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February 12, 2016

Mr. Lucas Berresford
South Carolina Department of Health and Environmental Control (SCDHEC) – Bureau of Land and Waste Management
State Remediation Section
2600 Bull Street
Columbia, SC 29201

Subject: Spartanburg Pine Street Manufactured Gas Plant (MGP) Feasibility Study Investigation Work Plan
Spartanburg County, Site ID #56553

Dear Mr. Berresford:

Per our meeting on October 22, 2015, and the submitted Work Plan Schedule memorandum dated November 10, 2015, attached is a copy of the Feasibility Study Work Plan for the above-referenced site. This Work Plan details the proposed scope of work and schedule for the additional data collection effort.

If you have any questions or concerns regarding the project or the proposed Work Plan, please feel free to contact me at 919-546-2104 or via email.

Sincerely,

Andrew W. Shull
Sr. Environmental Specialist

AECOM **Environment**

Submitted to
Duke Energy Co
410 S. Wilmington Street
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Submitted by
AECOM
Morrisville, NC
60400859

Feasibility Study Investigation Work Plan

Prepared for:

DUKE ENERGY CAROLINAS

Duke Energy Company
Former Pine Street MGP Site (Spartanburg)
Site No. 56553
684 North Pine Street
Spartanburg, SC

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List of Acronyms

ASTM	American Society for Testing and Materials
COCs	Constituents of Concern
CSM	Conceptual Site Model
DO	Dissolved Oxygen
DPT	Direct Push Technology
EPA	Environmental Protection Agency
FS	Feasibility Study
FID	Flame Ionization Detector
FFS	Focused Feasibility Study
Foc	Fraction Organic Carbon
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
ISCO	In-situ Chemical Oxidation
LIF	Laser Induced Fluorescence
MAROS	Monitoring and Remediation Optimization System
MGP	Manufactured Gas Plant
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
MNA	Monitored Natural Attenuation
MS/MSD	Matrix Spike / Matrix Duplicate
NTU	Nephelometric Turbidity Units
ORP	Oxidation-Reduction Potential
RBSL	Risk Based Screening Level
PWR	Partially Weathered Rock
PAH	Polycyclic Aromatic Hydrocarbons
PID	Photo Ionization Detector
PNG	Piedmont Natural Gas
SCDHEC	South Carolina Department of Health and Environmental Control
SVOCs	Semi-volatile Organic Compounds
QC	Quality Control
VOCs	Volatile Organic Compounds

1 Introduction

1.1 Purpose and Authority

This Work Plan has been prepared on behalf of Duke Energy (Duke) by AECOM to guide activities for additional soil and groundwater data collection, analysis, and reporting for the former Manufactured Gas Plant (MGP) site located at 684 North Pine Street in Spartanburg, South Carolina (the Site). Remediation efforts for the Site are regulated by South Carolina Department of Health and Environmental Control (SCDHEC) under the Voluntary Cleanup Program. During a meeting with SCDHEC on October 22, 2015, Duke and SCDHEC agreed that additional data collection is necessary to refine the Focused Feasibility Study (FFS) currently in development for the Site.

1.2 Background

The Site is approximately 7.4 acres bounded by North Pine Street (US Highway 176) to the west, Southern Railway System mainline tracks to the north, additional commercial/industrial property to the east, and Linder Road to the south. Piedmont Natural Gas Company (PNG) presently owns the majority of the former MGP property, which is located in a predominately commercial and industrial section of Spartanburg. Duke owns an electrical substation situated near the center of the property. Chinquapin Creek originates off-site and generally flows west to east through the center of the Site, eventually converging with Lawson Fork Creek approximately 3,600 feet east of the Site. In 2006, a Declaration of Covenants and Restrictions was executed by PNG that restricts the use of the property for residential, agricultural, recreational, child care and elderly care facilities, and schools (AMEC, 2012). The Site location and general layout are depicted on **Figures 1** and **2**, respectively.

MGP operations were conducted at the Site from the early 1900s to the mid-1950s. Extensive source area remediation was performed by Duke in 2003 and 2004. 67,596 tons of impacted soil and debris were excavated and properly disposed. In addition, a groundwater monitoring program was implemented to evaluate post-remediation groundwater quality. The well network has been sampled more than 30 times since 2004, which provides a statistically relevant dataset to evaluate Site groundwater conditions. Naphthalene and benzene are the primary constituents of concern (COCs) that currently remain at varying concentrations above regulatory cleanup levels in Site soil and groundwater at select locations. Overall, groundwater data indicate declining to stable COC conditions in groundwater.

Following approval of the 2005 Remedial Investigation, SCDHEC requested the development of a feasibility study (FS) to evaluate remedial options to improve Site groundwater quality. A focused FS (FFS) evaluating MNA, in-situ enhanced biodegradation, in-situ chemical oxidation (ISCO), in-situ stabilization, and excavation was delivered in 2008. Upon review of the report's conceptual site model (CSM), which suggested impacted materials remained at the Site, the SCDHEC requested a more thorough evaluation of soil data and remediation excavation limits.

A review of historical soil sampling data and excavation elevation data was performed by Duke to evaluate whether impacted soil exhibiting total PAH concentrations greater than 250 milligrams per kilogram (mg/kg) remained in the subsurface. The review concluded that while a majority of the known MGP-impacted material was removed from the Site, the localized presence of remaining impacted material above partially weathered rock (PWR) was likely (S&ME, 2011(a)). The majority of the suspected residual "source material" is limited to an area within the Phase I excavation area, near well clusters MW-12, MW-13 and MW-18, and is likely the source of COCs to groundwater in those areas (S&ME, 2011(b)). Historical groundwater monitoring data tend to corroborate the findings of the soil data review. The trend of COC concentrations in most wells over the past decade is an overall steady decline with periodic fluctuations. Although seasonal and drought-induced changes in the water table have been recorded, there is no strong correlation between these fluctuations and ephemeral fluctuations in COC concentrations. Plots of COC concentrations versus time are provided in **Appendix A**.

A remediation pilot study was performed in late 2012 and 2013, which consisted of injecting approximately 12,360 gallons of activated persulfate compound in the area of monitoring wells MW-13ISOC and MW-13S/D. The results of the ISCO pilot study were very good in that the persulfate compound caused reductions of COC concentrations by 65 to 95 percent in most observation wells. However, it was noted that the concentrations of COCs in one well (approximately 50 feet distance from the injection well) increased as result of nearby COC mass being influenced hydraulically (i.e., desorbed from soil matrix) without having been directly contacted by the persulfate compound (AMEC, 2014). Despite the generally very good short-term results in the observation wells, longer term groundwater monitoring data collected throughout a 22 month post-injection period indicate a rebounding trend in COC concentrations in wells MW-13S and MW-13D located approximately 20 feet from the location of the persulfate injection wells. These data, and conclusions from the injection completion report, indicate COC mass in the subsurface may remain in localized areas, continuing to influence nearby groundwater. The pilot test report recommended the collection and evaluation of additional data to enable the development of a FFS (AMEC, 2014).

As part of the initial data collection efforts, four new monitoring wells (ISOC-4S, -8, -15S, -18S) were installed in overburden material and three new wells (ISOC-4D, -15D, -18D) were installed in the PWR zone. The monitoring wells were sampled during semi-annual groundwater monitoring events in 2015 (AMEC, 2015(a)). Groundwater contour maps and COC plume boundary maps (for both shallow fractured bedrock and overburden) based on the September 2015 groundwater monitoring data are provided as **Figures 3** – **6**.

1.3 Current Conceptual Site Model

1.3.1 Nature and Extent

The Site formerly operated as a MGP facility, which resulted in the presence of coal gasification by-products in the saprolite and PWR below portions of the Site. Extensive remediation, consisting primarily of soil and sediment excavation, has successfully removed a significant amount of the coal gasification by-products. As a result, vadose zone soil impacts in exceedance of applicable criteria no longer remain. Due to Site constraints (e.g., shallow water table, occurrence of PWR), however, some residual coal gasification products were not removed during excavation and thus remain within saturated portions the subsurface. The presence of this residual material continues to affect portions of Site groundwater, which contains benzene and naphthalene above Risk Based Screening Levels (RBSLs) in both the saprolite and PWR horizons. The extent of COCs in groundwater has been delineated and COCs are contained on Site. Groundwater concentrations of both benzene and naphthalene are stable and/or decreasing based on over 30 groundwater monitoring events performed subsequent to the 2004 excavation activities. The extent of groundwater impacts is limited to a small area located north of Chinquapin Creek within the Site property boundary. The extent of groundwater impacts also appears to be stable or receding as monitoring within Chinquapin Creek has not revealed detectable concentrations of COCs (S&ME, 2011(c)).

Although groundwater impacts have been bounded, additional information concerning the areal extent and vertical distribution of coal gasification by-products would be useful for further remedial evaluation purposes and to provide a better understanding of degradation timeframes for COCs in Site groundwater.

1.3.2 Fate, Transport and Treatability

Geochemical and groundwater laboratory data suggest that anaerobic biodegradation processes are naturally occurring in groundwater. However, it is unknown if these geochemical signatures are the result of biodegradation of either benzene and/or naphthalene. Confirmation of biodegradation of both benzene and naphthalene is important to establish an understanding of natural attenuation. Soil physical properties (such as the fraction of organic carbon [foc]) are helpful to develop site-specific estimates of COC groundwater transport. While chemical oxidation has been demonstrated to be a short-term remedial technology candidate, it is uncertain if this technology is optimal, based on the known extent and likely occurrence of natural attenuation processes.

1.3.3 Risk Drivers

The primary risk drivers for the Site include exposure of industrial/utility workers to soils and groundwater. These risks are currently mitigated through land use restrictions.

Vapor intrusion and groundwater-surface water interaction pose no unacceptable risks or represent incomplete pathways. The site currently has development restrictions in place and there are no occupied buildings within the footprint of the underlying groundwater COC plume (ENSR, 2008). Furthermore, based on the post-remediation surface water data collected from Chinquapin Creek, a screening level ecological risk assessment concluded there were no unacceptable risks associated with the surface water from Chinquapin Creek (ENSR, 2008).

1.4 Investigation Objectives

As an overall objective, the activities outlined in this Work Plan will assist in the development of practical and acceptable remediation alternatives that address remaining COCs and facilitate groundwater remediation to acceptable cleanup levels in a reasonable timeframe. The specific objectives of this investigation are to gather data to (1) refine the distribution of residual COCs in the subsurface to inform the remedial alternatives analysis that will be included in the FFS, (2) prepare a fully developed CSM that includes fate and transport of COCs, and (3) properly evaluate the role and efficacy of MNA as part of the FFS.

2 Field Sampling Activities

The four main data collection activities outlined in this Work Plan are:

1. Utilization of Bio-Trap® samplers to quantitatively assess microbial activity in the subsurface, and specifically to evaluate if the biological degradation of benzene and naphthalene is naturally occurring and/or susceptible to enhancement.
2. Utilization of the TarGOST® high resolution profiling system to vertically and horizontally delineate potential residual source material above PWR.
3. Concurrent with the TarGOST® investigation, collect additional soil data necessary for fate and transport evaluation (i.e., analysis of natural organic carbon and potentially VOCs in the saturated zone).
4. Continuation of semi-annual groundwater monitoring events to further develop plume trends.

2.1 Activities Completed Prior to Fieldwork

SCDHEC Form 3736 (Monitoring Well Application) will be submitted and approved prior to advancing borings that meet the definition of a temporary well. Subsurface utility locating and mark-out will also be performed prior to the start of intrusive field work. Additionally, a site-specific health and safety plan (HASP) will be developed prior to field mobilization. All work will be performed in accordance with the health and safety protocols established by Duke and AECOM, as outlined in the HASP. SCDHEC will be notified at least five working days prior to initiating on-Site activities.

2.2 Bio-Trap® Installation

Microbiological data will be collected to determine (1) if hydrocarbon-degrading microbes are present and active in the subsurface and (2) if their activity is resulting in the biodegradation of benzene and naphthalene. These analyses will be performed using Bio-Trap® sampling methods. Bio-Trap® samplers are passive sampling devices that contain media (2-4 millimeter diameter beads) that are ideal for microbial colonization and growth. The sampler is deployed directly in groundwater monitoring wells (ideally submerged in the screened interval) and incubated for a period of 30 to 60 days to allow for microbial growth. Following incubation, samplers are retrieved and the growth media is analyzed via various methods to evaluate what microbial communities are present. Bio-Trap® samplers can be amended (baited) with a 13C-labeled constituent of interest (e.g., naphthalene). Following incubation, the presence of 13C in the remaining constituent of interest, biomass or inorganic carbon (CO2, HCO3-) is analyzed. The relative amount of 13C in each of these fractions is utilized to determine the extent and rate of intrinsic biodegradation (i.e., natural attenuation).

Five wells have been selected for deployment of Bio-Trap® samplers. Four of these wells are paired to evaluate the groundwater in the overburden and in the PWR. Wells ISOC-15S, ISOC-15D, MW-18S, MW-17S and ISOC-4D have been selected to represent the various Site conditions. The locations of these wells are illustrated on **Figure 7**. Wells MW-17S and ISOC-4D were selected to be representative of "background" conditions, while the remaining samplers are located within various areas of the groundwater plume. The samplers deployed in the background locations will contain only growth media; 13C labeled constituents will not be added. The samplers deployed within the groundwater plume will be baited with either 13C benzene or 13C naphthalene (only one 13C-labeled constituent will be placed within an individual well). Samplers will be deployed per manufacturer's instructions and are anticipated to be in the aforementioned Site wells for approximately six weeks.

2.3 TarGOST® Delineation

TarGOST®, a registered trademark of Dakota Technologies, is a version of laser induced fluorescence (LIF) technology specifically developed to evaluate sites impacted with high molecular weight PAHs, creosote, or coal tar. TarGOST® system technology will be used to delineate residual source material (i.e., coal tar residuals) in areas of the Site exhibiting persistent elevated COC concentrations in groundwater. The primary area to be investigated will be the historically named Phase I excavation area. The estimated boundary of data collection is shown on **Figure 8**. The objective is to generate enough corroborating data to identify and narrow the area and volume where concentrations of residual source material, if present, are located. It is anticipated that up to 40 borings may be advanced to accomplish the stated goals.

TarGOST® points will first be advanced at several locations where historical reports indicate residual COCs may still reside. Locations in the former Phase I excavation area that will be targeted are those adjacent to wells MW-12S, MW-13S, MW-18S, and MW-15S. A preliminary evaluation of the initial TarGOST® borings will be performed in the field, and a dynamic approach where subsequent boring locations are selected based on the preceding results will be implemented. This dynamic sampling approach requires field flexibility and will utilize active communication between field personnel, subcontractors, and the personnel primarily tasked with evaluating the information to obtain a sufficient degree of confidence that the area has adequately been delineated. TarGOST® points will typically be advanced to a depth of 5-feet below zones of apparent residual mass (i.e., positive LIF response) or until refusal, whichever is first. It is anticipated that most points would reach refusal at the PWR boundary, usually around 15 ft bgs.

Should areas of residual material be detected in locations where soil samples have not historically been collected, discrete soil samples may then be collected to definitively evaluate the concentration of remaining COC mass. These data are important in evaluating remediation options, especially MNA. The soil samples (if any) would be collected using a split-spoon sampler or direct push technology (DPT) rig capable of collecting soil samples at discrete intervals. Locations of soil borings would be determined in the field based on the analysis of the TarGOST® data. Samples would be submitted for laboratory analysis of VOCs by Environmental Protection Agency (EPA) Method 8260B. A flame-ionization detector (FID) would also be used to screen materials in the field for VOCs prior to sample collection.

Additionally, samples of non-impacted aquifer material will be collected and analyzed by American Society for Testing and Materials (ASTM) method D2974 (or similar EPA method) to evaluate the natural fraction of organic carbon (foc).

Upon completion, all borings will be properly sealed with bentonite grout delivered through a tremie pipe from the bottom of the borehole to the ground surface, per SCDHEC Well Standards.[1] The borings will be surveyed to record location and elevation, and documentation of boring abandonment will be provided to SCDHEC.

2.4 Semi-Annual Groundwater Monitoring

Semi-annual groundwater monitoring of the approved program wells will be performed. The seven new wells (ISOC -4S, -4D, -8, -15S, -15D, -18S, -18D) will also be sampled. The wells and corresponding analyses to be run are listed in **Table 1**.

Each monitoring well will be purged in accordance with EPA low-flow purging and sampling methods. Prior to sample collection a synoptic round of water levels will be collected to evaluate groundwater flow direction. The well ID, depth to water, date and time of water level collection will be recorded on a sample data sheet and field log book.

During purging of the well, water quality parameter measurements of pH, conductivity, temperature, turbidity, dissolved oxygen (DO), and oxidation-reduction potential (ORP) will be collected to evaluate when the purged water is representative of the groundwater conditions and ready for sample collection. Water quality instruments will be calibrated daily prior to sampling, and calibration will be re-verified periodically throughout the day. A groundwater sample is deemed representative of native groundwater if the above referenced water quality parameters are deemed stable.

Acceptable stability ranges are ±0.1 for pH, ±5% for conductivity, ≤10 nephelometric turbidity units (NTU) for turbidity, and ±0.2 milligrams per liter (mg/l) for DO.

All groundwater samples collected during semi-annual sampling events will be analyzed for VOCs (EPA Method 8260) and PAHs (EPA Method 8270). Select wells, as presented in **Table 1**, will be analyzed for MNA parameters by laboratory analytical methods as well as field testing procedures. The laboratory analytical suite for MNA include: methane, nitrogen/nitrate, nitrogen/nitrite, and alkalinity. The field testing procedures include: carbon dioxide, ferrous and ferric iron, hydrogen sulfide, and sulfate. A small subset of wells has been selected for collection and analysis of total organic carbon.

[1] SCDHEC 2002. South Carolina Well Standards; R.61-71 (I)

2.5 Laboratory Analysis

A SCDHEC-certified laboratory will be contracted through Duke to provide analytical services. Only pre-cleaned, laboratory-supplied sample containers will be used for sample collection. Samples will be preserved by the laboratory according to the specific analytical methods. Samples will be analyzed within method-specified holding times. All samples will be handled in accordance with chain-of-custody procedures. The laboratory analytical methods to be used during performance of the work are presented in **Table 2**.

2.6 Quality Control

Field quality control (QC) samples will be collected for each selected matrix. These will include field duplicates, trip blanks, and equipment blanks, as well as additional volumes for laboratory matrix spike and matrix spike duplicate (MS/MSD) analysis.

QC samples will be collected at the frequencies listed below and will be analyzed for each set of parameters on the chain-of-custody. Trip blanks will be analyzed only for VOCs and will only be analyzed in coolers containing VOCs for analysis.

QC sampling frequency:

- Equipment blanks - 5%
- Duplicate Samples - 5%
- Trip bank - 1 per event (minimum) and 1 per cooler containing samples for VOC analysis
- MS/MSD - 5%
- Equipment blank - 5%

2.7 Data Review Process

The certified laboratory will send results to the Duke laboratory staff for review. Laboratory data will also be reviewed and verified by AECOM for completeness.

2.8 Decontamination Procedures

Reusable or non-dedicated field equipment (e.g., augers, split-spoons, Macro-Core® samplers) will be properly decontaminated prior the first use and in between locations. This sampling equipment will be thoroughly decontaminated using a solution of anionic soap (e.g., Liquinox®) and deionized water and then rinsed with deionized water. Liquids generated during decontamination will be containerized in 55-gallon drums and handled as investigation derived waste (IDW).

2.9 Investigation Derived Waste Management

IDW (soils and liquids) will be temporarily stored in new or reconditioned, properly labeled 55-gallon drums. Labels will have the following information (at a minimum): date of generation, contents, and the generator name. Drums will be temporarily staged on pallets in a secure location until laboratory data is available to properly characterize and profile the waste. The IDW will then be promptly transported from the Site and properly disposed. General trash and disposables will be placed in plastic trash bags and disposed as municipal solid waste.

3 Data Evaluation and Deliverables

3.1 Investigation Results Report

Upon completion of the field data collection effort, the investigation results and data evaluation will be incorporated into the FFS currently in development. The data evaluation is aimed at filling specific gaps pertinent to the overall evaluation process of potential remedial options to complete groundwater remediation within an acceptable period of time.

3.1.1 TarGOST® Evaluation and CSM

The data generated by the TarGOST® system investigation, and laboratory-generated data (including data collected during the 2015 Additional Investigation and other historical data), will be used to evaluate the distribution of residual MGP COCs in the subsurface, if present. This information will allow for refinement of the current CSM which will be included in the FFS.

3.1.2 MNA Efficacy Evaluation

A multiple lines of evidence approach to assess the viability of MNA will be performed. Multiple lines of evidence are necessary to evaluate if site-specific COCs can attenuate naturally (and sufficiently) within a reasonable amount of time. The MNA data evaluation will focus on answering the following questions for each line of evidence:

- Plume stability (Is the plume stable or shrinking?)
- Groundwater geochemistry (Are groundwater parameters favorable to biodegradation processes?)
- Presence of microorganisms (Are there sufficient and correct microorganism populations present?)

A brief description of the work involved to analyze each line of evidence is provided below.

Plume Stability

The stability of the groundwater plume will be evaluated by calculating bulk plume metrics using the Monitoring and Remediation Optimization System (MAROS)[2] or Environmental Visualization System software. The software platforms are capable of calculating an overall plume mass, location of the plume center of mass and the change in location of the plume center of mass over time. These metrics are useful to develop a comprehensive understanding of the bulk behavior of the plume. To perform this analysis, a monitoring well network will be selected that is representative of the entire plume volume. The analysis will utilize the most recent 5 years of monitoring data and calculate parameters for benzene and naphthalene. Wells that may have been affected by pilot study injections will not be used in the plume assessment.

Geochemistry

The historical groundwater data set contains a substantial amount of geochemical information, including pH, DO, and ORP data collected during routine monitoring. Comparison of these geochemical parameters to the presence of benzene and naphthalene can help to provide an indication of the intrinsic biodegradation processes that are occurring. Additionally, the MNA parameters proposed for collection during 2016 monitoring events will help determine if electron acceptor concentrations are indicative of aerobic biodegradation processes.

Microbiology

Bio-Trap® samplers deployed at the Site will be analyzed via the QuantArray®-Petroleum methodology, which identifies functional genes specific to the aerobic and anaerobic biodegradation of petroleum hydrocarbons. Bio-Traps® and analyses will be performed by Microbial Insights Inc. (Knoxville, TN).

[2] GSI Environmental, Inc. 2013. Monitoring and Remediation Optimization System Software Version 3.0. User's Guide and Technical Manual.

3.2 Focused Feasibility Study

A FFS that establishes remedial action objectives, screens applicable remediation technologies, formulates viable remedial alternatives, and fairly evaluates the remedial alternatives based on implementability, effectiveness, and cost will be finalized based on the additional data collected.

Implementability and effectiveness will incorporate many aspects of the typical CERCLA-based FFS, including threshold and balancing criteria. For sites, such as this, which exhibit limited COCs, not all of the six additional balancing criteria are usually applicable. Therefore, an evaluation of the appropriate remedy based on effectiveness and the ability to implement, balanced by cost, will be needed to evaluate a concise list of available remedial alternatives.

3.3 Estimated Schedule

The anticipated project schedule is presented in **Appendix B**. Please note that the dates presented in the schedule are based on assumed submission dates and review times.

4 References

AMEC 2012. *Chemical Oxidation Pilot Test Work Plan, Pine Street Manufactured Gas Plant Site, Spartanburg, South Carolina*. Prepared for: Duke Energy, AMEC Environment & Infrastructure, Inc. Project No. 6228120021. May 29, 2012.

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S&ME 2011(a). *Soil Data Review Summary, Duke Energy Pine Street MGP Site, Spartanburg, South Carolina*. Prepared for: Duke Energy, S&ME Project No. 1264-02-146. February 28, 2011.

S&ME 2011(b). *Chemical Oxidation Work Plan, Duke Energy Pine Street MGP Site, Spartanburg, South Carolina*. Prepared for: Duke Energy, S&ME Project No. 1264-02-146. August 10, 2011.

S&ME 2011(c). *Groundwater and Surface Water Monitoring Report*, Duke Energy Pine Street MGP Site. S&ME Project No. 1264-08-107. November 30, 2011.

USEPA 2013. Operating Procedure: Groundwater Sampling. SESDPROC-301-R3. Effective March 6, 2013. <http://www.epa.gov/sites/production/files/2015-06/documents/Groundwater-Sampling.pdf>

Tables

TABLE 1
Summary of Proposed Semi-Annual Sampling and Laboratory Analyses
Duke Energy Pine Street MGP Site, Spartanburg, SC

Well ID		VOCs	SVOCs	Methane	Nitrogen/ Nitrate	Nitrogen/ Nitrite	Alkalinity	Hach Field Test				
		EPA Method 8260B	EPA Method 8270C	RSK-175	EPA Method 9056A	EPA Method 9056A	EPA Method 310.2	CO_2	Ferrous Iron	Ferric Iron	H_2S / Sulfide	Sulfate
Saprolite Wells	MW-1SS	X	X									
	MW-2SS	X	X									
	MW-3SS	X	X									
	MW-10S	X	X									
	MW-11S	X	X									
	MW-12S	X	X									
	MW-13S	X	X	X	X	X	X	X	X	X	X	X
	MW-13 ISOC	X	X									
	MW-14S	X	X									
	MW-15S	X	X									
	MW-16S	X	X									
	MW-17S	X	X	X	X	X	X	X	X	X	X	X
	MW-18S	X	X	X	X	X	X	X	X	X	X	X
	MW-19S	X	X									
	ISOC-4S	X	X									
	ISOC-8S	X	X									
	ISOC-15S	X	X	X	X	X	X	X	X	X	X	X
	ISOC-18S	X	X									
Partially Weathered / Fractured Rock Wells	MW-10D	X	X									
	MW-11D	X	X									
	MW-12D	X	X									
	MW-13D	X	X	X	X	X	X	X	X	X	X	X
	MW-14D	X	X									
	MW-15D	X	X									
	MW-16D	X	X									
	MW-18D	X	X	X	X	X	X	X	X	X	X	X
	ISOC-4D	X	X	X	X	X	X	X	X	X	X	X
	ISOC-15D	X	X	X	X	X	X	X	X	X	X	X
	ISOC-18D	X	X									
Deep Rock	MW-1DR	X	X									

Notes:
CO_2 - Carbon dioxide
EPA - Environmental Protection Agency
H_2S - Hydrogen sulfide
VOCs - Volatile Organic Compounds
SVOCs - Semi-Volatile Organic Compounds

TABLE 2
Summary of Proposed Laboratory Analytical Methods
Duke Energy Pine Street MGP Site, Spartanburg, SC

Parameter	Method
Soil Matrix	
Volatile Organic Compounds	SW-846 Method 8260B
Fraction of Organic Carbon	ASTM 2974
Groundwater Matrix	
Volatile Organic Compounds	SW-846 Method 8260B
Semi-Volatile Organic Compounds	SW-846 Method 8270D
Methane	RSK 175
Nitrogen/Nitrate	SW-846 Method 9056A
Nitrogen/Nitrite	SW-846 Method 9056A
Alkalinity	EPA Method 310.2

Notes:
ASTM - American Society for Testing and Materials
EPA - Environmental Protection Agency

Figures

Filename: P:\COMMON_PROJECTS\DUKE ENERGY\SPARTANBURG MGP\6.0 GRAPHICS\CAD\AECOM\FIGURE 1 - SITE LOCATION MAP.DWG

Project Management Initials: Designer: TSH Checked: SD Approved: CK

FEASIBILITY STUDY INVESTIGATION WORK PLAN
DUKE ENERGY CORPORATION-FORMER MGP SITE
SPARTANBURG, SOUTH CAROLINA
Project No.: 60400859 Date: 2016-01-07

SITE LOCATION MAP

AECOM

Figure: 1

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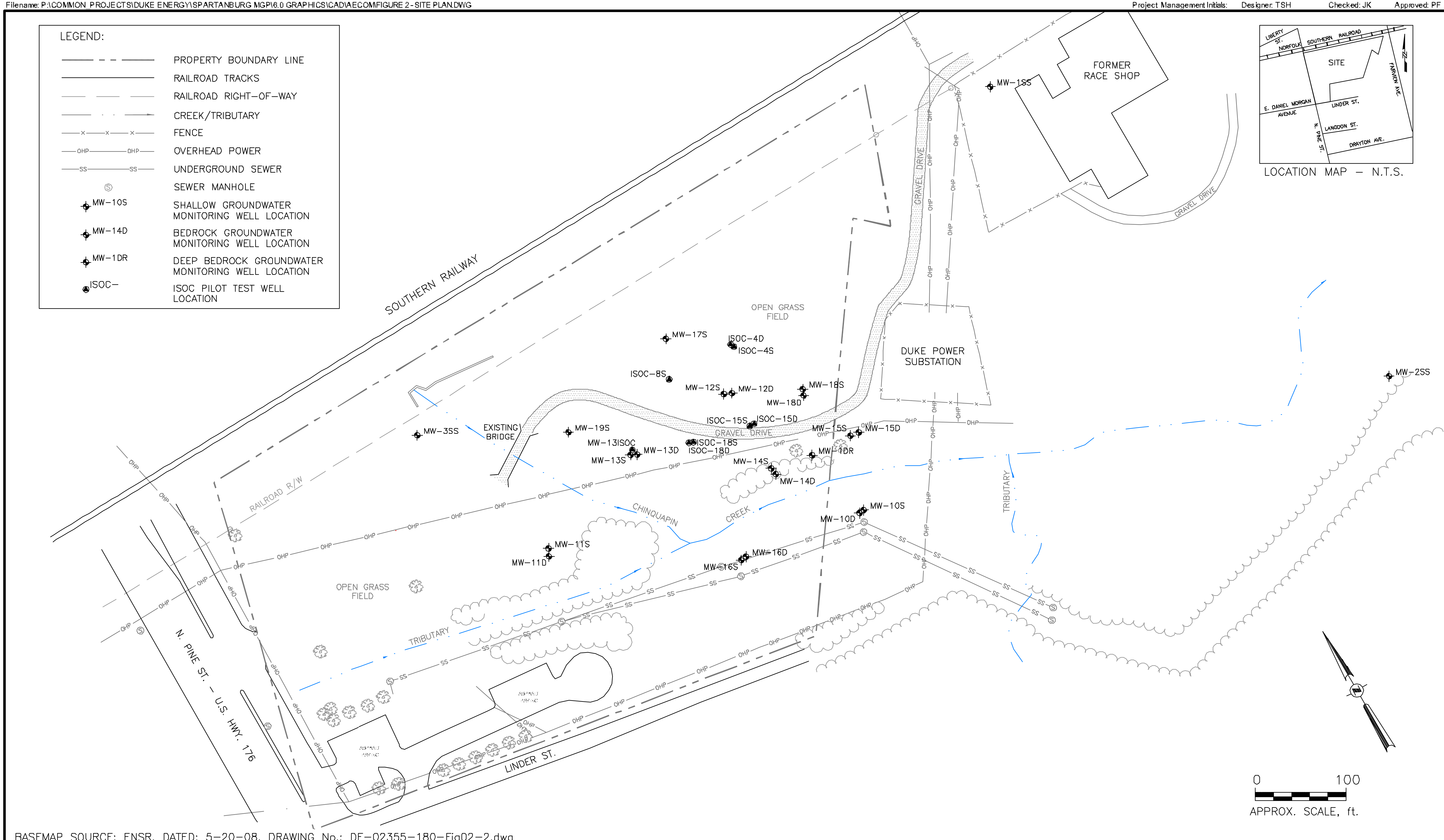
Project Management Initials: Designer: TSH Checked: JK Approved: PF



FEASIBILITY STUDY INVESTIGATION WORK PLAN
DUKE ENERGY CORPORATION-FORMER MGP SITE
SPARTANBURG, SOUTH CAROLINA
Project No.: 60400859 Date: 2016-01-08

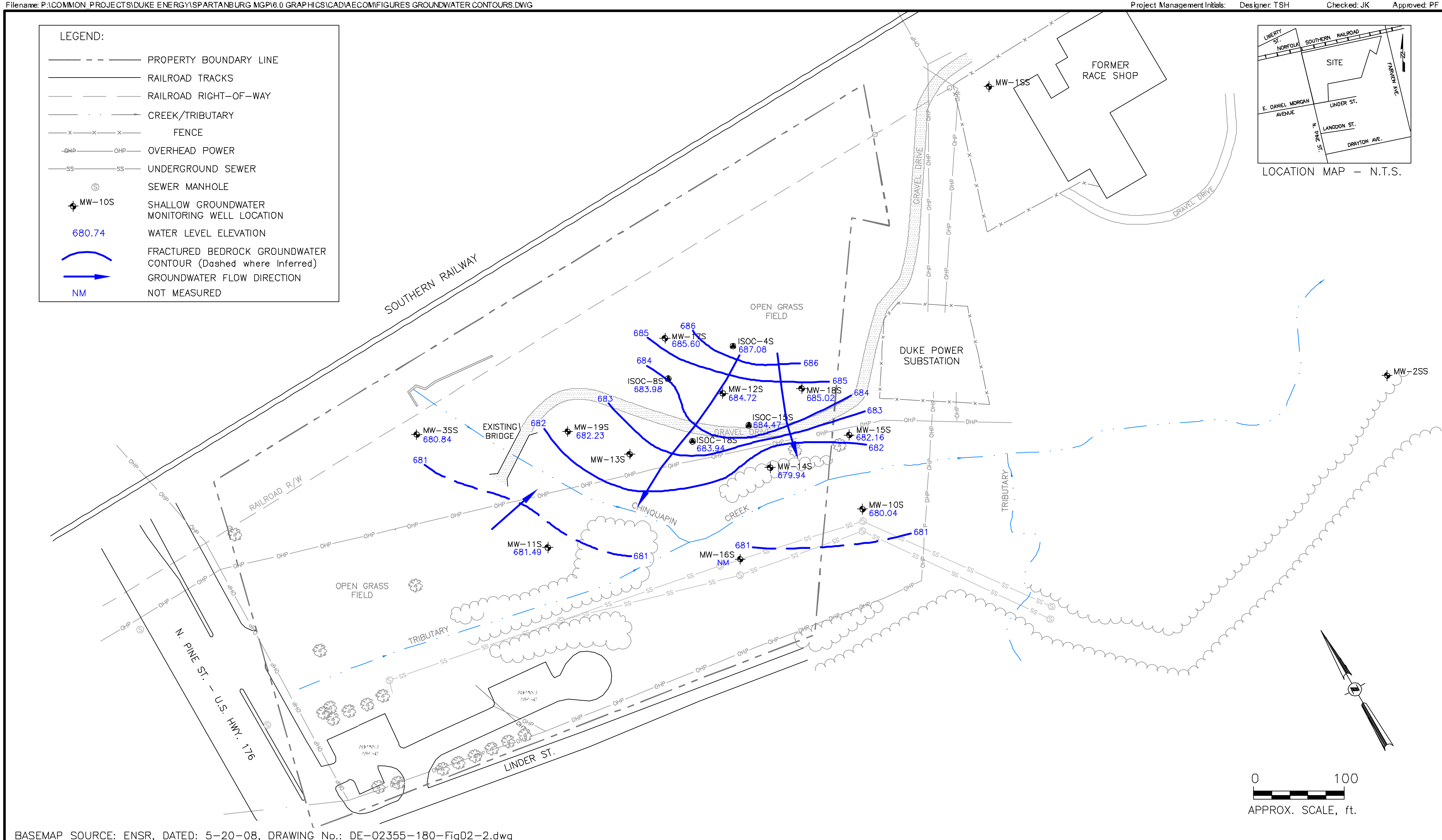
SITE PLAN

AECOM

Figure: 2

Filename: P:\COMMON_PROJECTS\DUKE ENERGY\SPARTANBURG MGP\6.0 GRAPHICS\CAD\AECOM\FIGURES GROUNDWATER CONTOURS.DWG

Project Management Initials: Designer: TSH Checked: JK Approved: PF



FEASIBILITY STUDY INVESTIGATION WORK PLAN
DUKE ENERGY CORPORATION-FORMER MGP SITE
SPARTANBURG, SOUTH CAROLINA
Project No.: 60400859 Date: 2016-01-08

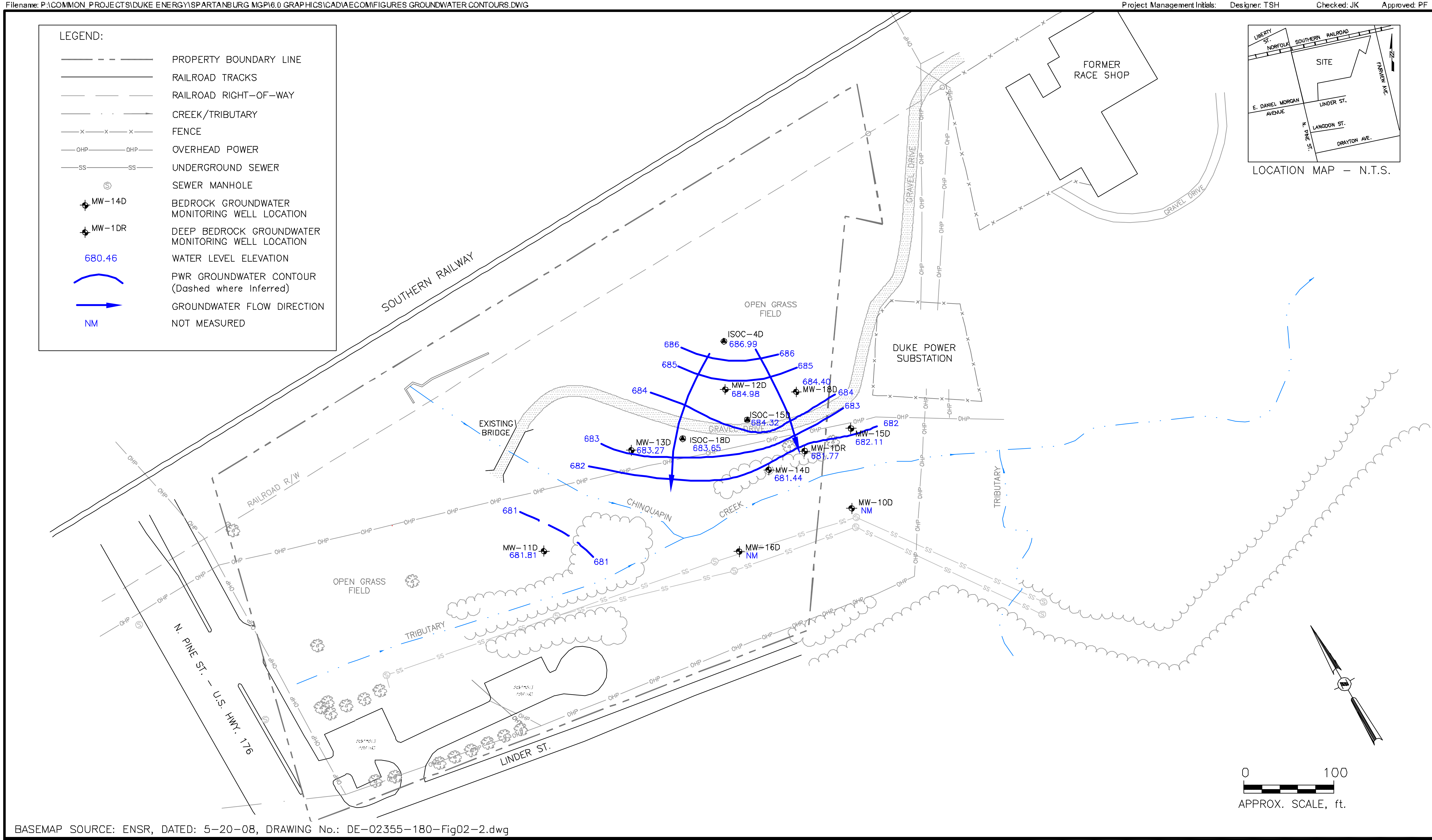
GROUNDWATER ELEVATIONS IN SAPROLITE WELLS - 9/14/2015

AECOM

Figure: 3

Filename: P:\COMMON_PROJECTS\DUKE ENERGY\SPARTANBURG MGP\6.0 GRAPHICS\CAD\AECOM\FIGURES GROUNDWATER CONTOURS.DWG

Project Management Initials: Designer: TSH Checked: JK Approved: PF



FEASIBILITY STUDY INVESTIGATION WORK PLAN
DUKE ENERGY CORPORATION-FORMER MGP SITE
SPARTANBURG, SOUTH CAROLINA
Project No.: 60400859 Date: 2016-01-08

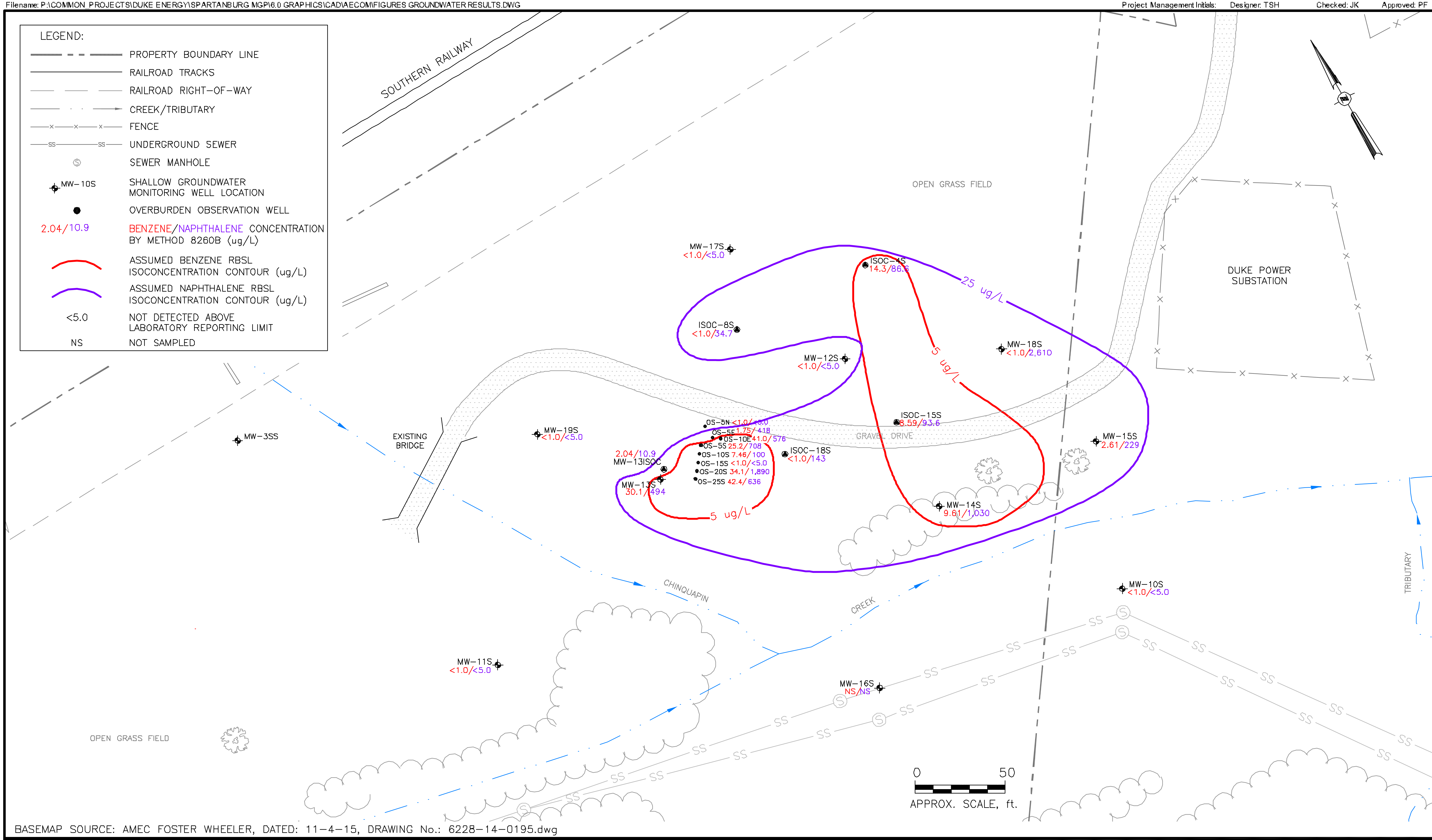
GROUNDWATER ELEVATIONS IN PWR AND FRACTURED ROCK WELLS - 9/14/2015

AECOM

Figure: 4

Filename: P:\COMMON_PROJECTS\DUKE ENERGY\SPARTANBURG MGP\6.0 GRAPHICS\CAD\AECOM\FIGURES GROUNDWATER RESULTS.DWG

Project Management Initials: Designer: TSH Checked: JK Approved: PF



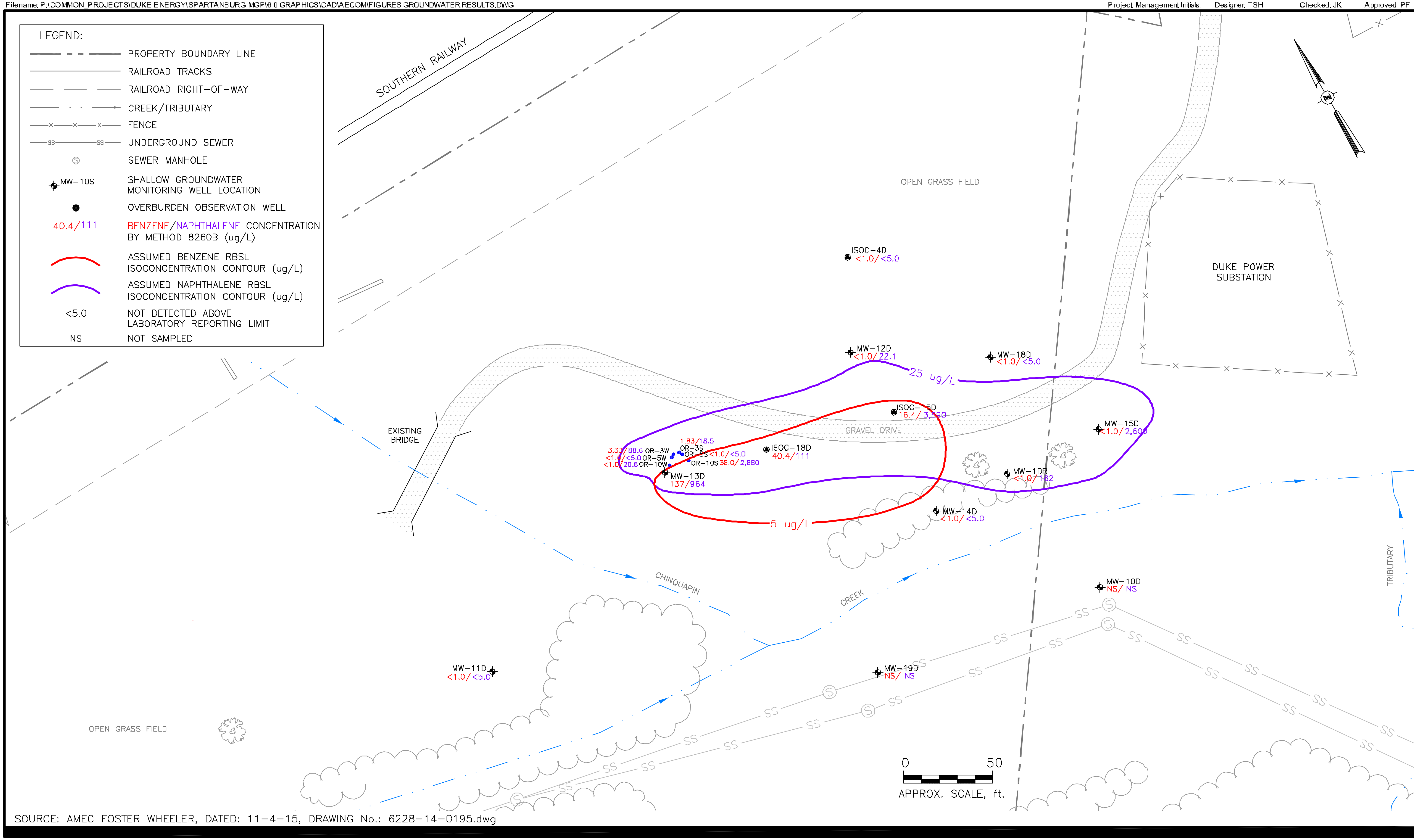
FEASIBILITY STUDY INVESTIGATION WORK PLAN
DUKE ENERGY CORPORATION-FORMER MGP SITE
SPARTANBURG, SOUTH CAROLINA
Project No.: 60400859 Date: 2016-01-08

BENZENE/NAPHTHALENE CONCENTRATIONS IN SAPROLITE WELLS - SEPTEMBER 2015

AECOM

Figure: 5

Filename: P:\COMMON_PROJECTS\DUKE ENERGY\SPARTANBURG MGP\6.0 GRAPHICS\CAD\AECOM\FIGURES GROUNDWATER RESULTS.DWG Project Management Initials: Designer: TSH Checked: JK Approved: PF



FEASIBILITY STUDY INVESTIGATION WORK PLAN
DUKE ENERGY CORPORATION-FORMER MGP SITE
SPARTANBURG, SOUTH CAROLINA
Project No.: 60400859 Date: 2016-01-08

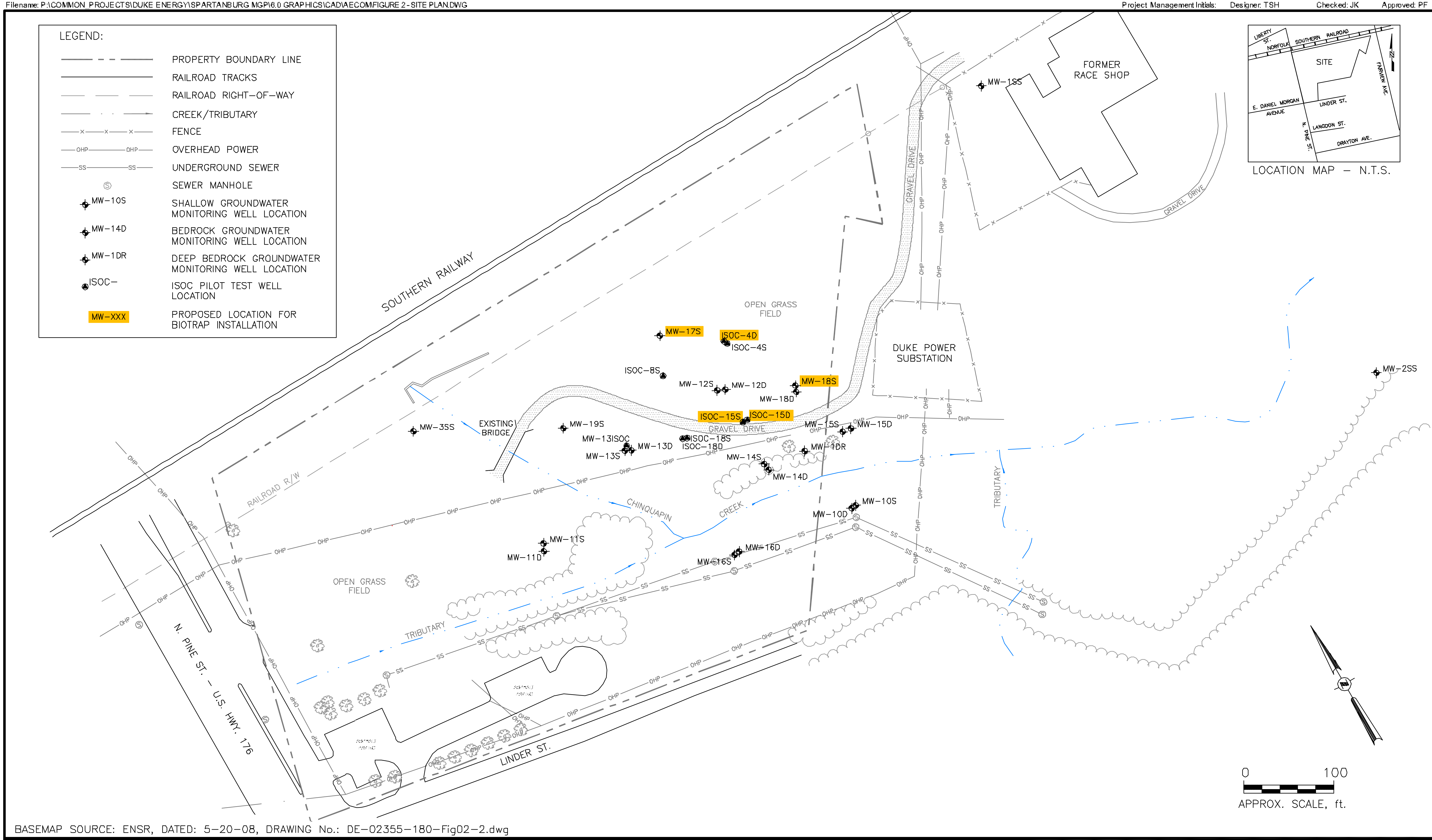
BENZENE/NAPHTHALENE CONCENTRATIONS IN PWR & FRACTURED ROCK WELLS - SEPTEMBER 2015

AECOM

Figure: 6

Filename: P:\COMMON_PROJECTS\DUKE ENERGY\SPARTANBURG MGP\6.0 GRAPHICS\CAD\AECOM\FIGURE 2 - SITE PLAN.DWG

Project Management Initials: Designer: TSH Checked: JK Approved: PF



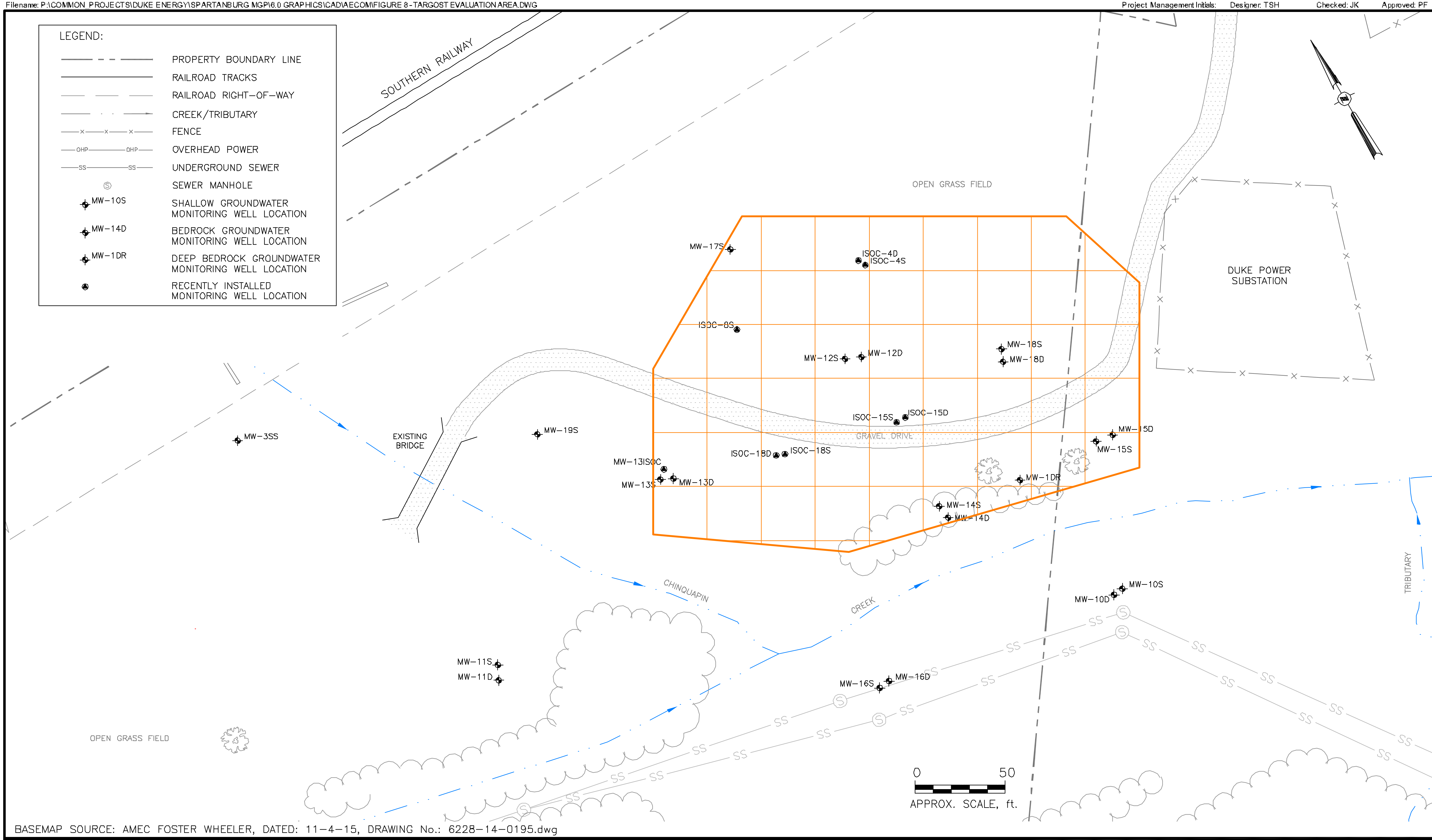
FEASIBILITY STUDY INVESTIGATION WORK PLAN
DUKE ENERGY CORPORATION-FORMER MGP SITE
SPARTANBURG, SOUTH CAROLINA
Project No.: 60400859 Date: 2016-01-08

PROPOSED LOCATIONS FOR BIOTRAP INSTALLATION

AECOM

Figure: 7

Filename: P:\COMMON_PROJECTS\DUKE ENERGY\SPARTANBURG MGP\6.0 GRAPHICS\CAD\AECOM\FIGURE 8-TARGOST EVALUATION AREA.DWG Project Management Initials: Designer: TSH Checked: JK Approved: PF



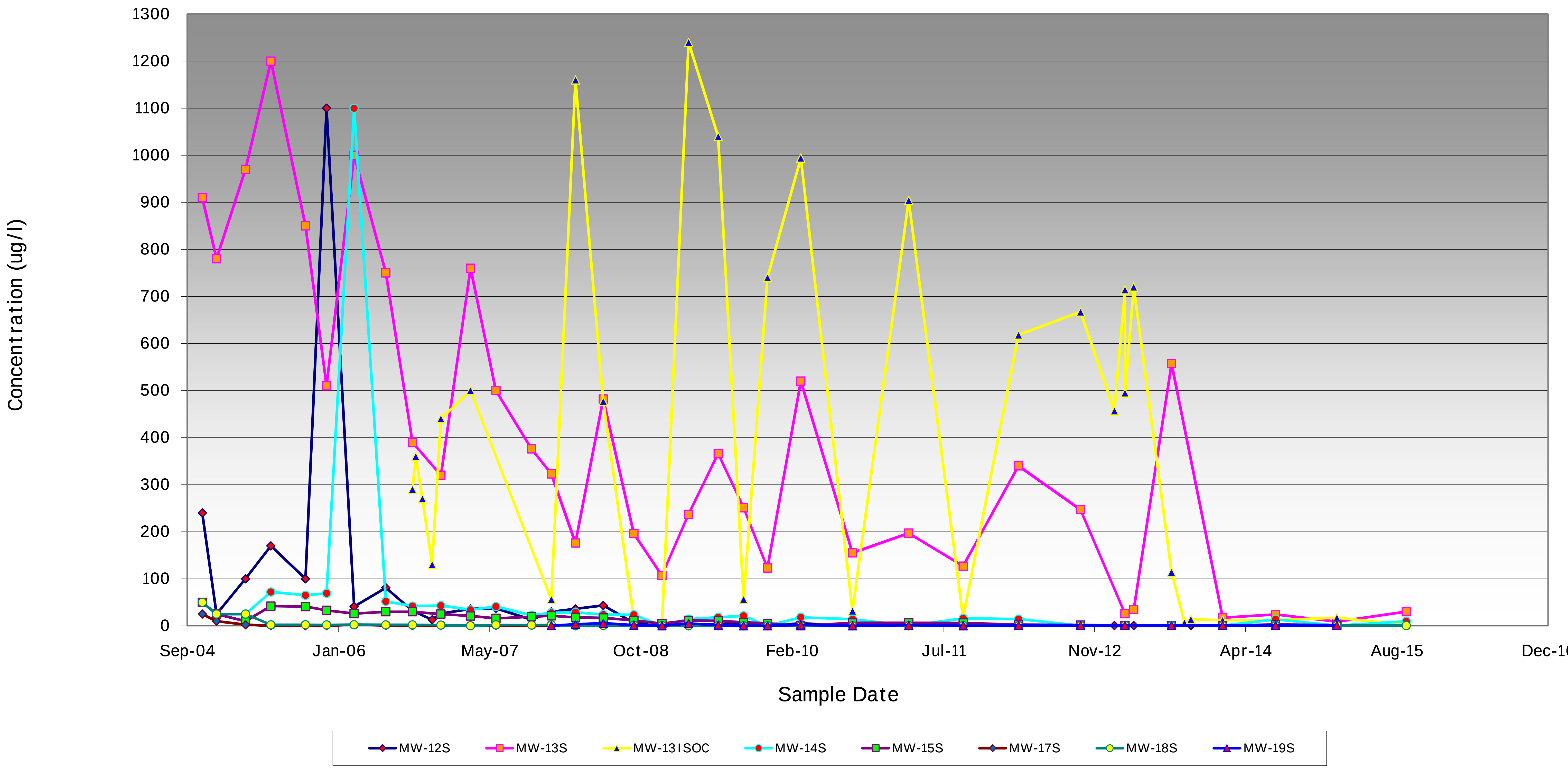
FEASIBILITY STUDY INVESTIGATION WORK PLAN
DUKE ENERGY CORPORATION-FORMER MGP SITE
SPARTANBURG, SOUTH CAROLINA
Project No.: 60400859 Date: 2016-01-08

TarGOST EVALUATION AREA

AECOM
Figure: 8

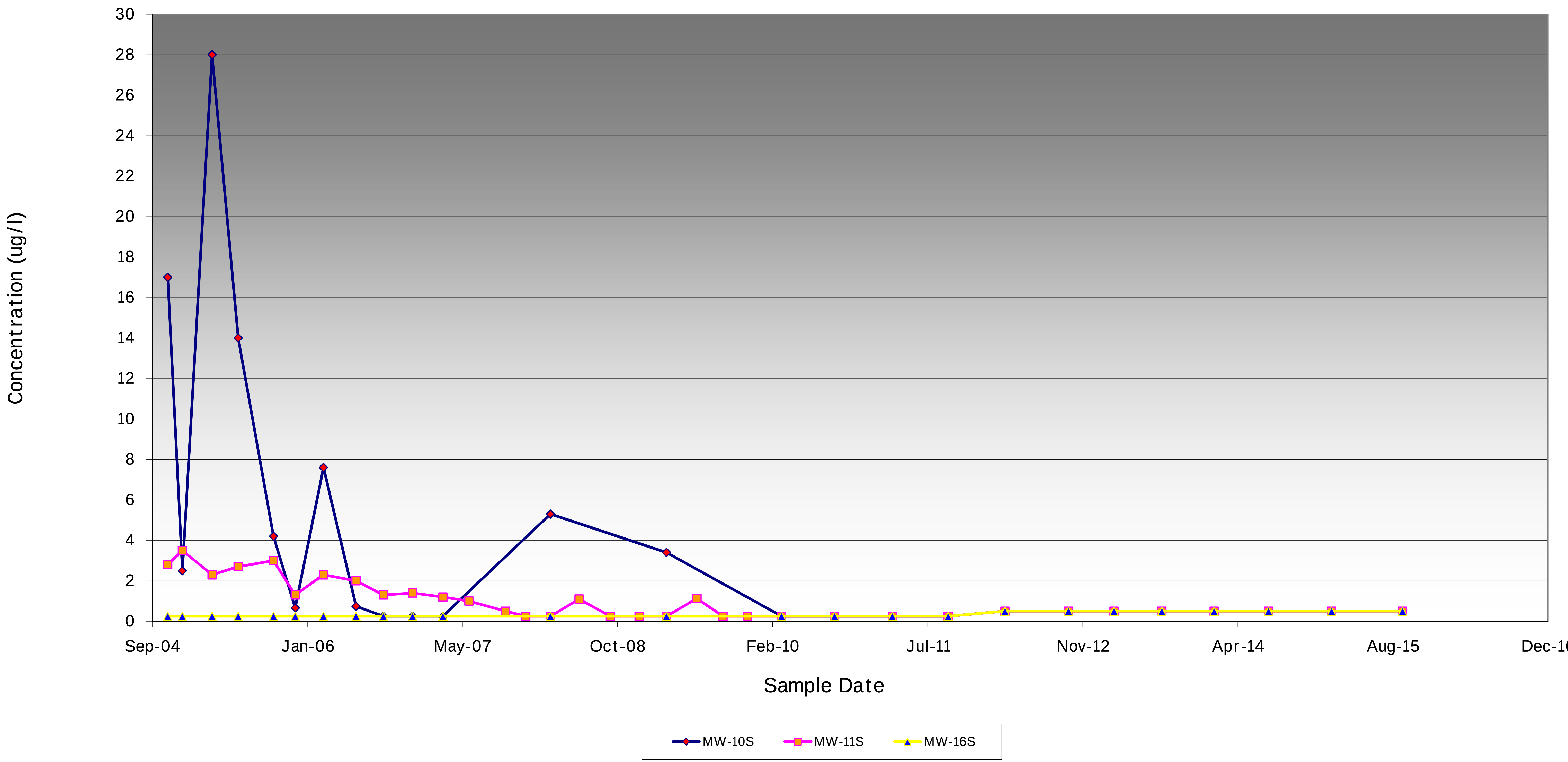
Appendix A. Groundwater COC Trend Graphs

Appendix A
Pine Street MGP
Historic Benzene Concentrations (8260B) in Saprolite Wells on North Side of Chinquapin Creek
MW-12S, MW-13S, MW-13ISOC, MW-14S, MW-15S, MW-17S, MW-18S and MW-19S

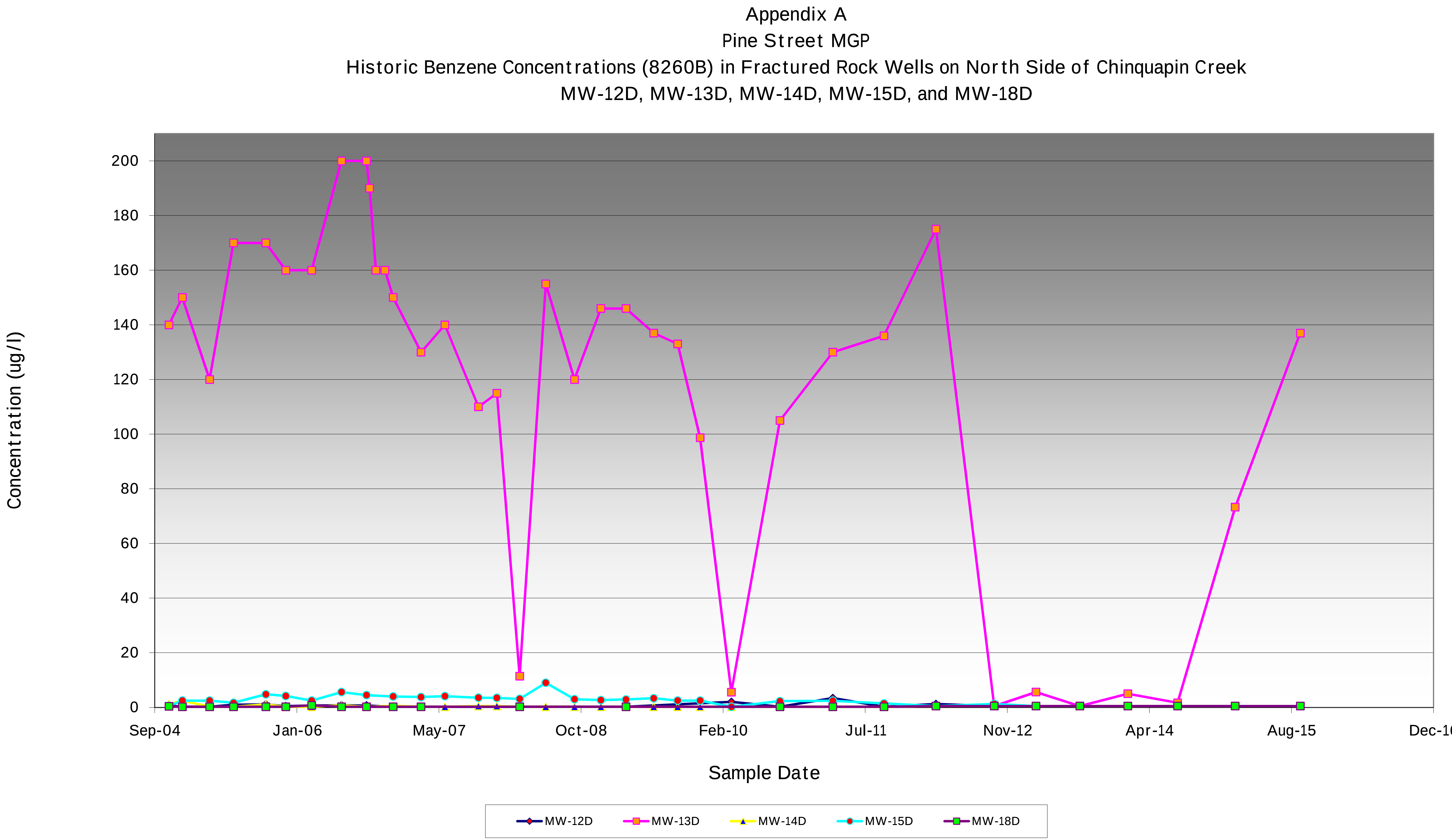


Results reported as non-detect have been plotted at half the detection limit.

Appendix A
Pine Street MGP
Historic Benzene Concentrations (8260B) in Saprolite Wells on South Side of Chinquapin Creek
MW-10S, MW-11S, and MW16S

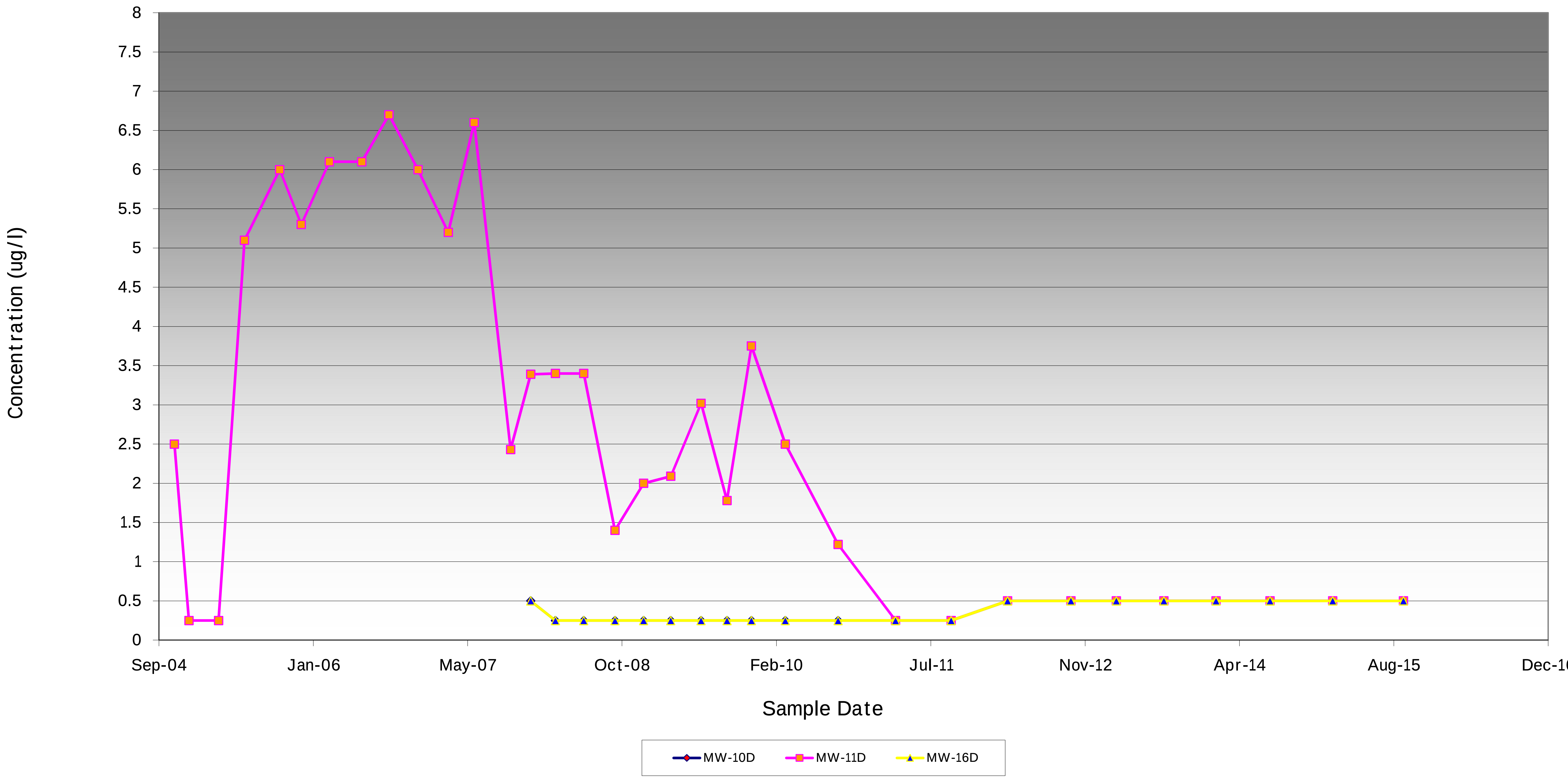


Results reported as non-detect have been plotted at half the detection limit.



Results reported as non-detect have been plotted at half the detection limit.

Appendix A
Pine Street MGP
Historic Benzene Concentrations (8260B) in Fractured Rock Wells on South Side of Chinquapin Creek
MW-10D, MW-11D, and MW16D



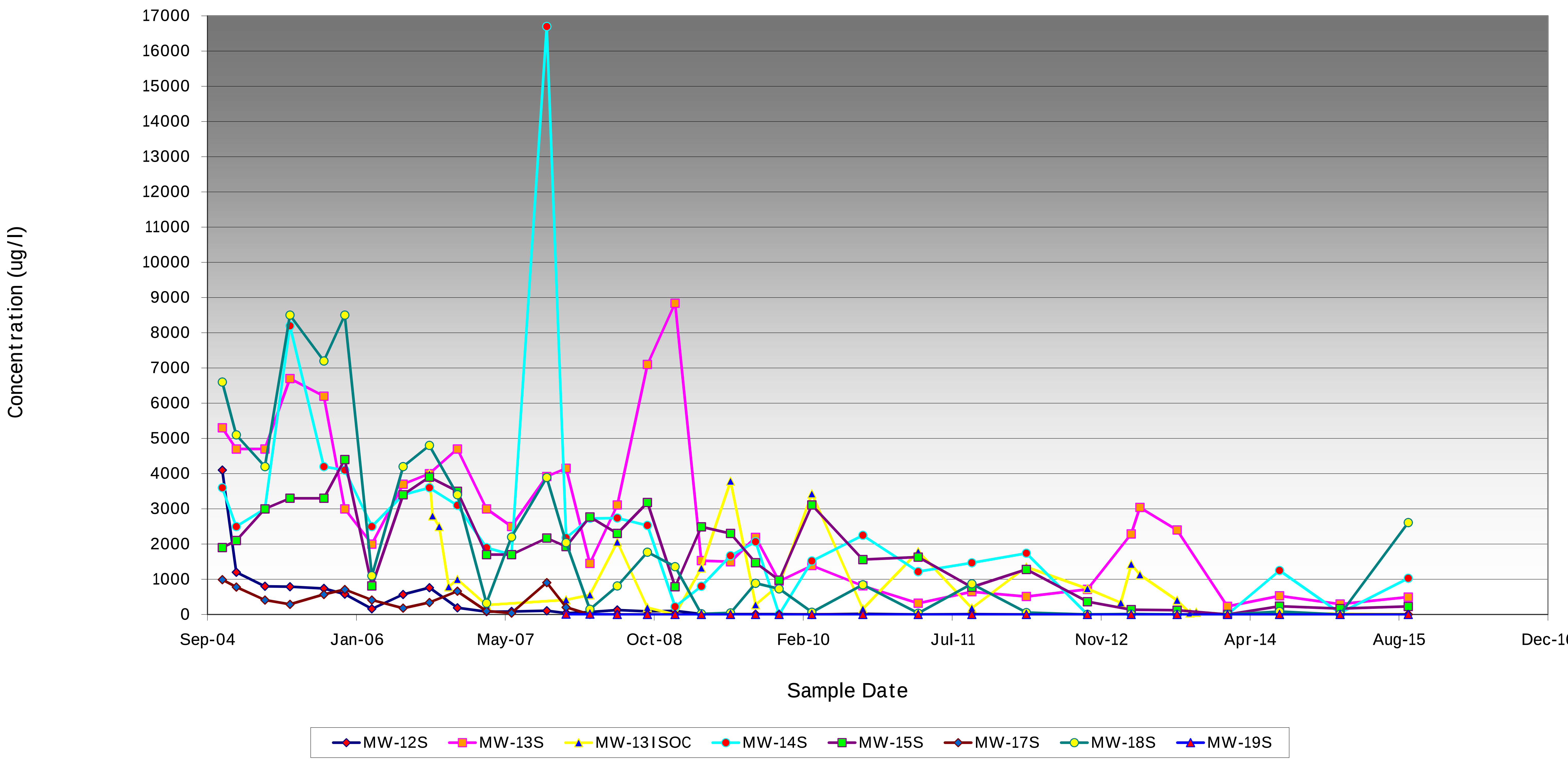
Results reported as non-detect have been plotted at half the detection limit.

Appendix A

Pine Street MGP

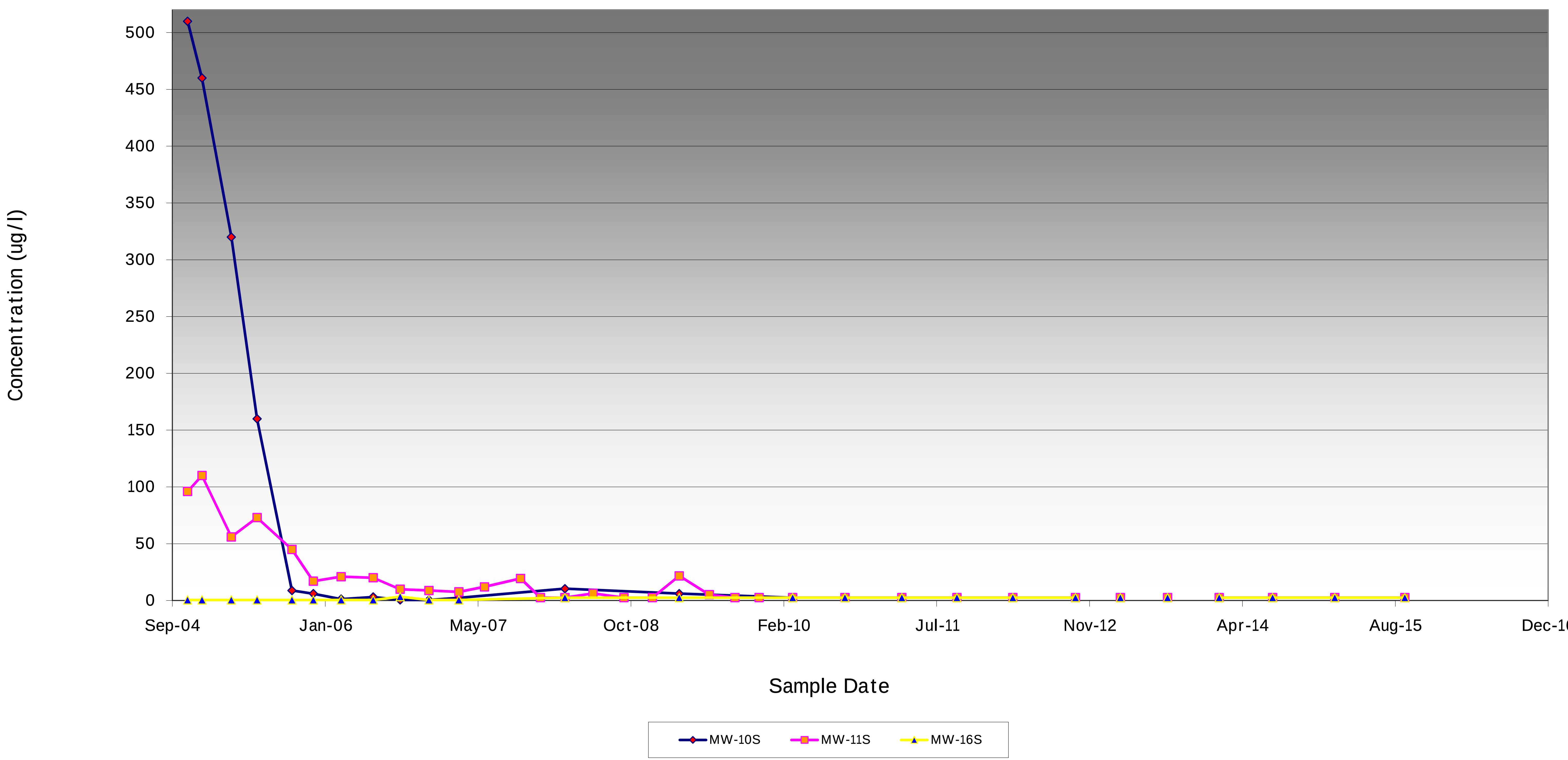
Historic Naphthalene Concentrations (8260B) in Saprolite Wells on North Side of Chinquapin Creek

MW-12S, MW-13S, MW13ISOC, MW-14S, MW-15S, MW-17S, MW-18S and MW-19S



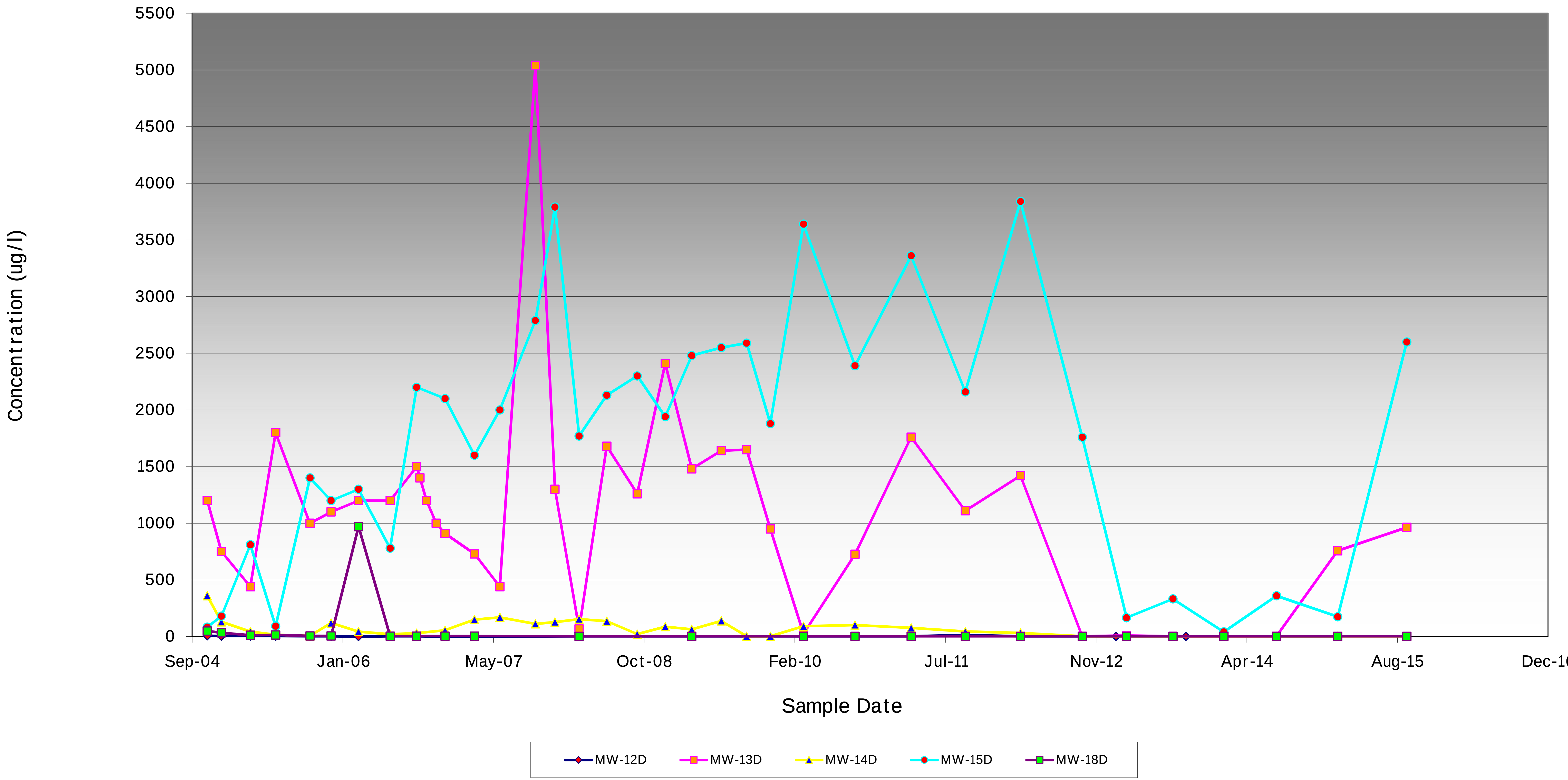
Results reported as non-detect have been plotted at half the detection limit.

Appendix A
Pine Street MGP
Historic Naphthalene Concentrations (8260B) in Saprolite Wells on South Side of Chinquapin Creek
MW-10S, MW-11S, and MW16S



Results reported as non-detect have been plotted at half the detection limit.

Appendix A
Pine Street MGP
Historic Naphthalene Concentrations (8260B) in Fractured Rock Wells on North Side of Chinquapin Creek
MW-12D, MW-13D, MW-14D, MW-15D, and MW-18D



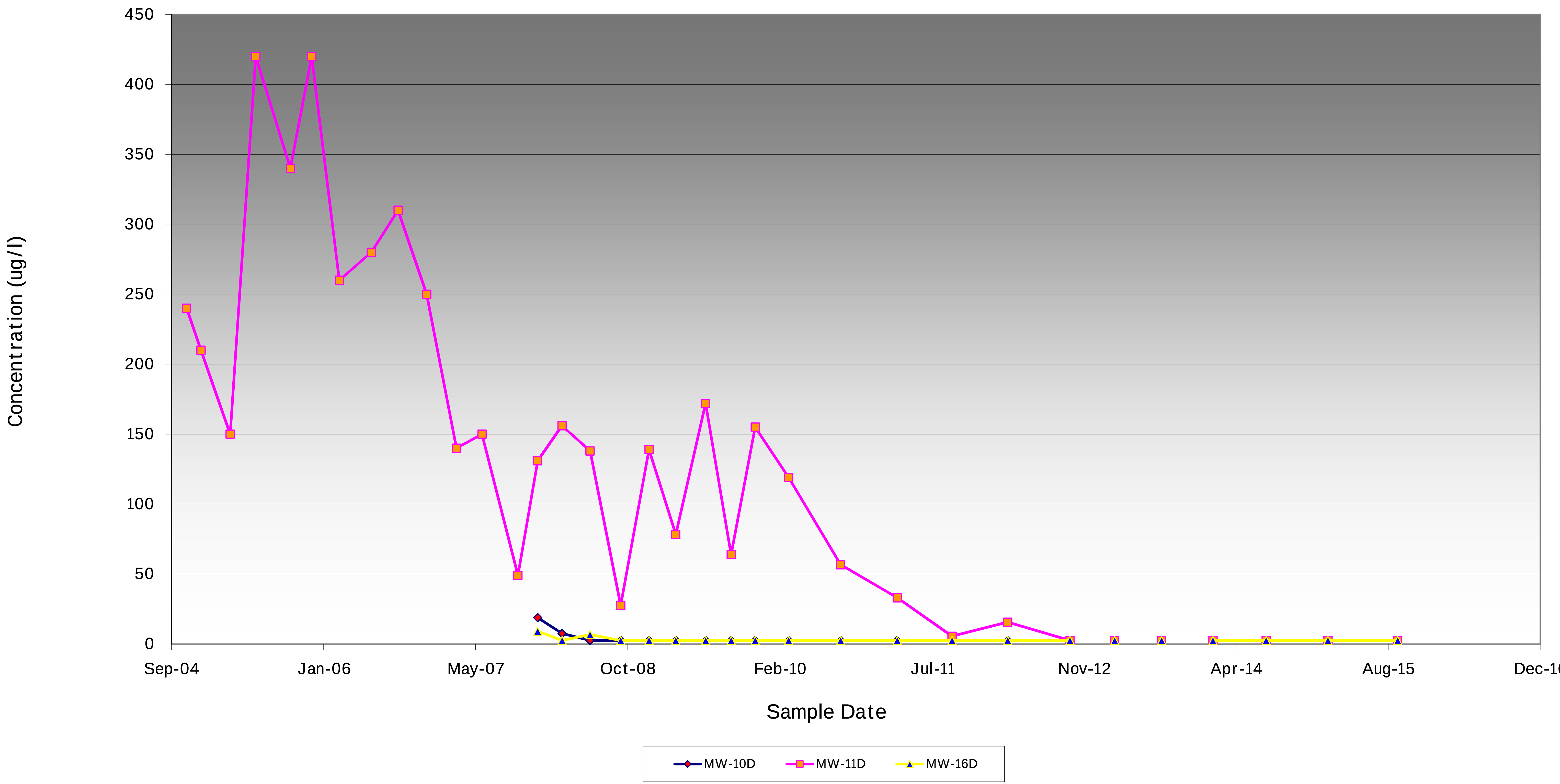
Results reported as non-detect have been plotted at half the detection limit.

Appendix A

Pine Street MGP

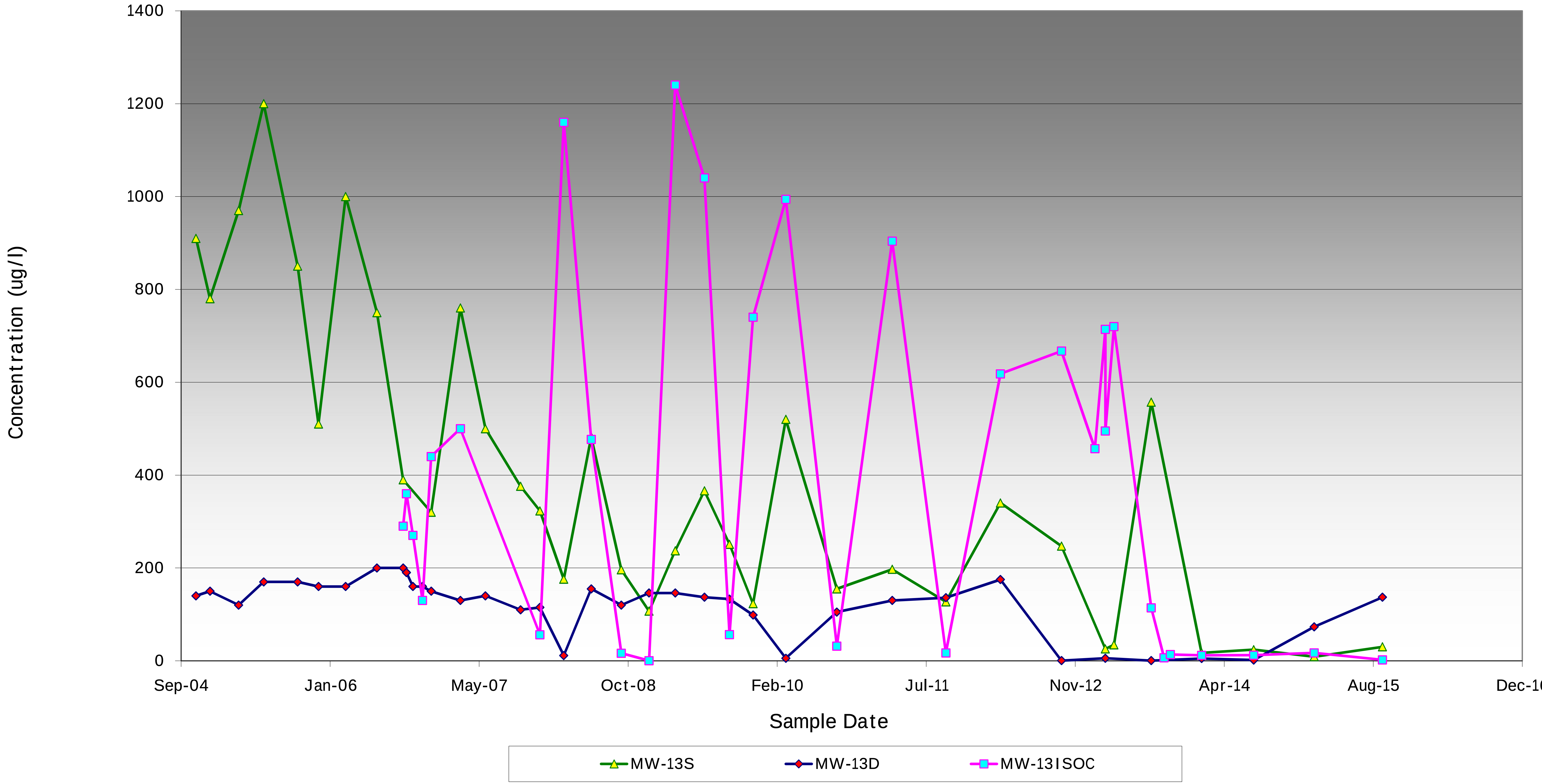
Historic Naphthalene Concentrations (8260B) in Fractured Rock Wells on South Side of Chinquapin Creek

MW-10D, MW-11D, and MW16D



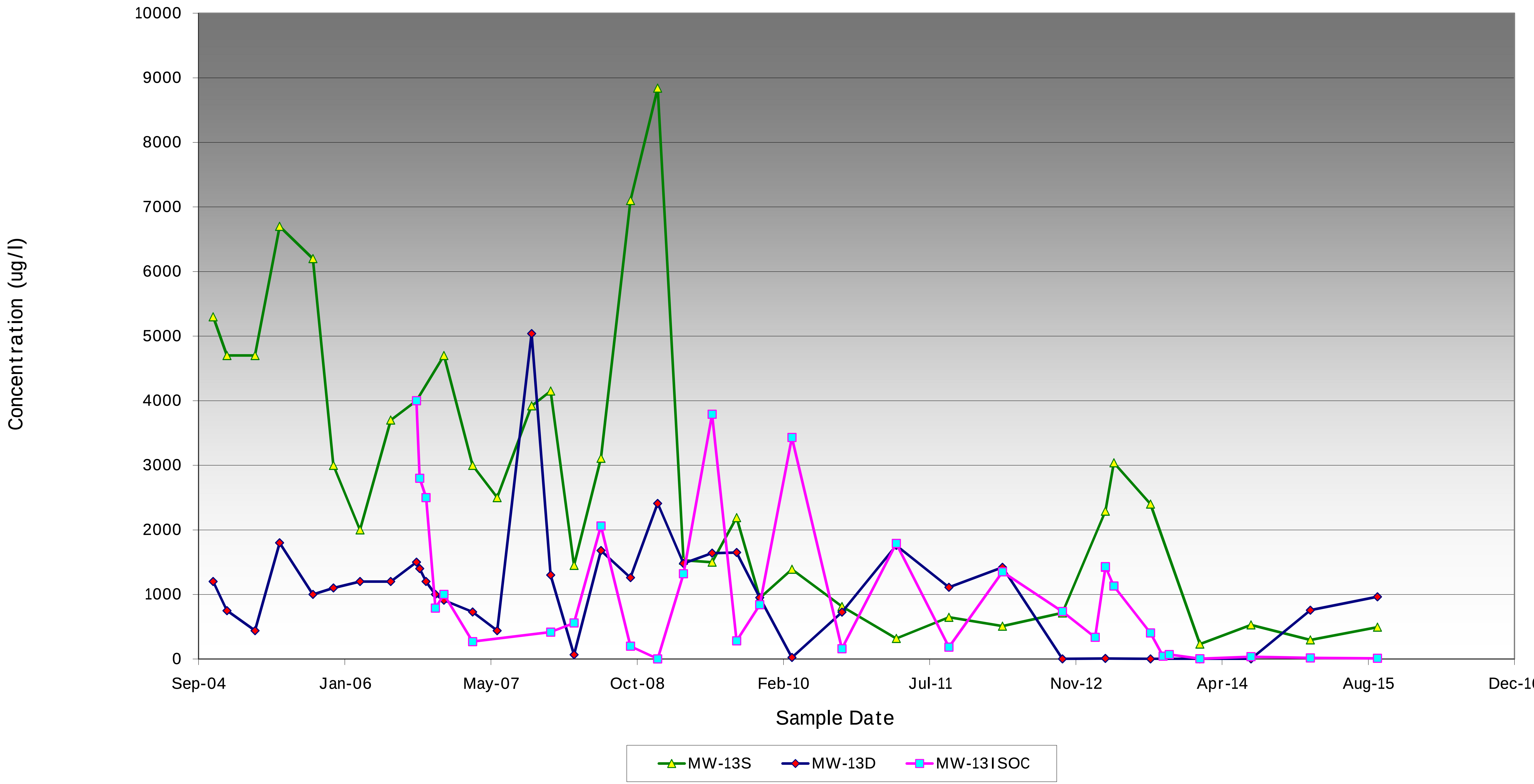
Results reported as non-detect have been plotted at half the detection limit.

Appendix A
Pine Street MGP Site
Benzene Groundwater Concentration (8260B) History - ISOC Pilot Study



Results reported as non-detect have been plotted at half the detection limit.

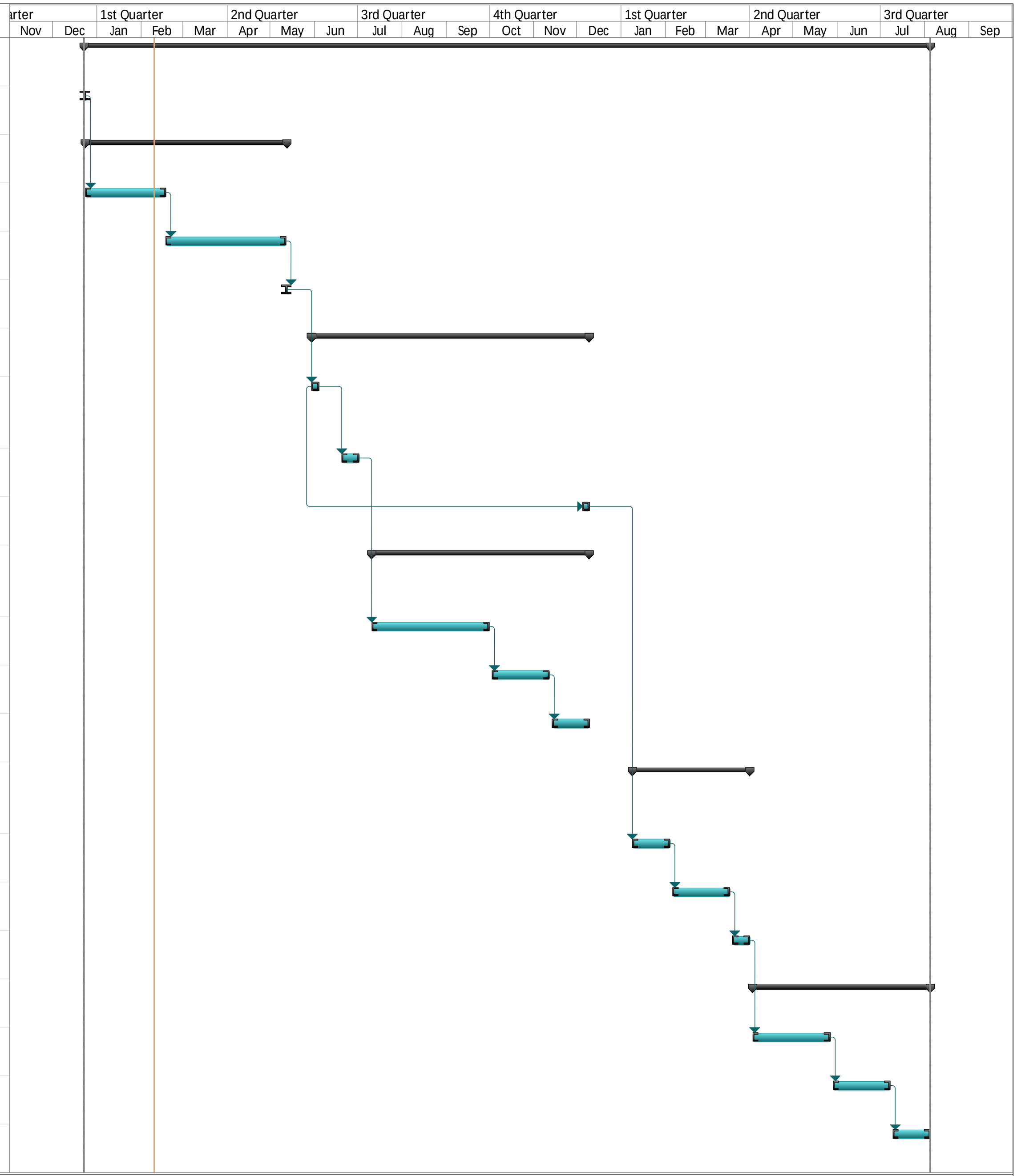
Appendix A
Pine Street MGP Site
Naphthalene Groundwater Concentration (8260B) History - ISOC Pilot Study



Results reported as non-detect have been plotted at half the detection limit.

Appendix B. Project Schedule

ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors
1			Spartanburg MGP Feasibility Study	423 days	Wed 12/23/15	Fri 8/4/17	
2			NTP	1 day	Wed 12/23/15	Wed 12/23/15	
3			Feasibility Study Work Plan	101 days	Thu 12/24/15	Thu 5/12/16	
4			Draft FS Work Plan	40 days	Thu 12/24/15	Wed 2/17/16	2
5			SCDHEC Review	60 days	Thu 2/18/16	Wed 5/11/16	4
6			FS WP Approval	1 day	Thu 5/12/16	Thu 5/12/16	5
7			Field Investigation	140 days	Mon 5/30/16	Fri 12/9/16	
8			1st Semi-Annual GW Monitoring Event & Depoly Bio-Traps	5 days	Mon 5/30/16	Fri 6/3/16	6FS+11 days
9			TarGOST Field Event collect Bio-Traps	10 days	Mon 6/20/16	Fri 7/1/16	8FS+10 days
10			2nd Semi-Annual GW Monitoring Event	5 days	Mon 12/5/16	Fri 12/9/16	8SS+135 days
11			Field Investigation Results/1st Semi-annual GWM Report	110 days	Mon 7/11/16	Fri 12/9/16	
12			Draft Field Investigation Report	60 days	Mon 7/11/16	Fri 9/30/16	9FS+5 days
13			SCDHEC Review	30 days	Mon 10/3/16	Fri 11/11/16	12
14			Field Investigation Report Approval	20 days	Mon 11/14/16	Fri 12/9/16	13
15			2nd Semi-Annual Groundwater Monitoring Report	60 days	Mon 1/9/17	Fri 3/31/17	
16			Draft Monitoring Report	20 days	Mon 1/9/17	Fri 2/3/17	10FS+20 days
17			SCDHEC Review	30 days	Mon 2/6/17	Fri 3/17/17	16
18			Monitoring Report Approval	10 days	Mon 3/20/17	Fri 3/31/17	17
19			Feasibility Study Report	90 days	Mon 4/3/17	Fri 8/4/17	
20			Draft Feasibility Study Report	40 days	Mon 4/3/17	Fri 5/26/17	18
21			SCDHEC Review	30 days	Mon 5/29/17	Fri 7/7/17	20
22			Feasibility Study Report Approval	20 days	Mon 7/10/17	Fri 8/4/17	21



Project: Spratanburg MGP Facility
Date: Wed 2/10/16

Task		Summary		External Milestone		Inactive Summary		Manual Summary Rollup		Finish-only	
Split		Project Summary		Inactive Task		Manual Task		Manual Summary		Deadline	
Milestone		External Tasks		Inactive Milestone		Duration-only		Start-only		Progress	