	0.6	J	0.7	J	ND	ND	---	ND	
29-Dec-10		0.10	1.0	---	ND	ND	ND	ND	ND	0.48	J	ND	
29-Jun-11		1.0	1.0	---	ND	ND	ND	ND	ND	ND	---	ND	
01-Nov-11		1.0	1.0	---	ND	ND	ND	ND	ND	ND	---	ND	
01-May-12		1.0	1.0	---	ND	ND	ND	ND	ND	ND	---	ND	
07-Nov-12		0.049	1.00	---	---	0.34	J	ND	ND	0.099	J	---	
09-May-13		1.0	1.0	---	ND	ND	ND	ND	ND	---	---	ND	
07-Nov-13		1.0	1.0	---	---	ND	ND	ND	ND	---	---	ND	
05-Jun-14		1.0	1.0	---	ND	ND	ND	ND	ND	ND	---	ND	
20-Nov-14		0.5	1.0	---	---	ND	ND	ND	ND	ND	---	ND	
27-Apr-15		0.5	1.0	---	---	ND	ND	ND	ND	ND	---	ND	
19-Nov-15		0.5	1.0	---	---	ND	ND	ND	ND	ND	---	ND	
28-Jun-16		0.5	1.0	---	---	0.60	J	0.74	J	ND	0.52	J	0.54
Cadmium NC 2L = 2 µg/L (1/11/10)		30-Dec-09	0.2	1.0	---	ND	0.5	J	5.6	ND	ND	---	ND
	01-Jun-10	0.2	1.0	---	2.9	1.0	B	5.3	0.4	B	0.4	B	---
	29-Dec-10	0.50	1.0	---	ND	ND	ND	ND	ND	ND	---	ND	
	29-Jun-11	1.0	1.0	---	ND	ND	ND	ND	ND	ND	---	ND	
	01-Nov-11	1.0	1.0	---	ND	ND	ND	ND	ND	ND	---	ND	
	01-May-12	1.0	1.0	---	ND	ND	ND	ND	ND	ND	---	ND	
	07-Nov-12	0.026	1.00	---	---	0.15	J	ND	ND	0.043	J	---	
	09-May-13	1.0	1.0	---	ND	ND	ND	ND	ND	---	---	ND	
	07-Nov-13	1.0	1.0	---	---	ND	ND	ND	ND	---	---	ND	
	05-Jun-14	1.0	1.0	---	ND	ND	ND	ND	ND	ND	---	ND	
	20-Nov-14	0.5	1.0	---	---	ND	ND	ND	ND	ND	---	ND	
	27-Apr-15	0.5	1.0	---	---	ND	ND	ND	ND	ND	---	ND	
	19-Nov-15	0.5	1.0	---	---	ND	ND	ND	ND	ND	---	ND	
	28-Jun-16	0.5	1.0	---	---	ND	---	2.6	ND	ND	---	ND	

APPENDIX A: HISTORICAL DETECTED GROUNDWATER CONSTITUENTS

Analyte	Sample Date	DL	RL	MW-1	MW-6	MW-2	MW-3S	MW-3D	MW-4	MW-5	Blanks		
Chromium NC 2L = 10 µg/L (1/11/10)	30-Dec-09	0.7	10.0	---	ND	2.7	J 9.7	J ND	3.1	J ---	ND		
	01-Jun-10	0.7	10.0	---	3.5	J	1.6	J 12.4	1.2	J ---	ND		
	29-Dec-10	0.40	10.0	---	0.48	J	1.3	J 0.57	J ND	5.5	J 3.8	J	
	29-Jun-11	5.0	10.0	---	ND	ND	ND	ND	ND	ND	ND	ND	
	01-Nov-11	5.0	10.0	---	ND	ND	ND	ND	10.3	ND	ND	ND	
	01-May-12	5.0	10.0	---	ND	ND	ND	ND	5.8	J ND	ND	ND	
	07-Nov-12	0.030	10.0	---	---	0.71	J 0.12	B 0.094	B 7.31	J ---	0.099	J	
	09-May-13	5.0	10.0	---	ND	ND	ND	ND	ND	---	ND	ND	
	07-Nov-13	5.0	10.0	---	---	ND	ND	ND	ND	---	ND	ND	
	05-Jun-14	5.0	10.0	---	ND	ND	ND	ND	ND	ND	ND	ND	
	20-Nov-14	2.5	10.0	---	---	ND	ND	ND	ND	ND	ND	ND	
	27-Apr-15	2.5	10.0	---	---	ND	ND	ND	7.2	J ND	ND	ND	
	19-Nov-15	2.5	10.0	---	---	ND	ND	ND	3.0	J ND	ND	ND	
	28-Jun-16	2.5	10.0	---	---	ND	11.9	ND	5.0	J ND	ND	ND	
	Cobalt GWPS = 70 µg/L (10/23/07) GWPS = 1 µg/L (10/1/10)	30-Dec-09	0.7	10.0	---	ND	6.4	J 11.2	ND	1.8	J ---	ND	
		01-Jun-10	0.7	10.0	---	1.8	J	2.5	J 8.5	J ND	1.7	J ---	ND
29-Dec-10		0.60	10.0	---	ND	4.9	J 1.7	J ND	1.6	J 10.2	ND	ND	
29-Jun-11		5.0	10.0	---	ND	ND	ND	ND	ND	9.9	J ND	ND	
01-Nov-11		5.0	10.0	---	ND	ND	ND	ND	ND	5.2	J ND	ND	
01-May-12		5.0	10.0	---	ND	ND	ND	ND	ND	13.9	ND	ND	
07-Nov-12		0.053	10.0	---	---	1.98	J 3.89	J 0.43	B 2.02	J ---	0.24	J	
09-May-13		5.0	10.0	---	ND	ND	ND	ND	ND	---	ND	ND	
07-Nov-13		5.0	10.0	---	---	ND	ND	ND	ND	---	ND	ND	
05-Jun-14		5.0	10.0	---	ND	ND	ND	ND	ND	12.0	ND	ND	
20-Nov-14		2.5	10.0	---	---	ND	2.5	J ND	ND	10.2	ND	ND	
27-Apr-15		2.5	10.0	---	---	ND	2.7	J ND	ND	10.7	ND	ND	
19-Nov-15		2.5	10.0	---	---	ND	3.9	J ND	ND	3.5	J ND	ND	
28-Jun-16		2.5	10.0	---	---	ND	8.7	J ND	2.6	J 23.0	ND	ND	
Copper NC 2L = 1,000 µg/L (10/23/07)		30-Dec-09	2.0	10.0	---	ND	ND	10.6	ND	1.5	J ---	ND	
		01-Jun-10	2.0	10.0	---	12.2	B	3.3	B 33.2	3.9	B 6.8	B ---	4.8
	29-Dec-10	0.30	10.0	---	ND	ND	0.49	J 0.59	J 1.5	J 7.9	J ND	ND	
	29-Jun-11	5.0	10.0	---	ND	ND	ND	ND	ND	16.6	ND	ND	
	01-Nov-11	5.0	10.0	---	ND	ND	ND	ND	5.4	J ND	ND	ND	
	01-May-12	5.0	10.0	---	ND	ND	ND	ND	ND	ND	ND	ND	
	07-Nov-12	0.093	10.0	---	---	3.56	B 0.54	B 0.98	B 1.83	B ---	1.23	J	
	09-May-13	5.0	10.0	---	ND	ND	ND	ND	ND	---	ND	ND	
	07-Nov-13	5.0	10.0	---	---	ND	ND	ND	ND	---	ND	ND	
	05-Jun-14	5.0	10.0	---	ND	ND	ND	ND	ND	6.1	J ND	ND	
	20-Nov-14	2.5	10.0	---	---	ND	ND	ND	ND	5.3	J ND	ND	
	27-Apr-15	2.5	10.0	---	---	ND	ND	ND	3.5	B 3.6	B 3.2	J	
	19-Nov-15	2.5	10.0	---	---	ND	ND	ND	2.6	J 5.1	J ND	ND	
	28-Jun-16	2.5	10.0	---	---	ND	17.6	ND	2.7	J 2.5	J ND	ND	
	Lead NC 2L = 15 µg/L (10/23/07)	30-Dec-09	2.0	10.0	---	ND	ND	10.2	ND	ND	---	ND	
		01-Jun-10	2.0	10.0	---	9.1	B	8.2	B 8.7	B 3.0	B 3.9	B ---	3.2
29-Dec-10		4.0	10.0	---	ND	ND	ND	ND	ND	6.5	J ND	ND	
29-Jun-11		5.0	10.0	---	ND	ND	ND	ND	ND	19.9	ND	ND	
01-Nov-11		5.0	10.0	---	5.5	J	ND	ND	ND	ND	ND	ND	
01-May-12		5.0	10.0	---	ND	ND	ND	ND	ND	ND	ND	ND	
07-Nov-12		0.025	10.0	---	---	1.00	B 0.091	B 0.066	B 1.12	B ---	0.58	J	
09-May-13		5.0	10.0	---	ND	ND	ND	ND	ND	---	ND	ND	
07-Nov-13		5.0	10.0	---	---	ND	ND	ND	ND	---	ND	ND	
05-Jun-14		5.0	10.0	---	ND	ND	ND	ND	ND	ND	ND	ND	
20-Nov-14		2.5	10.0	---	---	ND	ND	ND	ND	4.2	J ND	ND	
27-Apr-15		2.5	10.0	---	---	ND	ND	ND	ND	ND	ND	ND	
19-Nov-15		2.5	10.0	---	---	ND	ND	ND	ND	ND	ND	ND	
28-Jun-16		2.5	10.0	---	---	ND	6.3	J ND	3.7	J ND	ND	ND	
Nickel NC 2L = 100 µg/L (10/23/07)		30-Dec-09	0.6	50.0	---	ND	ND	8.1	J 1.8	J 1.6	J ---	ND	
		01-Jun-10	0.6	50.0	---	ND	ND	6.0	J ND	0.9	J ---	ND	
	29-Dec-10	1.7	50.0	---	ND	ND	ND	ND	ND	2.0	B ND	J	
	29-Jun-11	5.0	50.0	---	ND	ND	ND	ND	ND	ND	ND	ND	
	01-Nov-11	5.0	50.0	---	ND	ND	ND	ND	ND	ND	ND	ND	
	01-May-12	5.0	50.0	---	ND	ND	ND	ND	ND	ND	ND	ND	
	07-Nov-12	0.26	50.0	---	---	0.73	B 1.19	B 0.65	B 5.57	J ---	0.84	J	
	09-May-13	5.0	50.0	---	ND	ND	ND	ND	ND	---	ND	ND	
	07-Nov-13	5.0	50.0	---	---	ND	ND	ND	ND	---	ND	ND	
	05-Jun-14	5.0	50.0	---	ND	ND	ND	ND	ND	ND	ND	ND	
	20-Nov-14	2.5	50.0	---	---	ND	ND	ND	ND	ND	ND	ND	
	27-Apr-15	2.5	50.0	---	---	ND	ND	ND	3.4	J ND	ND	ND	
	19-Nov-15	2.5	50.0	---	---	ND	ND	ND	2.6	J ND	ND	ND	
	28-Jun-16	2.5	50.0	---	---	ND	6.2	J ND	2.6	J ND	ND	ND	

**APPENDIX A:
HISTORICAL DETECTED GROUNDWATER CONSTITUENTS**

Analyte	Sample Date	DL	RL	MW-1	MW-6	MW-2	MW-3S	MW-3D	MW-4	MW-5	Blanks	
Selenium NC 2L = 20 µg/L (1/11/10)	30-Dec-09	6.3	10.0	---	ND	ND	8.4 J	ND	ND	---	ND	
	01-Jun-10	6.3	10.0	---	ND	ND	6.3 J	ND	ND	---	ND	
	29-Dec-10	3.8	10.0	---	ND	ND	ND	ND	ND	ND	ND	
	29-Jun-11	10.0	10.0	---	ND	ND	ND	ND	ND	ND	ND	
	01-Nov-11	10.0	10.0	---	ND	ND	ND	ND	ND	ND	ND	
	01-May-12	10.0	10.0	---	ND	ND	ND	ND	ND	ND	ND	
	07-Nov-12	0.11	10.0	---	---	0.16 J	0.38 J	0.20 J	0.25 J	---	ND	
	09-May-13	10.0	10.0	---	ND	ND	ND	ND	ND	---	ND	
	07-Nov-13	10.0	10.0	---	---	ND	ND	ND	ND	---	ND	
	05-Jun-14	10.0	10.0	---	ND	ND	ND	ND	ND	ND	ND	
	20-Nov-14	5.0	10.0	---	---	ND	ND	ND	ND	ND	ND	
	27-Apr-15	5.0	10.0	---	---	ND	ND	ND	ND	ND	ND	
	19-Nov-15	5.0	10.0	---	---	ND	ND	ND	ND	ND	ND	
	28-Jun-16	5.0	10.0	---	---	ND	ND	ND	ND	ND	ND	
	Silver NC 2L = 20 µg/L (1/11/10)	30-Dec-09	1.1	10.0	---	ND	1.7 B	2.2 B	ND	ND	---	1.9 J
		01-Jun-10	1.1	10.0	---	ND	ND	ND	ND	ND	---	ND
29-Dec-10		0.10	10.0	---	ND	1.8 J	0.36 J	0.19 J	0.23 J	ND	ND	
29-Jun-11		5.0	10.0	---	ND	ND	ND	ND	ND	ND	ND	
01-Nov-11		5.0	10.0	---	ND	ND	ND	ND	ND	ND	ND	
01-May-12		5.0	10.0	---	ND	ND	ND	ND	ND	ND	ND	
07-Nov-12		0.017	10.0	---	---	0.18 J	ND	ND	0.078 J	---	ND	
09-May-13		5.0	10.0	---	ND	ND	ND	ND	ND	---	ND	
07-Nov-13		5.0	10.0	---	---	ND	ND	ND	ND	---	ND	
05-Jun-14		5.0	10.0	---	ND	ND	ND	ND	ND	ND	ND	
20-Nov-14		2.5	10.0	---	---	ND	ND	ND	ND	ND	ND	
27-Apr-15		2.5	10.0	---	---	ND	ND	ND	ND	ND	ND	
19-Nov-15		2.5	10.0	---	---	ND	ND	ND	ND	ND	ND	
28-Jun-16		2.5	10.0	---	---	ND	ND	ND	ND	ND	ND	
Thallium GWPS = 0.28 µg/L (10/23/07) GWPS = 0.2 µg/L (10/1/10)		30-Dec-09	2.7	5.5	---	ND	ND	ND	ND	ND	---	3.7 J
		01-Jun-10	2.7	5.5	---	ND	ND	ND	ND	ND	---	ND
	29-Dec-10	3.0	5.5	---	ND	3.2 J	ND	ND	4.8 J	ND	ND	
	29-Jun-11	5.4	5.5	---	ND	ND	ND	ND	ND	ND	ND	
	01-Nov-11	5.4	5.5	---	ND	ND	ND	ND	ND	ND	ND	
	01-May-12	5.4	5.5	---	ND	ND	ND	ND	ND	ND	ND	
	07-Nov-12	0.060	5.50	---	---	0.16 J	ND	ND	0.76 J	---	ND	
	09-May-13	5.4	5.5	---	ND	ND	ND	ND	ND	---	ND	
	07-Nov-13	5.4	5.5	---	---	ND	ND	ND	ND	---	ND	
	05-Jun-14	5.4	5.5	---	ND	ND	ND	ND	ND	ND	ND	
	20-Nov-14	5.0	5.5	---	---	ND	ND	ND	ND	ND	ND	
	27-Apr-15	5.0	5.5	---	---	ND	ND	ND	ND	ND	ND	
	19-Nov-15	5.0	5.5	---	---	ND	ND	8.8	8.8	ND	ND	
	28-Jun-16	5.0	5.5	---	---	ND	ND	ND	ND	ND	ND	
	Vanadium GWPS = 3.5 µg/L (10/23/07) GWPS = 0.3 µg/L (10/1/10)	30-Dec-09	0.4	25.0	---	ND	1.4 J	37.4	1.5 J	4.3 J	---	ND
		01-Jun-10	0.4	25.0	---	1.2 J	3.4 J	84.2	1.4 J	4.8 J	---	ND
29-Dec-10		0.20	25.0	---	1.2 B	2.8 J	2.3 J	1.6 J	5.5 J	14.5 J	0.26 J	
29-Jun-11		5.0	25.0	---	ND	ND	ND	ND	ND	22.0 J	ND	
01-Nov-11		5.0	25.0	---	7.2 J	ND	ND	ND	12.0 J	7.2 J	ND	
01-May-12		5.0	25.0	---	ND	ND	ND	ND	7.2 J	7.6 J	ND	
07-Nov-12		0.085	25.0	---	---	2.48 J	2.02 J	2.35 J	4.55 J	---	ND	
09-May-13		5.0	25.0	---	ND	ND	ND	ND	ND	---	ND	
07-Nov-13		5.0	25.0	---	---	ND	ND	ND	ND	---	ND	
05-Jun-14		5.0	25.0	---	ND	ND	11.4 J	ND	ND	ND	ND	
20-Nov-14		2.5	25.0	---	---	ND	3.2 J	ND	ND	9.4 J	ND	
27-Apr-15		2.5	25.0	---	---	ND	ND	ND	8.9 J	5.6 J	ND	
19-Nov-15		2.5	25.0	---	---	3.1 J	4.3 J	ND	6.5 J	3.9 J	ND	
28-Jun-16		2.5	25.0	---	---	ND	45.2	ND	6.8 J	7.6 J	ND	
Zinc NC 2L = 1,000 µg/L (1/11/10)		30-Dec-09	2.7	10.0	---	ND	10.1 B	204	15.9 B	24.8 B	---	5.8 J
		01-Jun-10	2.7	10.0	---	16.2	13.5	415	8.5 J	22.2	---	ND
	29-Dec-10	0.40	10.0	---	12.2 B	15.8 B	8.9 B	ND	4.6 B	38.1 B	12.5	
	29-Jun-11	10.0	10.0	---	ND	23.6 B	22.3 B	ND	15.5 B	91.2	10.5	
	01-Nov-11	10.0	10.0	---	16.6	ND	40.0	ND	16.2	31.4	ND	
	01-May-12	10.0	10.0	---	ND	ND	13.5	ND	10.2	12.0	ND	
	07-Nov-12	1.31	10.0	---	---	8.61 J	5.20 J	3.98 J	4.65 J	---	ND	
	09-May-13	10.0	10.0	---	ND	ND	ND	ND	ND	---	ND	
	07-Nov-13	10.0	10.0	---	---	13.8	10.4	ND	ND	---	ND	
	05-Jun-14	10.0	10.0	---	ND	ND	89.0	ND	ND	19.4	ND	
	20-Nov-14	5.0	10.0	---	---	ND	20.9	ND	ND	55.0	ND	
	27-Apr-15	5.0	10.0	---	---	7.3 B	11.5 B	8 B	14.1 B	10.3 B	7.5 J	
	19-Nov-15	5.0	10.0	---	---	ND	23.1	7.3 J	10.7	16.3	ND	
	28-Jun-16	5.0	10.0	---	---	ND	404	ND	6.5 J	5.7 J	ND	

**APPENDIX A:
HISTORICAL DETECTED GROUNDWATER CONSTITUENTS**

Analyte	Sample Date	DL	RL	MW-1	MW-6	MW-2	MW-3S	MW-3D	MW-4	MW-5	Blanks	
Organic Compounds												
Acetone NC 2L = 6,000 µg/L (1/11/10)	29-Jun-11	2.2	100	---	ND	2.3	B 2.4	B 3.9	B ND	3.8	B 5.3	
	01-Nov-11	2.2	100	---	ND	ND	ND	ND	ND	ND	14.6	
	01-May-12	2.2	100	---	ND	ND	ND	ND	ND	ND	ND	
	07-Nov-12	0.193	100	---	---	ND	ND	ND	ND	---	ND	
	09-May-13	10.0	100	---	ND	ND	ND	ND	ND	---	12.0	
	07-Nov-13	10.0	100	---	---	ND	ND	ND	ND	---	ND	
	05-Jun-14	10.0	100	---	ND	ND	ND	ND	ND	ND	ND	
	20-Nov-14	10.0	100	---	---	ND	ND	ND	ND	ND	ND	
	27-Apr-15	10.0	100	---	---	ND	14.8	B ND	21.3	B 14.1	B 20.7	
	19-Nov-15	10.0	100	---	---	ND	ND	ND	ND	ND	ND	
	28-Jun-16	10.0	100	---	---	ND	ND	ND	ND	ND	ND	
	Benzene NC 2L = 1 µg/L (10/23/07)	30-Dec-09	0.1	1.0	---	ND	8.4	0.3	J 0.4	J 0.3	J ---	ND
		01-Jun-10	0.1	1.0	---	ND	2.9	ND	ND	ND	---	ND
29-Dec-10		0.25	1.0	---	ND	8.1	ND	ND	ND	ND	ND	
29-Jun-11		0.25	1.0	---	ND	7.2	0.38	J 0.45	J 0.42	J ND	ND	
01-Nov-11		0.25	1.0	---	ND	8.6	ND	ND	ND	ND	ND	
01-May-12		0.25	1.0	---	ND	6.7	0.36	J 0.45	J 0.42	J ND	ND	
07-Nov-12		0.111	1.0	---	---	8.63	0.430	J 0.504	J 0.478	J ---	ND	
09-May-13		0.25	1.0	---	ND	5.2	0.27	J 0.32	J 0.30	J ---	ND	
07-Nov-13		0.25	1.0	---	---	6.9	0.33	J 0.38	J 0.39	J ---	ND	
05-Jun-14		0.25	1.0	---	ND	6.0	ND	0.42	J 0.40	J ND	ND	
20-Nov-14		0.25	1.0	---	---	6.2	0.30	J ND	0.32	J ND	ND	
27-Apr-15		0.25	1.0	---	---	6.4	0.38	J 0.48	J 0.45	J ND	ND	
19-Nov-15		0.25	1.0	---	---	6.0	ND	0.37	J ND	ND	ND	
28-Jun-16	0.25	1.0	---	---	4.9	ND	ND	ND	ND	ND		
Bromoform NC 2L = µg/L 4 (10/23/07)	09-May-13	0.26	3.0	---	ND	ND	0.37	B ND	ND	---	0.37	
	07-Nov-13	0.26	3.0	---	---	ND	ND	ND	ND	---	ND	
	05-Jun-14	0.26	3.0	---	ND	ND	ND	ND	ND	ND	ND	
	20-Nov-14	0.26	3.0	---	---	ND	ND	ND	ND	ND	ND	
	27-Apr-15	0.26	3.0	---	---	ND	ND	ND	ND	ND	ND	
	19-Nov-15	0.26	3.0	---	---	ND	ND	ND	ND	ND	ND	
	28-Jun-16	0.26	3.0	---	---	ND	ND	ND	ND	ND	ND	
Chlorobenzene NC 2L = 50 µg/L (10/23/07)	30-Dec-09	0.1	3.0	---	ND	0.5	J 0.6	J ND	ND	---	ND	
	01-Jun-10	0.1	3.0	---	ND	ND	ND	ND	ND	---	ND	
	29-Dec-10	0.23	3.0	---	ND	0.61	J ND	ND	ND	ND	ND	
	29-Jun-11	0.23	3.0	---	ND	0.46	J 1.0	J 0.37	J ND	ND	ND	
	01-Nov-11	0.23	3.0	---	ND	0.59	J 1.1	J 0.37	J ND	ND	ND	
	01-May-12	0.23	3.0	---	ND	{0.42}	J 0.94	B 0.38	B ND	ND	0.30 {ND}	
	07-Nov-12	0.083	3.00	---	---	0.468	J 1.30	J 0.476	J ND	---	ND	
	09-May-13	0.23	3.0	---	ND	0.27	J 0.72	J 0.27	J ND	---	ND	
	07-Nov-13	0.23	3.0	---	---	0.42	J 0.97	J 0.38	J ND	---	ND	
	05-Jun-14	0.23	3.0	---	ND	0.30	J 0.78	J 0.33	J ND	ND	ND	
	20-Nov-14	0.23	3.0	---	---	0.37	J 0.95	J 0.36	J ND	ND	ND	
	27-Apr-15	0.23	3.0	---	---	0.27	J 1.0	J 0.40	J ND	ND	ND	
	19-Nov-15	0.23	3.0	---	---	0.31	J 0.81	J 0.33	J ND	ND	ND	
28-Jun-16	0.23	3.0	---	---	0.26	J 1.1	J 0.34	J ND	ND	ND		
Chloroethane NC 2L = 3,000 µg/L (1/11/10)	30-Dec-09	0.1	10.0	---	ND	ND	0.5	J 0.5	J ND	---	0.1	
	01-Jun-10	0.1	10.0	---	ND	ND	0.4	J ND	ND	---	ND	
	29-Dec-10	0.54	10.0	---	ND	ND	ND	ND	ND	ND	ND	
	29-Jun-11	0.54	10.0	---	ND	ND	0.77	J ND	0.57	J ND	ND	
	01-Nov-11	0.54	10.0	---	ND	ND	0.79	J ND	ND	ND	ND	
	01-May-12	0.54	10.0	---	ND	ND	ND	ND	ND	ND	ND	
	07-Nov-12	0.235	10.0	---	---	ND	ND	ND	ND	---	ND	
	09-May-13	0.54	10.0	---	ND	ND	ND	ND	ND	---	ND	
	07-Nov-13	0.54	10.0	---	---	ND	ND	ND	ND	---	ND	
	05-Jun-14	0.54	10.0	---	ND	ND	ND	ND	ND	ND	ND	
	20-Nov-14	0.54	10.0	---	---	ND	ND	ND	ND	ND	ND	
	27-Apr-15	0.54	10.0	---	---	ND	0.95	J 0.65	J 0.57	J ND	ND	
	19-Nov-15	0.54	10.0	---	---	ND	ND	ND	ND	ND	ND	
28-Jun-16	0.54	10.0	---	---	ND	ND	ND	ND	ND	ND		
1,4-Dichlorobenzene NC 2L = 6 µg/L (1/11/10)	30-Dec-09	0.1	1.0	---	ND	3.8	2.2	2.3	3.1	---	ND	
	01-Jun-10	0.1	1.0	---	ND	1.2	0.9	J ND	1.2	---	ND	
	29-Dec-10	0.33	1.0	---	ND	3.9	1.1	2.3	1.9	ND	ND	
	29-Jun-11	0.33	1.0	---	ND	3.8	2.8	3.6	3.2	ND	ND	
	01-Nov-11	0.33	1.0	---	ND	4.7	4.1	4.1	3.5	ND	ND	
	01-May-12	0.33	1.0	---	ND	4.0	2.7	4.1	3.2	ND	ND	
	07-Nov-12	0.083	1.00	---	---	5.12	2.93	4.08	3.64	---	ND	
	09-May-13	0.33	1.0	---	ND	3.6	2.0	3.1	2.3	---	ND	
	07-Nov-13	0.33	1.0	---	---	5.4	2.5	4.2	3.2	---	ND	
	05-Jun-14	0.33	1.0	---	ND	5.0	1.9	4.0	2.7	ND	ND	
	20-Nov-14	0.33	1.0	---	---	4.7	1.9	3.8	2.6	ND	ND	
	27-Apr-15	0.33	1.0	---	---	4.7	2.1	4.2	2.7	ND	ND	
	19-Nov-15	0.33	1.0	---	---	4.8	1.4	3.5	2.5	ND	ND	
28-Jun-16	0.33	1.0	---	---	4.8	1.7	3.9	2.4	ND	ND		

**APPENDIX A:
HISTORICAL DETECTED GROUNDWATER CONSTITUENTS**

Analyte	Sample Date	DL	RL	MW-1	MW-6	MW-2	MW-3S	MW-3D	MW-4	MW-5	Blanks	
1,1-Dichloroethane NC 2L = 6 µg/L (1/11/10)	30-Dec-09	0.2	5.0	---	ND	22.8	1.9 J	4.0 J	2.4 J	---	ND	
	01-Jun-10	0.2	5.0	---	ND	11.0	1.1 J	ND	1.2 J	---	ND	
	29-Dec-10	0.32	5.0	---	ND	28.2	2.4 J	4.1 J	2.6 J	ND	ND	
	29-Jun-11	0.32	5.0	---	ND	25.0	2.5 J	3.9 J	2.6 J	ND	ND	
	01-Nov-11	0.32	5.0	---	ND	27.2	2.3 J	4.0 J	2.3 J	ND	ND	
	01-May-12	0.32	5.0	---	ND	22.6	2.0 J	3.8 J	2.0 J	ND	ND	
	07-Nov-12	0.208	5.0	---	---	28.1	2.06 J	4.08 J	ND	---	ND	
	09-May-13	0.32	5.0	---	ND	18.7	1.4 J	3.0 J	1.6 J	---	ND	
	07-Nov-13	0.32	5.0	---	---	26.6	1.7 J	4.2 J	2.2 J	---	ND	
	05-Jun-14	0.32	5.0	---	ND	21.9	1.4 J	3.9 J	1.9 J	ND	ND	
	20-Nov-14	0.32	5.0	---	---	21.5	1.3 J	3.2 J	1.8 J	ND	ND	
	27-Apr-15	0.32	5.0	---	---	24.2	1.4 J	4.3 J	2.4 J	ND	ND	
	19-Nov-15	0.32	5.0	---	---	20.7	0.82 J	3.1 J	1.8 J	ND	ND	
	28-Jun-16	0.32	5.0	---	---	19.1	0.90 J	3.3 J	1.9 J	ND	ND	
	1,2-Dichloroethane NC 2L = 0.4 µg/L (1/11/10)	30-Dec-09	0.1	1.0	---	ND	1.2	0.7 J	1.2	ND	---	ND
		01-Jun-10	0.1	1.0	---	ND	ND	ND	ND	ND	---	ND
29-Dec-10		0.12	1.0	---	ND	ND	0.82 J	1.1	ND	ND	ND	
29-Jun-11		0.12	1.0	---	ND	0.76 J	0.86 J	1.3	ND	ND	ND	
01-Nov-11		0.12	1.0	---	ND	0.95 J	ND	1.3	ND	ND	ND	
01-May-12		0.12	1.0	---	ND	0.71 J	0.70 J	1.1	ND	ND	ND	
07-Nov-12		0.171	1.00	---	---	ND	ND	ND	ND	---	ND	
09-May-13		0.12	1.0	---	ND	0.50 J	0.49 J	0.81 J	ND	---	ND	
07-Nov-13		0.12	1.0	---	---	0.93 J	0.66 J	1.3	ND	---	ND	
05-Jun-14		0.12	1.0	---	ND	0.76 J	0.52 J	0.99 J	ND	ND	ND	
20-Nov-14		0.12	1.0	---	---	0.68 J	0.47 J	0.81 J	ND	ND	ND	
27-Apr-15		0.12	1.0	---	---	ND	0.56 J	1.2	0.15 J	ND	ND	
19-Nov-15		0.24	1.0	---	---	0.86 J	0.40 J	1.1	ND	ND	ND	
28-Jun-16		0.24	1.0	---	---	0.76 J	0.29 J	0.89 J	ND	ND	ND	
1,1-Dichloroethene NC 2L = 7 µg/L (10/23/07) NC 2L = 350 µg/L (04/01/2013)		30-Dec-09	0.1	5.0	---	ND	0.4 J	ND	ND	ND	---	ND
		01-Jun-10	0.1	5.0	---	ND	ND	ND	ND	ND	---	ND
	29-Dec-10	0.56	5.0	---	ND	ND	ND	ND	ND	ND	ND	
	29-Jun-11	0.56	5.0	---	ND	ND	ND	ND	ND	ND	ND	
	01-Nov-11	0.56	5.0	---	ND	ND	ND	ND	ND	ND	ND	
	01-May-12	0.56	5.0	---	ND	ND	ND	ND	ND	ND	ND	
	07-Nov-12	0.208	5.00	---	---	ND	ND	ND	ND	---	ND	
	09-May-13	0.56	5.0	---	ND	ND	ND	ND	ND	---	ND	
	07-Nov-13	0.56	5.0	---	---	ND	ND	ND	ND	---	ND	
	05-Jun-14	0.56	5.0	---	ND	4.7 J	ND	ND	ND	ND	ND	
	20-Nov-14	0.56	5.0	---	ND	ND	ND	ND	ND	ND	ND	
	27-Apr-15	0.56	5.0	---	---	ND	ND	ND	ND	ND	ND	
	19-Nov-15	0.56	5.0	---	---	ND	ND	ND	ND	ND	ND	
	28-Jun-16	0.56	5.0	---	---	ND	ND	ND	ND	ND	ND	
	cis-1,2-Dichloroethene NC 2L = 70 µg/L (10/23/07)	30-Dec-09	0.1	5.0	---	ND	68.2	11.0	51.0	21.8	---	ND
		01-Jun-10	0.1	5.0	---	ND	23.0	7.6	ND	10.2	---	ND
29-Dec-10		0.19	5.0	---	ND	66.7	16.8	56.7	24.1	ND	ND	
29-Jun-11		0.19	5.0	---	ND	55.1	16.5	62.7	25.1	ND	ND	
01-Nov-11		0.19	5.0	---	ND	59.4	15.2	59.3	23.2	ND	ND	
01-May-12		0.19	5.0	---	ND	[48.7]	14.2	59.5	22.1	ND	0.21 {ND} J	
07-Nov-12		0.103	5.00	---	---	59.7	13.6	71.3	26.4	---	ND	
09-May-13		0.19	5.0	---	ND	39.9	10.9	49.7	17.4	---	ND	
07-Nov-13		0.19	5.0	---	---	53.9	10.7	67.1	21.8	---	ND	
05-Jun-14		0.19	5.0	---	ND	47.0	11.2	58.1	20.0	ND	ND	
20-Nov-14		0.19	5.0	---	---	44.9	9.6	55.4	19.3	ND	ND	
27-Apr-15		0.19	5.0	---	---	51.8	9.7	65.3	24.0	ND	ND	
19-Nov-15		0.19	5.0	---	---	44.4	5.6	51.2	18.8	ND	ND	
28-Jun-16		0.19	5.0	---	---	42.4	7.5	53.2	19.5	ND	ND	
trans-1,2-Dichloroethene NC 2L = 100 µg/L (10/23/07)		30-Dec-09	0.1	5.0	---	ND	1.4 J	ND	0.2 J	0.2 J	---	ND
		01-Jun-10	0.1	5.0	---	ND	0.6 J	ND	ND	ND	---	ND
	29-Dec-10	0.49	5.0	---	ND	1.7 J	ND	ND	ND	ND	ND	
	29-Jun-11	0.49	5.0	---	ND	1.5 J	ND	ND	ND	ND	ND	
	01-Nov-11	0.49	5.0	---	ND	1.6 J	ND	ND	ND	ND	ND	
	01-May-12	0.49	5.0	---	ND	1.4 J	ND	ND	ND	ND	ND	
	07-Nov-12	0.077	5.00	---	---	1.59 J	ND	ND	ND	---	ND	
	09-May-13	0.49	5.0	---	ND	1.1 J	ND	ND	ND	---	ND	
	07-Nov-13	0.49	5.0	---	---	1.6 J	ND	ND	ND	---	ND	
	05-Jun-14	0.49	5.0	---	ND	1.4 J	ND	ND	ND	ND	ND	
	20-Nov-14	0.49	5.0	---	---	1.4 J	ND	ND	ND	ND	ND	
	27-Apr-15	0.49	5.0	---	---	1.6 J	ND	ND	ND	ND	ND	
	19-Nov-15	0.49	5.0	---	---	1.5 J	ND	ND	ND	ND	ND	
	28-Jun-16	0.49	5.0	---	---	1.4 J	ND	ND	ND	ND	ND	

**APPENDIX A:
HISTORICAL DETECTED GROUNDWATER CONSTITUENTS**

Analyte	Sample Date	DL	RL	MW-1	MW-6	MW-2	MW-3S	MW-3D	MW-4	MW-5	Blanks	
1,2-Dichloropropane NC 2L = 0.6 µg/L (1/11/10)	30-Dec-09	0.1	1.0	---	ND	5.7	0.6 J	1.1	0.7 J	---	ND	
	01-Jun-10	0.1	1.0	---	ND	1.9	ND	ND	ND	---	ND	
	29-Dec-10	0.27	1.0	---	ND	5.3	ND	ND	ND	ND	ND	
	29-Jun-11	0.27	1.0	---	ND	4.8	0.90 J	1.3	0.73 J	ND	ND	
	01-Nov-11	0.27	1.0	---	ND	4.9	0.76 J	1.3	ND	ND	ND	
	01-May-12	0.27	1.0	---	ND	4.4	0.76 J	1.4	0.62 J	ND	ND	
	07-Nov-12	0.150	1.0	---	---	4.93	ND	1.66	ND	---	ND	
	09-May-13	0.27	1.0	---	ND	3.3	0.51 J	0.96 J	0.45 J	---	ND	
	07-Nov-13	0.27	1.0	---	---	4.4	0.63 J	1.3	0.57 J	---	ND	
	05-Jun-14	0.27	1.0	---	ND	4.0	0.51 J	ND	0.41 J	ND	ND	
	20-Nov-14	0.27	1.0	---	---	4.1	0.56 J	1.2	0.36 J	ND	ND	
	27-Apr-15	0.27	1.0	---	---	4.8	0.59 J	1.6	0.57 J	ND	ND	
	19-Nov-15	0.27	1.0	---	---	4.3	ND	1.1	ND	ND	ND	
	28-Jun-16	0.27	1.0	---	---	4.3	ND	1.2	ND	ND	ND	
	Ethylbenzene NC 2L = 600 µg/L (10/23/07)	30-Dec-09	0.1	1.0	---	ND	ND	ND	0.4 J	ND	---	ND
		01-Jun-10	0.1	1.0	---	ND	ND	ND	ND	ND	---	ND
29-Dec-10		0.30	1.0	---	ND	ND	ND	ND	ND	ND	ND	
29-Jun-11		0.30	1.0	---	ND	ND	ND	ND	ND	ND	ND	
01-Nov-11		0.30	1.0	---	ND	ND	ND	ND	ND	ND	ND	
01-May-12		0.30	1.0	---	ND	ND	ND	ND	ND	ND	ND	
07-Nov-12		0.109	1.00	---	---	ND	ND	ND	ND	---	ND	
09-May-13		0.30	1.0	---	ND	ND	ND	ND	ND	---	ND	
07-Nov-13		0.30	1.0	---	---	ND	ND	ND	ND	---	ND	
05-Jun-14		0.30	1.0	---	ND	ND	ND	ND	ND	ND	ND	
20-Nov-14		0.30	1.0	---	---	ND	ND	ND	ND	ND	ND	
27-Apr-15		0.30	1.0	---	---	ND	ND	ND	ND	ND	ND	
19-Nov-15		0.30	1.0	---	---	ND	ND	ND	ND	ND	ND	
28-Jun-16		0.30	1.0	---	---	ND	ND	ND	ND	ND	ND	
Tetrachloroethene NC 2L = 0.7 µg/L (10/23/07)		30-Dec-09	0.2	1.0	---	ND	1.2	ND	ND	ND	---	ND
		01-Jun-10	0.2	1.0	---	ND	1.4	ND	ND	ND	---	ND
	29-Dec-10	0.46	1.0	---	ND	2.8	ND	ND	ND	ND	ND	
	29-Jun-11	0.46	1.0	---	ND	3.6	ND	ND	ND	ND	ND	
	01-Nov-11	0.46	1.0	---	ND	2.9	ND	ND	ND	ND	ND	
	01-May-12	0.46	1.0	---	ND	3.0	ND	ND	ND	ND	ND	
	07-Nov-12	0.193	1.00	---	---	2.52	ND	ND	ND	---	ND	
	09-May-13	0.46	1.0	---	ND	1.9	ND	ND	ND	---	ND	
	07-Nov-13	0.46	1.0	---	---	1.8	ND	ND	ND	---	ND	
	05-Jun-14	0.46	1.0	---	ND	2.3	ND	ND	ND	ND	ND	
	20-Nov-14	0.46	1.0	---	---	1.1	ND	ND	ND	ND	ND	
	27-Apr-15	0.46	1.0	---	---	1.4	ND	ND	ND	ND	ND	
	19-Nov-15	0.46	1.0	---	---	0.90 J	ND	ND	ND	ND	---	
	28-Jun-16	0.46	1.0	---	---	1.0	ND	ND	ND	ND	ND	
	Toluene NC 2L = 600 µg/L (1/11/10)	29-Jun-11	0.26	1.0	---	ND	ND	ND	ND	ND	0.76 J	ND
		01-Nov-11	0.26	1.0	---	ND	ND	ND	ND	ND	ND	ND
01-May-12		0.26	1.0	---	ND	ND	ND	ND	ND	ND	ND	
07-Nov-12		0.122	1.00	---	---	ND	ND	ND	ND	---	ND	
09-May-13		0.26	1.0	---	ND	ND	ND	ND	ND	---	ND	
07-Nov-13		0.26	1.0	---	---	ND	ND	ND	ND	---	ND	
05-Jun-14		0.26	1.0	---	ND	ND	ND	ND	ND	ND	ND	
20-Nov-14		0.26	1.0	---	---	ND	ND	ND	ND	ND	ND	
27-Apr-15		0.26	1.0	---	---	ND	ND	ND	ND	ND	ND	
19-Nov-15		0.26	1.0	---	---	ND	ND	ND	ND	ND	ND	
28-Jun-16		0.26	1.0	---	---	ND	ND	ND	ND	ND	ND	
Trichloroethene NC 2L = 3 µg/L (1/11/10)		30-Dec-09	0.1	1.0	---	ND	8.0	ND	ND	0.2 J	---	ND
		01-Jun-10	0.1	1.0	---	ND	6.4	ND	ND	ND	---	ND
		29-Dec-10	0.47	1.0	---	ND	10.1	ND	ND	ND	ND	ND
		29-Jun-11	0.47	1.0	---	ND	14.6	ND	ND	ND	ND	ND
		01-Nov-11	0.47	1.0	---	ND	10.2	ND	ND	ND	ND	ND
	01-May-12	0.47	1.0	---	ND	11.6	ND	ND	ND	ND	ND	
	07-Nov-12	0.161	1.00	---	---	9.97	ND	ND	ND	---	ND	
	09-May-13	0.47	1.0	---	ND	8.4	ND	ND	ND	---	ND	
	07-Nov-13	0.47	1.0	---	---	8.0	ND	ND	ND	---	ND	
	05-Jun-14	0.47	1.0	---	ND	8.9	ND	ND	ND	ND	ND	
	20-Nov-14	0.47	1.0	---	---	5.1	ND	ND	ND	ND	ND	
	27-Apr-15	0.47	1.0	---	---	7.1	ND	ND	ND	ND	ND	
	19-Nov-15	0.47	1.0	---	---	4.7	ND	ND	ND	ND	ND	
	28-Jun-16	0.47	1.0	---	---	4.9	ND	ND	ND	ND	ND	

APPENDIX A: HISTORICAL DETECTED GROUNDWATER CONSTITUENTS

Analyte	Sample Date	DL	RL	MW-1	MW-6	MW-2	MW-3S	MW-3D	MW-4	MW-5	Blanks	
Trichlorofluoromethane NC 2L = 2000 µg/L (1/11/10)	29-Jun-11	0.20	1.0	---	ND	0.95	J ND	ND	ND	ND	ND	
	01-Nov-11	0.20	1.0	---	ND	ND	ND	ND	ND	ND	ND	
	01-May-12	0.20	1.0	---	ND	ND	ND	ND	ND	ND	ND	
	07-Nov-12	0.157	1.00	---	---	ND	ND	ND	ND	---	ND	
	09-May-13	0.20	1.0	---	ND	0.66	J ND	ND	ND	---	ND	
	07-Nov-13	0.20	1.0	---	---	ND	ND	ND	ND	---	ND	
	05-Jun-14	0.20	1.0	---	ND	ND	ND	ND	ND	ND	ND	
	20-Nov-14	0.20	1.0	---	---	ND	ND	ND	ND	ND	ND	
	27-Apr-15	0.20	1.0	---	---	ND	ND	ND	ND	ND	ND	
	19-Nov-15	0.20	1.0	---	---	0.41	J ND	ND	ND	ND	ND	
	28-Jun-16	0.20	1.0	---	---	ND	ND	ND	ND	ND	ND	
	Vinyl chloride NC 2L = 0.03 µg/L (1/11/10)	30-Dec-09	0.1	1.0	---	ND	4.0	2.8	4.1	26.2	---	ND
		01-Jun-10	0.1	1.0	---	ND	2.2	3.0	ND	26.7	---	ND
29-Dec-10		0.62	1.0	---	ND	3.5	2.4	4.7	25.6	ND	ND	
29-Jun-11		0.62	1.0	---	ND	2.8	2.8	4.6	28.7	ND	ND	
01-Nov-11		0.62	1.0	---	ND	5.1	2.6	6.9	24.0	ND	ND	
01-May-12		0.62	1.0	---	ND	3.5	2.0	4.8	21.8	ND	ND	
07-Nov-12		0.127	1.00	---	---	7.94	2.73	6.99	29.9	---	ND	
09-May-13		0.62	1.0	---	ND	2.8	1.9	4.2	18.6	---	ND	
07-Nov-13		0.62	1.0	---	---	6.3	2.1	6.0	21.9	---	ND	
05-Jun-14		0.62	1.0	---	ND	7.1	5.6	8.9	21.9	ND	ND	
20-Nov-14		0.62	1.0	---	---	5.2	2.1	5.3	16.2	ND	ND	
27-Apr-15		0.62	1.0	---	---	5.3	2.4	7.1	21.4	ND	ND	
19-Nov-15		0.62	1.0	---	---	7.7	2.0	6.7	17.3	ND	ND	
28-Jun-16		0.62	1.0	---	---	4.6	2.3	6.1	17.0	ND	ND	
Xylene (Total) NC 2L = 500 µg/L (1/11/10)		30-Dec-09	0.3	4.0	---	ND	ND	ND	3.5	J ND	---	ND
		01-Jun-10	0.3	4.0	---	ND	ND	ND	ND	ND	---	ND
	29-Dec-10	0.66	2.0	---	ND	ND	ND	ND	ND	ND	ND	
	29-Jun-11	0.66	2.0	---	ND	ND	ND	ND	ND	ND	ND	
	01-Nov-11	0.66	2.0	---	ND	ND	ND	ND	ND	ND	ND	
	01-May-12	0.66	2.0	---	ND	0.89	J ND	ND	ND	ND	ND	
	07-Nov-12	0.179	5.00	---	---	ND	ND	ND	ND	---	ND	
	09-May-13	0.66	5.0	---	ND	ND	ND	ND	ND	---	ND	
	07-Nov-13	0.66	5.0	---	---	ND	ND	ND	ND	---	ND	
	05-Jun-14	0.66	5.0	---	ND	ND	ND	ND	ND	ND	ND	
	20-Nov-14	0.66	5.0	---	---	ND	ND	ND	ND	ND	ND	
	27-Apr-15	0.66	5.0	---	---	ND	ND	ND	ND	ND	ND	
	19-Nov-15	0.66	5.0	---	---	ND	ND	ND	ND	ND	ND	
	28-Jun-16	0.66	5.0	---	---	ND	ND	ND	ND	ND	ND	

Notes:

DL = Detection limit.

RL = Reporting limit (NC SWSL).

All concentrations are in micrograms per liter (µg/l).

NC 2L Standard is the groundwater quality standard established under 15A NCAC 2L.

GWPS = Groundwater Protection Standard (GWPS is used when the NC 2L Standard has not been established.)

Blanks = Quality control blanks, including trip, field, and laboratory blanks. The listed concentration is the highest value reported in all blanks associated with the samples.

ND = Not detected at the laboratory's detection limit.

J = Estimated value - concentration is less than the reporting limit but greater than the detection limit.

B = Blank-qualified data - the concentration is within five times the concentration reported in associated quality control blanks.

--- = Monitoring well was not sampled.

Bold values are greater than the NC 2L Standard or GWPS.

Appendix B

Historical Detected Surface Water Constituents

APPENDIX B: HISTORICAL DETECTED SURFACE WATER CONSTITUENTS

Analyte	Sample Date	DL	QL	SW-1	SW-2	SW-3	Blanks
Inorganic Compounds							
Antimony NC 2B = NE µg/L (05/01/07)	30-Dec-09	1.2	6.0	1.5 B	6.4 B	NS	1.4 J
	01-Jun-10	1.2	6.0	6.7 B	2.5 B	NS	3.9 J
	29-Dec-10	2.6	6.0	ND	ND	ND	ND
	29-Jun-11	5.0	6.0	ND	ND	ND	ND
	01-Nov-11	5.0	6.0	ND	ND	ND	ND
	01-May-12	5.0	6.0	ND	ND	ND	ND
	07-Nov-12	0.48	6.0	ND	ND	ND	ND
	09-May-13	5.0	6.0	ND	ND	ND	ND
	07-Nov-13	5.0	6.0	ND	ND	ND	ND
	05-Jun-14	5.0	6.0	ND	ND	ND	ND
	20-Nov-14	3.8	6.0	ND	ND	ND	ND
	27-Apr-15	3.8	6.0	ND	ND	ND	ND
	19-Nov-15	3.8	6.0	ND	ND	ND	ND
	28-Jun-16	3.8	6.0	ND	ND	ND	ND
Arsenic NC 2B = 50 µg/L (05/01/07)	07-Nov-12	0.094	10.0	0.17 B	0.26 B	0.24 B	1.0 J
	09-May-13	5.0	10.0	ND	ND	ND	ND
	07-Nov-13	5.0	10.0	ND	ND	ND	ND
	05-Jun-14	5.0	10.0	ND	ND	ND	ND
	20-Nov-14	2.5	10.0	ND	ND	ND	ND
	27-Apr-15	2.5	10.0	ND	ND	ND	ND
	19-Nov-15	2.5	10.0	3.0 J	ND	ND	ND
	28-Jun-16	2.5	10.0	ND	ND	ND	ND
Barium NC 2B = NE µg/L (05/01/07)	30-Dec-09	1.1	100	25.1 J	34 J	NS	3.4 J
	01-Jun-10	1.1	100	28.8 J	31.5 J	NS	2.0 J
	29-Dec-10	0.20	100	22.3 B	27.8 B	27.9 B	11.3 J
	29-Jun-11	5.0	100	40.0 J	39.4 J	39.3 J	ND
	01-Nov-11	5.0	100	30.1 J	35.2 J	34.3 J	ND
	01-May-12	5.0	100	66.1 J	35.4 J	33.3 J	ND
	07-Nov-12	0.39	100	27.6 B	31.5 B	29.9 B	12.2 J
	09-May-13	5.0	100	33.6 J	33.8 J	32.6 J	ND
	07-Nov-13	5.0	100	36.6 J	32.0 J	29.8 J	ND
	05-Jun-14	5.0	100	31.2 J	35.8 J	33.6 J	ND
	20-Nov-14	2.5	100	26.6 J	31.2 J	29.4 J	ND
	27-Apr-15	2.5	100	28.9 J	33.7 J	36.0 J	ND
	19-Nov-15	2.5	100	45.8 J	44.1 J	43.6 J	ND
	28-Jun-16	2.5	100	30.8 J	34.8 J	32.5 J	ND
Cadmium NC 2B = 2 µg/L (05/01/07)	30-Dec-09	0.2	1.0	ND	ND	NS	ND
	01-Jun-10	0.2	1.0	0.9 B	0.4 B	NS	0.4 J
	29-Dec-10	0.50	1.0	ND	ND	ND	ND
	29-Jun-11	1.0	1.0	ND	ND	ND	ND
	01-Nov-11	1.0	1.0	ND	ND	ND	ND
	01-May-12	1.0	1.0	ND	ND	ND	ND
	07-Nov-12	0.026	1.000	ND	ND	ND	ND
	09-May-13	1.0	1.0	ND	ND	ND	ND
	07-Nov-13	1.0	1.0	ND	ND	ND	ND
	05-Jun-14	1.0	1.0	ND	ND	ND	ND
	20-Nov-14	0.5	1.0	ND	ND	ND	ND
	27-Apr-15	0.5	1.0	ND	ND	ND	ND
	19-Nov-15	0.5	1.0	ND	ND	ND	ND
	28-Jun-16	0.5	1.0	ND	ND	ND	ND

**APPENDIX B:
HISTORICAL DETECTED SURFACE WATER CONSTITUENTS**

Analyte	Sample Date	DL	QL	SW-1	SW-2	SW-3	Blanks
Chromium NC 2B = 50 µg/L (05/01/07)	30-Dec-09	0.7	10.0	ND	ND	NS	ND
	01-Jun-10	0.7	10.0	1.7 J	1.2 J	NS	ND
	29-Dec-10	0.40	10.0	0.69 J	0.53 J	0.41 J	ND
	29-Jun-11	5.0	10.0	ND	ND	ND	ND
	01-Nov-11	5.0	10.0	ND	ND	ND	ND
	01-May-12	5.0	10.0	ND	ND	ND	ND
	07-Nov-12	0.030	10.0	0.29 B	0.13 B	0.11 B	0.099 J
	09-May-13	5.0	10.0	ND	ND	ND	ND
	07-Nov-13	5.0	10.0	ND	ND	ND	ND
	05-Jun-14	5.0	10.0	ND	ND	ND	ND
	20-Nov-14	2.5	10.0	ND	ND	2.7 J	ND
	27-Apr-15	2.5	10.0	ND	ND	ND	ND
	19-Nov-15	2.5	10.0	6.3 J	8.6 J	5.7 J	ND
	28-Jun-16	2.5	10.0	ND	ND	ND	ND
Cobalt NC 2B = NE µg/L (05/01/07)	30-Dec-09	0.7	10.0	ND	ND	NS	ND
	01-Jun-10	0.7	10.0	ND	ND	NS	ND
	29-Dec-10	0.60	10.0	ND	1.8 J	1.9 J	ND
	29-Jun-11	5.0	10.0	ND	ND	ND	ND
	01-Nov-11	5.0	10.0	ND	ND	ND	ND
	01-May-12	5.0	10.0	ND	ND	ND	ND
	07-Nov-12	0.053	10.0	0.34 B	0.76 B	0.76 B	0.24 J
	09-May-13	5.0	10.0	ND	ND	ND	ND
	07-Nov-13	5.0	10.0	ND	ND	ND	ND
	05-Jun-14	5.0	10.0	ND	ND	ND	ND
	20-Nov-14	2.5	10.0	ND	ND	ND	ND
	27-Apr-15	2.5	10.0	ND	ND	ND	ND
	19-Nov-15	2.5	10.0	ND	ND	ND	ND
	28-Jun-16	2.5	10.0	ND	ND	ND	ND
Copper NC 2B = 7 µg/L (05/01/07)	30-Dec-09	2.0	10.0	ND	ND	NS	ND
	01-Jun-10	2.0	10.0	6.9 B	5.8 B	NS	4.8 J
	29-Dec-10	0.30	10.0	0.38 J	ND	ND	ND
	29-Jun-11	5.0	10.0	ND	ND	ND	ND
	01-Nov-11	5.0	10.0	ND	ND	ND	ND
	01-May-12	5.0	10.0	ND	ND	ND	ND
	07-Nov-12	0.093	10.0	0.27 B	0.38 B	0.38 B	1.23 J
	09-May-13	5.0	10.0	ND	ND	ND	ND
	07-Nov-13	5.0	10.0	ND	ND	ND	ND
	05-Jun-14	5.0	10.0	ND	ND	ND	ND
	20-Nov-14	2.5	10.0	ND	ND	ND	ND
	27-Apr-15	2.5	10.0	3.5 B	7.2 B	ND	3.2 J
	19-Nov-15	2.5	10.0	5.2 J	6.5 J	5.9 J	ND
	28-Jun-16	2.5	10.0	ND	ND	ND	ND

APPENDIX B: HISTORICAL DETECTED SURFACE WATER CONSTITUENTS

Analyte	Sample Date	DL	QL	SW-1	SW-2	SW-3	Blanks
Lead NC 2B = 25 µg/L (05/01/07)	30-Dec-09	2.0	10.0	ND	ND	NS	ND
	01-Jun-10	2.0	10.0	2.7 B	2.8 B	NS	3.2 J
	29-Dec-10	4.0	10.0	ND	ND	ND	ND
	29-Jun-11	5.0	10.0	ND	ND	ND	ND
	01-Nov-11	5.0	10.0	ND	ND	ND	ND
	01-May-12	5.0	10.0	ND	ND	ND	ND
	07-Nov-12	0.025	10.0	0.071 B	0.049 B	0.060 B	0.58 J
	09-May-13	5.0	10.0	ND	ND	ND	ND
	07-Nov-13	5.0	10.0	ND	ND	ND	ND
	05-Jun-14	5.0	10.0	ND	ND	ND	ND
	20-Nov-14	2.5	10.0	ND	ND	ND	ND
	27-Apr-15	2.5	10.0	ND	ND	ND	ND
	19-Nov-15	2.5	10.0	4.7 J	2.6 J	5.0 J	ND
	28-Jun-16	2.5	10.0	ND	ND	ND	ND
Nickel NC 2B = 88 µg/L (05/01/07)	07-Nov-12	0.26	50.0	0.46 B	0.39 B	0.35 B	0.84 J
	09-May-13	5.0	50.0	ND	ND	ND	ND
	07-Nov-13	5.0	50.0	ND	ND	ND	ND
	05-Jun-14	5.0	50.0	ND	ND	ND	ND
	20-Nov-14	2.5	50.0	ND	ND	ND	ND
	27-Apr-15	2.5	50.0	ND	ND	ND	ND
	19-Nov-15	2.5	50.0	ND	3.0 J	ND	ND
	28-Jun-16	2.5	50.0	ND	ND	ND	ND
Vanadium NC 2B = NE µg/L (05/01/07)	30-Dec-09	0.4	25.0	2.0 J	0.8 J	NS	ND
	01-Jun-10	0.4	25.0	2.2 J	2.4 J	NS	ND
	29-Dec-10	0.20	25.0	0.67 B	0.37 B	0.62 B	0.26 J
	29-Jun-11	5.0	25.0	ND	ND	ND	ND
	01-Nov-11	5.0	25.0	ND	ND	ND	ND
	01-May-12	5.0	25.0	ND	ND	ND	ND
	07-Nov-12	0.085	25.0	0.63 J	0.44 J	0.52 J	ND
	09-May-13	5.0	25.0	7.8 J	9.1 J	9.4 J	ND
	07-Nov-13	5.0	25.0	ND	ND	ND	ND
	05-Jun-14	5.0	25.0	ND	ND	ND	ND
	20-Nov-14	2.5	25.0	ND	ND	ND	ND
	27-Apr-15	2.5	25.0	ND	2.80 J	ND	ND
	19-Nov-15	2.5	25.0	13.9 J	18.8 J	14.4 J	ND
	28-Jun-16	2.5	25.0	ND	ND	ND	ND
Zinc NC 2B = 50 µg/L (05/01/07)	30-Dec-09	2.7	10.0	6.7 B	ND	NS	4.7 J
	01-Jun-10	2.7	10.0	6.7 J	8.7 J	NS	ND
	29-Dec-10	0.40	10.0	ND	1.2 B	1.2 B	12.5
	29-Jun-11	10.0	10.0	ND	ND	ND	10.5
	01-Nov-11	10.0	10.0	ND	ND	ND	ND
	01-May-12	10.0	10.0	ND	ND	ND	ND
	07-Nov-12	1.31	10.0	ND	ND	1.56 J	ND
	09-May-13	10.0	10.0	ND	ND	ND	ND
	07-Nov-13	10.0	10.0	ND	ND	ND	ND
	05-Jun-14	10.0	10.0	ND	ND	ND	ND
	20-Nov-14	5.0	10.0	ND	ND	ND	ND
	27-Apr-15	5.0	10.0	8.9 B	10.5 B	9.3 B	7.5 J
	19-Nov-15	5.0	10.0	7.5 J	9.2 J	10.1	ND
	28-Jun-16	5.0	10.0	ND	ND	ND	ND

APPENDIX B: HISTORICAL DETECTED SURFACE WATER CONSTITUENTS

Analyte	Sample Date	DL	QL	SW-1	SW-2	SW-3	Blanks
Organic Compounds							
Acetone NC 2B = NE µg/L (05/01/07)	29-Jun-11	2.2	100	2.8 B	3.3 B	4.4 B	5.3 J
	01-Nov-11	2.2	100	ND	ND	ND	14.6 J
	01-May-12	2.2	100	ND	ND	ND	ND
	07-Nov-12	0.193	100	ND	ND	ND	ND
	09-May-13	10.0	100	ND	ND	ND	12.0 J
	07-Nov-13	10.0	100	ND	ND	ND	ND
	05-Jun-14	10.0	100	ND	ND	ND	ND
	20-Nov-14	10.0	100	ND	ND	ND	ND
	27-Apr-15	10.0	100	12.4 B	10.6 B	13.8 B	20.7 J
	19-Nov-15	10.0	100	ND	ND	ND	ND
	28-Jun-16	10.0	100	ND	ND	ND	ND
cis-1,2-Dichloroethene NC 2B = NE µg/L (05/01/07)	30-Dec-09	0.1	5.0	ND	ND	NS	ND
	01-Jun-10	0.1	5.0	ND	ND	NS	ND
	29-Dec-10	0.19	5.0	ND	0.39 J	ND	ND
	29-Jun-11	0.19	5.0	0.26 J	0.30 J	0.33 J	ND
	01-Nov-11	0.19	5.0	ND	ND	ND	ND
	01-May-12	0.19	5.0	0.31 B	ND	ND	0.21 (ND) J
	07-Nov-12	0.103	5.00	ND	ND	ND	ND
	09-May-13	0.19	5.0	ND	ND	ND	ND
	07-Nov-13	0.19	5.0	ND	0.38 J	ND	ND
	05-Jun-14	0.19	5.0	ND	0.33 J	ND	ND
	20-Nov-14	0.19	5.0	ND	0.49 J	ND	ND
	27-Apr-15	0.19	5.0	ND	ND	0.39 J	ND
	19-Nov-15	0.19	5.0	ND	ND	ND	ND
	28-Jun-16	0.19	5.0	ND	ND	ND	ND

Notes:

DL = Detection limit.

RL = Reporting limit (NC SWSL).

All concentrations are in micrograms per liter (µg/L).

Blanks = Quality control blanks, including trip, field, and laboratory blanks. The listed concentration is the highest reported in all blanks.

NC 2B = Surface Water Quality Standard from 15A NCAC 2B. (Freshwater Aquatic Life or Human Health Standard, whichever is lower.)

NE = Not established.

ND = Not detected at the laboratory's detection limit.

J = Estimated value - concentration is less than the reporting limit but greater than the detection limit.

B = Blank-qualified data, concentration within five times the concentration reported in the associated quality control blanks.

--- = Monitoring point was not sampled.

Bold values are greater than the NC 2B Standard.

Appendix C

BIOCHLOR Modeling Input & Output

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Town of Kernersville
Landfill
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ or 0.02 → 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

TYPE OF CHLORINATED SOLVENT: Ethenes Ethanes

1. ADVECTION

Seepage Velocity* Vs 61.0 (ft/yr)
Hydraulic Conductivity K 1.2E-06 (cm/sec)
Hydraulic Gradient i 0.05 (ft/ft)
Effective Porosity n 0.2 (-)

2. DISPERSION

Alpha x* 50 (ft) Calc.
(Alpha y) / (Alpha x)* 0.33 (-)
(Alpha z) / (Alpha x)* 1.E-99 (-)

3. ADSORPTION

Retardation Factor* R
Soil Bulk Density, rho 1.6 (kg/L)
Fraction Organic Carbon, foc 1.8E-3 (-)
Partition Coefficient Koc
PCE 426 (L/kg) 7.13 (-)
TCE 130 (L/kg) 2.87 (-)
DCE 125 (L/kg) 2.80 (-)
VC 30 (L/kg) (-)
ETH 302 (L/kg) (-)
Common R (used in model)* = 2.87

4. BIOTRANSFORMATION

Zone 1
PCE → TCE 2.300 (-) half-life (yrs) 0.79 Yield 0.79
TCE → DCE 2.100 (-) 0.74
DCE → VC 1.200 (-) 0.64
VC → ETH 0.000 (-) 0.45
Zone 2
PCE → TCE 2.300 (-) half-life (yrs) **λ HELP**
TCE → DCE 2.100 (-)
DCE → VC 1.200 (-)
VC → ETH 0.000 (-)

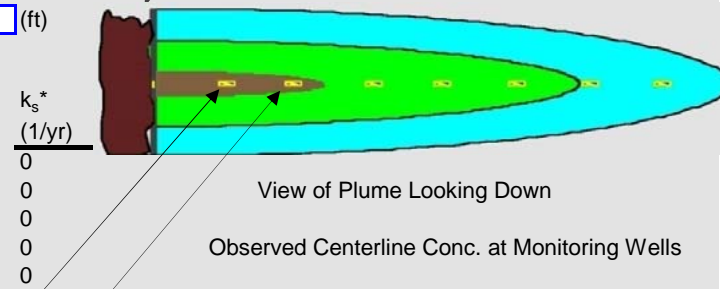
5. GENERAL

Simulation Time* 10 (yr)
Modeled Area Width* 700 (ft)
Modeled Area Length* 200 (ft)
Zone 1 Length* 150 (ft)
Zone 2 Length* 50 (ft)
Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Continuous Single Planar
Source Options
Source Thickness in Sat. Zone* 30 (ft)
Width* (ft) 700
Conc. (mg/L)* C1
PCE 0.0010
TCE 0.0049
DCE 0.0424
VC 0.0046
ETH 0.0000

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



7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	0.0010	0.0008	0.0005	0.0002	0.0001	0.0000				
TCE Conc. (mg/L)	0.0049	0.0040	0.0300	0.0020	0.0010	0.0000				
DCE Conc. (mg/L)	0.0424	0.0400	0.0300	0.0200	0.0100	0.0000				
VC Conc. (mg/L)	0.0046	0.0040	0.0300	0.0020	0.0010	0.0000				
ETH Conc. (mg/L)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
Distance from Source (ft)	20	40	60	80	100	120				
Date Data Collected	2014-06									

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

RUN ARRAY

Help

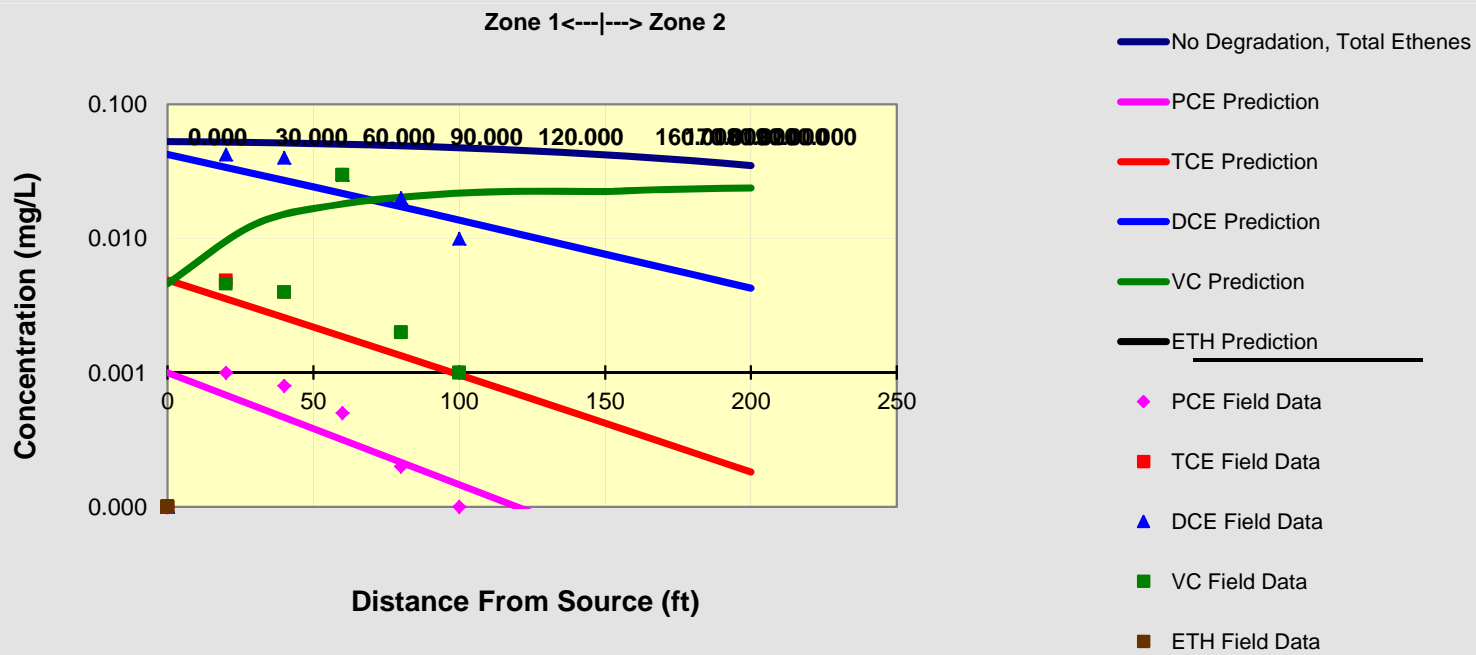
Restore

RESE

SEE

Paste

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE



Log Linear

Time:

To Input

To Individual Compounds

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

- Start Here
- PCE
 - TCE
 - DCE
 - VC
 - ETH

Transverse Distance (ft)

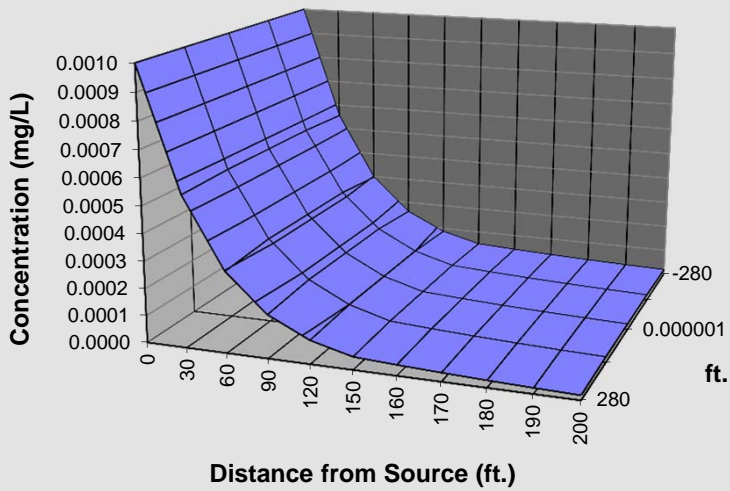
Distance from Source (ft)

	0	30	60	90	120	150	160	170	180	190	200
280	0.0010	0.0006	0.0003	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
140	0.0010	0.0006	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
0	0.0010	0.0006	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
-140	0.0010	0.0006	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
-280	0.0010	0.0006	0.0003	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Show No

Show

MASS RATE (mg/day) Time: yr Target Level: mg/L Displayed Model:



Plume Mass (Order-of-Magnitude Accuracy)

See Gallon

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)

See acre-ft

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	30	60	90	120	150	160	170	180	190	200
280	0.0049	0.0030	0.0018	0.0010	0.0006	0.0004	0.0003	0.0003	0.0002	0.0002	0.0001
140	0.0049	0.0030	0.0019	0.0011	0.0007	0.0004	0.0004	0.0003	0.0003	0.0002	0.0002
0	0.0049	0.0030	0.0019	0.0011	0.0007	0.0004	0.0004	0.0003	0.0003	0.0002	0.0002
-140	0.0049	0.0030	0.0019	0.0011	0.0007	0.0004	0.0004	0.0003	0.0003	0.0002	0.0002
-280	0.0049	0.0030	0.0018	0.0010	0.0006	0.0004	0.0003	0.0003	0.0002	0.0002	0.0001

Show No

Show

MASS
RATE
(mg/day)

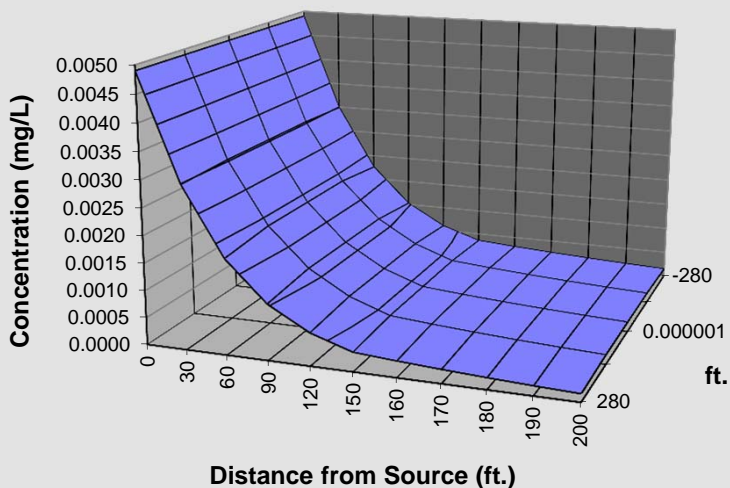
9.7E+1	6.0E+1	3.6E+1	2.2E+1	1.3E+1	7.8E+0	6.6E+0	5.6E+0	4.7E+0	4.0E+0	3.3E+0
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Displayed Compound

Time: yr

Target Level: mg/L

Displayed Model:



Plume Mass (Order-of-Magnitude Accuracy)

See Gallon 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)

See
acre-ft

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)

Plot All Data

Plot Data > Target

Mass HELP

To Centerline

Return to Input

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

- Start Here** → PCE
 TCE
 DCE
 VC
 ETH

Transverse Distance (ft)

Distance from Source (ft)

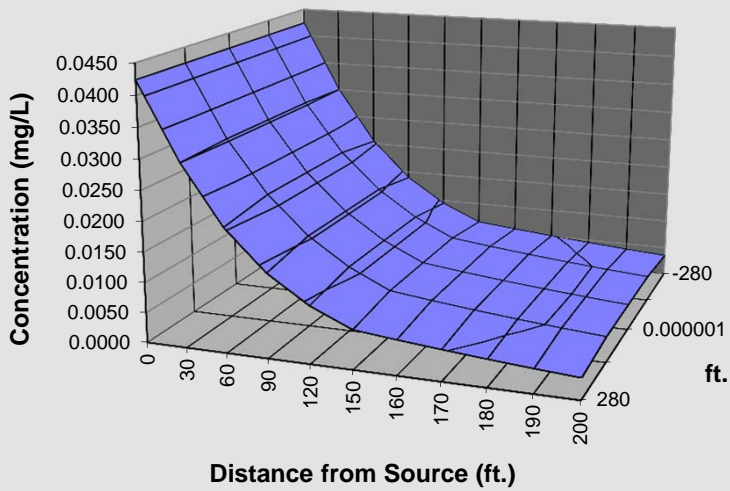
	0	30	60	90	120	150	160	170	180	190	200
280	0.0424	0.0300	0.0204	0.0139	0.0094	0.0064	0.0057	0.0051	0.0045	0.0039	0.0035
140	0.0424	0.0304	0.0217	0.0154	0.0109	0.0077	0.0068	0.0061	0.0054	0.0048	0.0042
0	0.0424	0.0304	0.0217	0.0154	0.0109	0.0077	0.0068	0.0061	0.0054	0.0048	0.0043
-140	0.0424	0.0304	0.0217	0.0154	0.0109	0.0077	0.0068	0.0061	0.0054	0.0048	0.0042
-280	0.0424	0.0300	0.0204	0.0139	0.0094	0.0064	0.0057	0.0051	0.0045	0.0039	0.0035

Show No

Show

MASS RATE (mg/day)

Time: yr Target Level: mg/L Displayed Model: Displayed Compound



Plume Mass (Order-of-Magnitude Accuracy)

See Gallon 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)

See acre-ft 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	30	60	90	120	150	160	170	180	190	200
280	0.0046	0.0126	0.0170	0.0190	0.0195	0.0188	0.0192	0.0194	0.0195	0.0194	0.0193
140	0.0046	0.0128	0.0181	0.0212	0.0225	0.0224	0.0228	0.0232	0.0234	0.0235	0.0236
0	0.0046	0.0128	0.0181	0.0212	0.0225	0.0224	0.0229	0.0232	0.0235	0.0237	0.0238
-140	0.0046	0.0128	0.0181	0.0212	0.0225	0.0224	0.0228	0.0232	0.0234	0.0235	0.0236
-280	0.0046	0.0126	0.0170	0.0190	0.0195	0.0188	0.0192	0.0194	0.0195	0.0194	0.0193

Show No

Show

MASS RATE (mg/day)

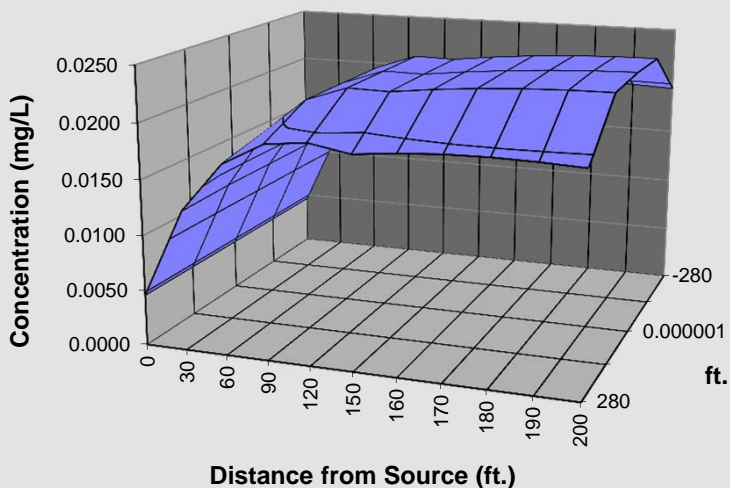
9.1E+1	2.5E+2	3.5E+2	4.0E+2	4.2E+2	4.2E+2	4.2E+2	4.2E+2	4.3E+2	4.3E+2	4.4E+2	4.3E+2
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Displayed Compound

Time: yr

Target Level: mg/L

Displayed Model:



Plume Mass (Order-of-Magnitude Accuracy)

See Gallon

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)

See acre-ft

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)

Plot All Data

Plot Data > Target

Mass HELP

To Centerline

Return to Input