16-63376

0190100008 – Champaign
Champaign/Ameren Illinois MGP
SR/Tech

FILE COPY

November 3, 2016

Mr. Todd Hall
Illinois Environmental Protection Agency
Bureau of Land
Site Remediation Program
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

Dear Mr. Hall:

Subject: **Addendum Combined Remedial Objectives Report/Remedial Action Plan – Residual MGP Impact**
Ambient Air Monitoring Plan
Ameren Remediation Project – Former Manufactured Gas Plant Site
Champaign, Illinois
LPC# 019010008

On behalf of Ameren Illinois, PSC Industrial Outsourcing, LP (PSC) is submitting two reports for the Champaign Former Manufactured Gas Plant (MGP) site in Champaign, Illinois. PSC is submitting two copies of each report. The two reports are the:

- Addendum Combined Remedial Objectives Report/Remedial Action Plan; and
- Ambient Air Monitoring Plan

Previous remedial actions were performed at the project site between 2009 and 2011. In-Situ chemical oxidation treatment was conducted within limited areas of the site in 2013. Impact remains along the northwest boundary of the site that exceeds project remediation objectives. Ameren will address remaining impact within ten feet of ground surface through soil excavation and disposal. Material impacted at a depth greater than 10 feet within this area will be addressed using various institutional controls, engineered barriers, and Tier 2 evaluations.

The results of the additional remedial actions will be described along with the previous remedial activities in a Remedial Action Completion Report (RACR).

Baseline ambient air monitoring is scheduled to begin November 8, 2016. The remedial actions for the residual MGP-impact is scheduled to begin November 16, 2016.

PSC Industrial Outsourcing, LP
210 West Sand Bank Road, Columbia, Illinois 62236
Tel (618) 281-7173 Fax (618) 281-5120 www.PSCnow.com

If you have any questions please contact me at 618-281-1583 or at mike.crutcher@pscnow.com or the Ameren Project Manager, Mr. Brian Martin, at 314-554-2233 or bmartin2@ameren.com.

Sincerely,

PSC Industrial Outsourcing, LP

Michael Crutcher PG, PE
Senior Project Manager

Enclosures: Addendum Combined ROR/RAP (2 copies)
Ambient Air Monitoring Plan (2 copies)
CD with both reports (1 copy)

cc: Ameren (Brian Martin)

16-63376

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0190100008 – Champaign
Champaign/Ameren Illinois MGP
SR/Tech

Illinois Environmental Protection Agency

Bureau of Land • 1021 North Grand Avenue East • P.O. Box 19276 • Springfield • Illinois • 62794-9276

Site Remediation Program Form (DRM-2)
(To be Submitted with all Plans and Reports)

You may complete this form online, save a copy, print, sign and mail it to the address above.

I. Site Identification:

Site Name: Champaign Former Manufactured Gas Plant Site
Street Address: 308 N. Fifth Street P.O. Box:
City: Champaign State: IL Zip Code: 61820 Phone:
Illinois Inventory ID Number: 0190100008 IEMA Incident Number:

II. Remediation Applicant:

Applicant's Name: Mr./Ms. Mr. Brian Martin
Company: Ameren Services
Street Address: 1901 Chouteau Avenue; MC 602 P.O. Box: 66149
City: St. Louis State: MO Zip Code: 63166 Phone: 314-554-2233
Email Address: bmartin2@ameren.com

I hereby request that the Illinois EPA review and evaluate the attached project documents in accordance with the terms and conditions of the Environmental Protection Act (415 ILCS 5), implementing regulations, and the review and evaluation services agreement.

Remediation Applicant's Signature: Brian H. Martin Date: 11/2/16

III. Contact Person for Remediation Applicant:

Contact's Name: Mr./Ms. Mr. Brian Martin
Company: Ameren Services
Street Address: 1901 Chouteau Avenue; MC 602 P.O. Box: 66149
City: St. Louis State: MO Zip Code: 63166 Phone: 314-554-2233
Email Address: bmartin2@ameren.com

Contact Person for Consultant:

Contact's Name: Mr./Ms. Mr. Michael Crutcher
Company: PSC Industrial Outsourcing, LP
Street Address: 210 West Sand Bank Road P.O. Box:
City: Columbia State: Illinois Zip Code: 62236 Phone: 618-281-1583
Email Address: mike.crutcher@pscnow.com

IV. Review & Evaluation Licensed Professional Engineer or Geologist ("RELPEG"), if applicable:

RELPEG's Name: Mr./Ms.
Company:
Street Address: P.O. Box:
City: State: Zip Code: Phone:
Email Address:

IL 532-2547
LPC 566 June 2012

V. Project Documents Being Submitted:

Document Title: Revised ROR-RAP
Prepared by: PSC Industrial Outsourcing, LP
Date of Preparation of Plan or Report: 11/1/2016
Prepared For: Ameren Services

Type of Document Submitted:

- [ ] Site Investigation Report - Comprehensive
- [ ] Site Investigation Report - Focused
- [x] Remediation Objectives Report - Tier 1 or 2
- [ ] Remediation Objectives Report - Tier 3
- [x] Remedial Action Plan
- [ ] Remedial Action Completion Report
- [ ] Sampling Plan
- [ ] Health and Safety Plan
- [ ] Community Relations Plan
- [ ] Risk Assessment
- [ ] Containment Fate & Transport Modeling
- [ ] Other: _____

Document Title: AAMP
Prepared by: PSC Industrial Outsourcing, LP
Date of Preparation of Plan or Report: 11/1/2016
Prepared For: Ameren Services

Type of Document Submitted:

- [ ] Site Investigation Report - Comprehensive
- [ ] Site Investigation Report - Focused
- [ ] Remediation Objectives Report - Tier 1 or 2
- [ ] Remediation Objectives Report - Tier 3
- [ ] Remedial Action Plan
- [ ] Remedial Action Completion Report
- [ ] Sampling Plan
- [ ] Health and Safety Plan
- [ ] Community Relations Plan
- [ ] Risk Assessment
- [ ] Containment Fate & Transport Modeling
- [x] Other: Ambient Air Monitoring Plan

Document Title: _____
Prepared by: _____
Date of Preparation of Plan or Report: _____
Prepared For: _____

Type of Document Submitted:

- [ ] Site Investigation Report - Comprehensive
- [ ] Site Investigation Report - Focused
- [ ] Remediation Objectives Report - Tier 1 or 2
- [ ] Remediation Objectives Report - Tier 3
- [ ] Remedial Action Plan
- [ ] Remedial Action Completion Report
- [ ] Sampling Plan
- [ ] Health and Safety Plan
- [ ] Community Relations Plan
- [ ] Risk Assessment
- [ ] Containment Fate & Transport Modeling
- [ ] Other: _____

VI. Professional Engineer's or Geologist's Seal or Stamp:

I attest that all site investigations or remedial activities that are subject of this plan(s) or report(s) were performed under my direction, and this document and all attachments were prepared under my direction or reviewed by me, and to the best of my knowledge and belief, the work described in the plan and report has been designed or completed in accordance with the Illinois Environmental Protection Act (415 ILCS 5), 35 Ill. Adm. Code 740, and generally accepted engineering practices or principles of professional geology, and the information presented is accurate and complete.

Any person who knowingly makes a false, fictitious, or fraudulent material statement, orally or in writing, to the Illinois EPA commits a Class 4 felony. A second or subsequent offense after conviction is a Class 3 felony. (415 ILCS 5/44(h))

Professional Engineer's or Geologist's Seal or Stamp:

MICHAEL R. CRUTCHER
062-057791
LICENSED
PROFESSIONAL
ENGINEER
OF
ILLINOIS
11/30/2017

Engineer's or Geologist's Name: Michael Crutcher

Company: PSC Industrial Outsourcing, LP

Registration Number: 062.057791 Phone: 618-281-1583

License Expiration Date: 11/30/2017

Signature: _____ Date: 11/2/2016

Note: The authority of a Licensed Professional Geologist to certify documents submitted to the Illinois Environmental Protection Agency for review and evaluation pursuant to Title XVII of the Environmental Protection Act is limited to Site Investigation Reports (415 ILCS 58.7(f)), as amended by P. A. 92-0735, effective July 25, 2002. A Licensed Professional Geologist cannot certify Remediation Objectives Reports, Remedial Action Plans or Remedial Action Completion Reports.

All information submitted is available to the public except when specifically designated by the Remediation Applicant to be treated confidentially as a trade secret or secret process in accordance with the Illinois Compiled Statutes, Section 7(a) of the Environmental Protection Act, applicable Rules and Regulations of the Illinois Pollution Control Board and applicable Illinois EPA rules and guidelines. The Illinois EPA is authorized to require this information under Sections 415 ILCS 5/58 - 58.12 of the Environmental Protection Act and regulations promulgated thereunder. Disclosure of this information is required as a condition of participation in the Site Remediation Program. Failure to do so may prevent this form from being processed and could result in your plan(s) or report(s) being rejected. This form has been approved by the Forms Management Center.

Addendum Combined Remedial Objectives Report and Remedial Action Plan

Champaign Former Manufactured Gas Plant
Champaign, Illinois
State ID 019010008

October 28, 2016

Prepared for:

AMEREN SERVICES

St. Louis, Missouri

Prepared by:

PSC Industrial Outsourcing, LP

Columbia, Illinois

Addendum Combined Remedial Objectives Report and Remedial Action Plan

Champaign Former Manufactured Gas Plant
Champaign, Illinois
State ID 019010008

October 28, 2016

Prepared for:

AMEREN SERVICES

ST. LOUIS, MISSOURI

PSC INDUSTRIAL OUTSOURCING, LP
210 West Sand Bank Road
Columbia, Illinois 62236-0230

Project 624-1610-0001

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1 INTRODUCTION

On behalf of Ameren Services (Ameren), PSC Industrial Outsourcing, LP (PSC) has prepared this Addendum Combined Remedial Objectives Report (ROR) and Remedial Action Plan (RAP) for the former Manufactured Gas Plant (MGP) located in Champaign, Illinois (Figure 1-1). This ROR/RAP is being submitted in accordance with Title 35 of the Illinois Administrative Code (IAC) Section 740.445 to establish the remedial objectives and remedial action plan for residual impact that is still present along the northwest edge or perimeter of the remediation project site. The residual MGP-related impact remains after the excavation and disposal activities performed between 2009 and 2011 and subsequent in-situ remedial actions performed in 2013. The objective of this ROR/RAP is to present the approach for addressing the remaining impact along the northwest edge or perimeter of the property. Upon completion of this additional remediation, the results will be combined with the previous remedial actions and presented in a Remedial Action Completion Report (RACR).

2 SITE DESCRIPTION

The following sections provide a brief description of the remediation site. A full description of the remediation site, the regional setting, and the operational history and historical use of the property as required under Section 740.435(b)(2) is in the Comprehensive Site Investigation Report (SIR) dated August 22, 2008.

2.1 Site Information

The remediation project site is located in the northeast quarter of the southwest quarter of Section 7, Township 19 North, Range 9 East of the Third Principal Meridian. The remediation project site is located at 308 North 5th Street in Champaign, Illinois. (Figure 1-1). The remediation site is depicted in Figure 2-1 and currently consists of approximately 3.1 acres. For the residual remedial activities described in this ROR/RAP, the remaining area is located at the extreme northwest edge of the property (Figure 2-2).

2.2 Site History and Previous Site Activities

A detailed description of the site and surrounding property history is provided in the Site Investigation Report (SIR) dated August 22, 2008. Briefly, the former MGP operated from as early as 1869 and continued through 1933. The former MGP was demolished between 1955 and 1960. In 1979 the property was sold to the American Legion. Ameren repurchased the property in 1991.

Investigation activities were performed between 1986 and 2004. Remedial actions were performed between 2009 and 2013. Significant areas of the site were remediated between 2009 and 2011 through conventional excavation and disposal methods. Physical restrictions prevented remediation around the perimeter of the site using conventional methods. To address the remaining impact around the perimeter of the remediation site, in-situ chemical oxidation remediation was performed in 2013.

As noted by post-remediation confirmation sampling, the levels of impact were reduced by the in-situ oxidation. However, impact still remains along the northwest perimeter of the property at levels that exceed remediation objectives.

2.3 Site Topography

The site is mostly flat lying with isolated sloped areas along the east side where Sixth Street was formerly located. The property drainage is generally toward the northeast. No surface bodies of water are present on the site. The nearest surface water is the Boneyard Creek approximately 1,000 feet to the southwest of the site.

2.4 Subsurface Hydrogeology

The following sections provide a brief description of the subsurface hydrogeology prior to remedial actions. More detail on the subsurface hydrogeology can be found in the Comprehensive SIR.

During the remedial actions, the excavated areas were backfilled with various types of aggregate/rock and clay soil. The general depth of the excavations extended to 20 to 25 feet bgs across the remediation project site. Quarterly groundwater monitoring has been performed since 1996.

2.4.1 Subsurface Geology

The pre-remediation subsurface geology has been characterized using the methods described in the SIR. Prior to remedial actions the general subsurface geology for the remediation site consisted of:

- surficial fill layer;
- weather till unit (Wedron);
- unweathered till unit (Wedron); and
- lower silty sand member of the Glasford Formation.

In areas around the perimeter of the remediation project site where no soil excavation activities were performed, the subsurface geologic conditions should be similar to the aforementioned.

Within areas of the site where remedial actions included soil excavation and disposal, the subsurface materials are typically aggregate limestone, gravel, rock, and lime screenings or clay soil. Figure 2-3 identifies the limits of the soil excavation areas remediated in 2009 thru 2011.

2.4.2 Hydrogeologic Conditions

Groundwater at the remediation project site and in the vicinity of the project site includes a shallow, an intermediate, and a deep system. The shallow groundwater system has been classified as Class II groundwater. The intermediate groundwater system has been classified as Class I groundwater. The deep groundwater system has been classified as Class I groundwater.

Quarterly groundwater monitoring of the shallow and intermediate groundwater systems has been performed since 1996. The monitoring wells screened within the deep groundwater system were abandoned in 1999 following six years of groundwater monitoring.

Quarterly groundwater monitoring has been continued following the remedial actions completed in 2011. The general groundwater flow conditions for the most groundwater monitoring event for the remediation site are depicted in Figure 2-4 and Figure 2-5.

2.5 Recognized Environmental Conditions

Significant areas of the remediation project site were remediated between 2009 and 2011. To the extent practical and accessible at that time, impacted material was removed across all but the perimeter of the site. In-Situ chemical oxidation remediation approaches were applied in 2013 to address limited areas of impact with elevated constituents exceeding project remediation objectives.

The in-situ chemical oxidation approach addressed the levels of impact around most of the perimeter of the remediation project site. However along the northwestern edge of the remediation project site, remaining impact could not be addressed using in-situ chemical oxidation. Therefore residual MGP-related impact remains along the northwest perimeter of the remediation project site (Figure 2-2). The residual impact includes organic constituents at levels that exceed the project remediation objectives for soil inhalation.

3 PREVIOUS REMEDIAL ACTIONS

Remedial actions consisting of soil excavation and disposal were performed at the Champaign MGP site between 2009 and 2011. Residual impact remained around the perimeter of the remediation site and at varying depths. To address impact around the perimeter of the project remediation site and in remaining areas, in-situ chemical oxidation was performed as efforts to reduce the remaining levels of subsurface impact. The following sections provide a brief description of the 2009 thru 2011 remedial actions and the 2013 in-situ remediation.

3.1 Soil Excavation Activities

Excavation and disposal of MGP-impacted soil began in June 2009. The soil excavation activities were performed within tent-structures for nine areas across the site. In general, the depth of excavation within the nine areas under the tent-structures extended to approximately 20 to 25 feet bgs. Figure 2-3 depicts the extent of excavation that was performed beneath the tent-structures.

Because the tent-structures could not extend beyond the property boundary, areas around the perimeter of the site could not be excavated within the tent-structure. The perimeter areas that could not be excavated under the tent-structures were typically areas ranging in width from 10 feet to 25 feet from the property or the remediation project boundary. Limited perimeter excavation was performed in 2011. The perimeter excavations are depicted in Figure 3-1. The excavations around the perimeter of the remediation project site extended to depths of approximately 3 feet to 10 feet bgs. Any impacted material beneath these areas is to be addressed through engineered barriers and institutional controls.

Confirmation soil samples were collected from the sidewalls and the floors of the excavations. The sidewall samples were collected from approximately every 25 linear feet of the excavation. The sidewall samples were typically collected from three sample depth intervals: 0- to 3-foot; 3- to 10-foot; and greater than 10-foot. Confirmation floor samples were collected within a grid system typically laid out on a 50-foot by 50-boot pattern. Approximately 374 confirmation soil samples were collected during the excavation and disposal remediation activities between 2009 and 2011. Figure 3-2 depicts the locations of the confirmation soil samples collected from the 2009 thru 2011 remedial actions.

Results of all of the confirmation soil samples were summarized and will be presented in the RACR. The analytical results of the confirmation soil samples indicated that residual MGP-related impact remained in areas around the perimeter of the remediation property at levels that exceeded project ROs. Impact was present at levels that exceeded project ROs for soil inhalation exposure pathways and for the soil component to groundwater ingestion. Impact exceeding the ROs for soil ingestion and soil inhalation were present within 10 feet of the ground surface. Elevated levels of MGP-related constituents were also present within the center portion of the site at concentrations exceeding soil attenuation or soil saturation limits.

3.2 In-Situ Remediation Activities

Because constituents of concern remained at locations on the remediation site and the concentrations were at levels above project ROs and could not be addressed through engineered barriers, Ameren elected to perform in-situ remedial methods in 2013. The intent of the in-situ remediation activities was to address the primary volatile organic compounds (VOCs) consisting of benzene, toluene, ethylbenzene, and total xylenes (BTEX) and naphthalene that are typically related to releases at MGP sites. The objective of the in-situ remediation activities was to reduce the concentration of these parameters to levels less than project ROs.

The in-situ remediation consisted of the injection of a neutral chelated iron catalyst and stabilized 8% hydrogen peroxide (Fenton's Reagent) injected using direct push methods. The injection points were closely spaced with two injection depths at each injection point. Up to three in-situ chemical injection activities were performed within the areas of residual MGP-related impact. Confirmation soil samples were collected following each in-situ chemical oxidation injection activity.

The soil samples were analyzed for BTEX, naphthalene, and total petroleum hydrocarbons (TPH). In areas where confirmation soil samples continued to exceed project ROs, a second or third application was performed. Figure 3-3 depicts the points of chemical oxidant injection for each application. Figure 3-4 depicts the soil sample confirmation points.

3.3 Summary of In-Situ Remediation Results

Based upon the soil confirmation samples collected during the in-situ remediation activities, residual impact was addressed around most of the perimeter of the remediation site to the project ROs for soil inhalation (outdoor air). However residual MGP-related impact is still present along the northwest perimeter of the project remediation site at depths less than 10 feet bgs. The remaining impact exceeds ROs for the soil inhalation exposure pathway (outdoor air). Because of surfacing of the chemical oxidants in this portion of the project remediation site and the ineffectiveness of the chemical oxidants, Ameren elected not to perform continued applications. The remaining area of impact and the soil sample confirmation locations with constituents that still exceed project ROs are depicted in Figure 2-2. A summary of information from the in-situ chemical oxidation is provided in Appendix A.

4 PROPOSED ADDITIONAL REMEDIAL ACTIONS

Ameren will perform additional remedial actions along the northwest perimeter of the remediation project site. The additional remedial actions described within this Addendum ROR/RAP are limited to the northwest perimeter of the site.

4.1 Soil Excavation and Disposal

Impacted material along the northwest perimeter of the project remediation site will be excavated and disposed. The extent of the soil removal activities is depicted in Figure 2-2. The soil removal activities will begin at the boundary of the previous remediation performed between 2009 and 2011 and extent toward the west edge of the property boundary. The soil excavation will be an area of approximately 24 feet wide east-west by 155 long north-south. The excavation will extend to an approximate depth of 12 feet bgs. This will permit the non-impacted backfill material to be used as an engineered barrier for deeper impact that remains and that may potentially exceed project ROs for soil ingestion and/or soil inhalation.

The material will be excavated and loaded directly into trucks for transport to the Republic Brickyard Disposal Facility in Danville, Illinois. The waste material will be characterized as a non-special waste for disposal. The MGP-impacted soil from the 2009 thru 2011 remediation activities was disposed at the Brickyard Disposal Facility.

4.2 Excavation Backfilling

After the projected depth of 12 feet bgs has been reached, it will be backfilled with non-impacted material from an off-site borrow source. The backfill material to be used will be clay soil backfill. The source for the backfill material will be the same borrow site as the source for backfill from the 2009 thru 2011 remediation activities.

Prior to use as backfill material, the clay soil backfill will be sampled and the samples analyzed for the constituents on the Target Analyte List (TAL) outlined in IAC Section 740; Appendix A; Table A. One soil sample will be collected for a representation of approximately 1,000 tons of backfill material.

4.3 Ambient Air Monitoring

Ambient air monitoring will be performed during the upcoming remedial activities. Baseline, pre-remediation air monitoring will be performed prior to excavation activities. Post remediation air monitoring will also be performed. A separate ambient air monitoring plan was prepared and submitted to the IEPA.

5 DETAILED PATHWAY EVALUATION FOR REMEDIATION OBJECTIVES

Residual impact remains along the northwest edge of the remediation site property. The remaining impact exceeds Tier 1 ROs for the following:

- soil ingestion;
- soil inhalation; and
- soil component to groundwater ingestion.

Impact is present above remediation objectives for residential, commercial/industrial, and construction worker scenarios.

Tables presented in Appendix A summarize the concentrations of constituents still present within the northwest perimeter of the site following the in-situ remedial actions. Figure 3-4 identifies the sample locations for the post in-situ confirmation soil sampling.

6 TIER 2 EVALUATIONS

As permitted in IAC Sections 742.600 and 742.900, Tier 2 evaluations have been performed using site-specific input parameters to establish Tier 2 ROs. The Tier 2 evaluations were performed for the soil inhalation exposure pathway. Even with remediation of the residual MGP-impact, constituents of concern will remain in place that exceed Tier 1 ROs for soil component to groundwater ingestion. Tier 2 calculations will be performed to model projected down gradient extent of impact resulting from the leaching of the constituent from soil.

Tier 2 evaluations for the soil component to groundwater ingestion and the groundwater migration for groundwater ingestion will be presented in the Remedial Action Completion Report (RACR) to be submitted upon completion of all remedial actions and post-remediation groundwater monitoring. Tier 2 evaluations for soil inhalation are provided in Appendix B.

7 PROPOSED PATHWAY EXCLUSIONS

The following sections provide descriptions of how the COCs for each exposure route and property use scenario will be addressed within the northwest portion of the remediation project site and the area of this remedial action. The approaches used for the northwest area will be incorporated into the overall remedial approach and methods for the project site and will be presented in a single Remedial Action Completion Report.

7.1 Soil Ingestion Exposure Pathway

In the area of this remedial action, soil impact exceeding a project RO for the soil ingestion exposure pathway will be excluded by performing soil removal and disposal, implementing institutional controls, and by the use of an engineered barrier.

7.1.1 Soil Removal and Disposal

Excavation activities will extend to a depth of approximately 12 feet bgs within this remedial action area. This will remove impacted soil that exceeds project ROs for soil ingestion to a depth of 12 feet bgs. The excavation will be backfilled with non-impacted soil from an offsite borrow location. The removal of impacted materials to a depth of 12 feet bgs will address the soil ingestion pathway within 12 feet of ground surface.

7.1.2 Engineered Barrier

Impact that is present below 12 feet and exceeds a soil ingestion project RO will be excluded through the use of an engineered barrier. The engineered barrier will be 12 feet of non-impacted soil from an off-site borrow location.

7.1.3 Institutional Controls

An institutional control will be in place that requires that the engineered barrier be maintained as specified by the NFR letter. Soil impact that is not removed and is present at a depth greater than 12 feet bgs and exceeds construction worker exposure scenarios will be excluded through the use of a construction worker notification institutional control.

7.2 Soil Inhalation Exposure Pathway (Outdoor Air)

Soil impact exceeding a project RO for the soil inhalation exposure pathway (outdoor air) will be excluded by performing soil removal and disposal, implementing institutional controls, Tier 2 evaluations, and by the use of an engineered barrier.

7.2.1 Soil Removal and Disposal

Excavation activities will extend to a depth of approximately 12 feet bgs within this remedial action area. This will remove impacted soil that exceeds project ROs for soil inhalation to a depth of 12 feet bgs. The excavation will be backfilled with non-impacted soil from an off-site borrow location. The removal of impacted materials to a depth of 12 feet bgs will address the soil inhalation pathway (outdoor air) within 12 feet of ground surface.

7.2.2 Engineered Barrier

Impact that is present below 12 feet and exceeds a soil inhalation project RO will be excluded through the use of an engineered barrier. The engineered barrier will be 12 feet of non-impacted soil from an off-site borrow location. The engineered barrier will consist of non-impacted soil with a thickness of at least 10 feet as per IAC Section 742.1105.

7.2.3 Institutional Controls

An institutional control will be in place that requires that the engineered barrier be maintained as specified by the NFR letter. Soil impact that is not removed and is present at a depth greater than 12 feet bgs and exceeds construction worker exposure scenarios will be excluded through the use of a construction worker notification institutional control.

7.2.4 Tier 2 Remediation Objectives

Tier 2 evaluations were performed for the soil inhalation exposure pathway (outdoor air) for residential and commercial/industrial property use scenarios. Tier 2 evaluations were also performed for COCs for the soil inhalation pathway for the construction worker exposure scenario. Through the Tier 2 evaluations, Tier 2 ROs or site-specific ROs were established for the soil. Any impact that is less than the Tier 2 RO will be considered to be excluded from these potential exposure pathways. Tier 2 RO calculations are provided in Appendix A.

7.3 Soil Inhalation Exposure Pathway (Indoor Air)

No evaluation for the soil inhalation exposure pathway for indoor air has been performed. Ameren anticipates using institutional controls for the exclusion of this exposure pathway for

residential and commercial/industrial property use scenarios. The institutional control will meet the requirements of IAC Section 742.1200.

7.4 Soil Component to Groundwater Ingestion Exposure Pathway

Soil impact exceeding a Tier 1 RO for the soil component to groundwater ingestion exposure pathway will be excluded by use of Tier 2 evaluations and ROs, soil removal and disposal, and institutional controls.

7.4.1 Soil Removal and Disposal

Impacted soil will be removed to a depth of approximately 12 feet bgs. The soil removal activities will address the impact exceeding project ROs for this exposure pathway for the impact present within 12 feet of bgs.

7.4.2 Tier 2 Remediation Objectives

Tier 2 evaluations will be performed for the soil component to groundwater ingestion exposure pathway for the remaining MGP-related impact present in soil at depths greater than 12 feet bgs. The Tier 2 evaluations will be incorporated into the RACR and will be used to estimate the migration of impact in soil with respect to the groundwater ingestion component of the soil to groundwater pathway. The Tier 2 evaluation will be used to model projected down gradient impact distances for issuing notification letters to potentially affected property owners.

7.4.3 Institutional Control

The City of Champaign has a local groundwater prohibition ordinance that meets the IEPA's requirements for prohibiting the installation of groundwater wells and the use of groundwater within the City. The local groundwater prohibition ordinance will be used as an institutional control to exclude the impact that remains at depths greater than 12 feet bgs.

7.5 Groundwater Ingestion Exposure Pathway

Groundwater impact exceeding Tier 1 ROs for the groundwater ingestion exposure pathway is present at the site. No remedial actions will be performed to address the groundwater impact as the City of Champaign has an ordinance that prohibits the installation of new water wells and prohibits the use of groundwater. Ameren will use the local groundwater ordinance to exclude this pathway.

7.5.1 Tier 2 Evaluations

Upon completion of the remedial actions, Tier 2 evaluations will be performed on the remaining impact that may be present underlying the area at the northwest corner of the project remediation site.

7.5.2 Institutional Controls

The City of Champaign has an existing city ordinance that prohibits the installation of water wells and the use of groundwater. The existing ordinance meets the requirements of the IEPA for an institutional control to exclude the groundwater ingestion exposure pathway.

7.6 Inhalation of Vapors from Groundwater (Indoor Air)

The inhalation of vapors from the groundwater (indoor air) exposure pathway will be excluded through institutional controls.

7.6.1 Institutional Control

For COCs within groundwater that exceed the ROs for the inhalation of vapors from groundwater (indoor air), Ameren will exclude this pathway by the use of an institutional control. The institutional control will restrict to certain areas of the property or completely prohibit the construction of buildings used for occupancy or may require the use of building control technologies.

8 CONFIRMATION SAMPLING PLAN

Confirmation sampling will be performed to verify that the project ROs have been achieved for soil. The following sections discuss the confirmation sampling plan.

8.1 Confirmation Soil Sampling

The following sections discuss the collection and analysis of confirmation soil samples.

8.1.1 Sample Locations and Depths

Once the soil has been removed to the planned excavation depth and to the lateral extents, confirmation soil samples will be collected and submitted for laboratory analysis. Confirmation soil samples will be obtained from the floor and the western sidewall of the excavation area. From the western sidewall, soil samples will be retained from spacings of approximately 25 feet. From the floor of the excavation, one confirmation soil sample will be retained from the center of an area represented by approximately 50-foot spacings. No soil samples will be collected from the eastern sidewall as this is the edge of the previous remediation activities.

The soil samples will be collected from the following depth intervals:

- 0- to 3-foot depth interval and
- 3- to 12-foot depth interval.

Sidewall samples will be retained from either an area where the most heavily impacted materials remain based upon field screening methods or from depths that correspond to the zones of highest impact based upon results from the in-situ confirmation sampling depths.

Floor confirmation soil samples will be obtained from the 12-foot depth interval as this is the target excavation depth for this residual remediation activity.

For health and safety purposes, personnel will not be able to enter the excavation. Soil will be recovered from the bucket of the excavator. The on-site engineer or geologist will inspect the recovered soil and collect the soil sample.

8.1.2 Laboratory Analysis

Soil samples will be submitted and analyzed for the constituents identified in Appendix A of IAC Section 740. Samples will be analyzed for the following parameters:

- VOCs using USEPA Method 5035/8260;
- PNAs using USEPA Method 8270-SIM;
- SVOCs using USEPA Method 8270;

- amenable and total cyanide using USEPA Method 9012;
- RCRA metals using USEPA Methods 6010, 7420, and 7470, as appropriate;
- Total petroleum hydrocarbons (TPH) using USEPA Method 8015 OA2; and
- Soil pH using USEPA Method 9045.

8.1.3 Sample Collection

Soil samples will be retained for VOC analysis using USEPA Method 5035. A portion of the soil will be retained for laboratory analysis using an Easydraw™ Syringe. The soil will be placed in 40-ml vials provided by the laboratory. The 40-ml vials will have sodium bisulfate or methanol preservative, as appropriate. Soil samples to be analyzed for PNAs, cyanide, inorganics, metals and TPH, will be collected using SW 846. The soil will be placed in 8-ounce jars provided by the laboratory. Disposable sampling equipment will be used and discarded after sampling.

After placing the soil in the sample jars, labels will be affixed and the samples will be given unique sample identifications based upon the sample location and depth. Chain of custody records will be completed and the samples placed in a cooler with ice. The samples will remain on ice until delivered to the laboratory for analysis. Samples will either be delivered to the laboratory or shipped via overnight services.

8.1.4 Evaluation of Confirmation Sample Results

Upon receipt of laboratory analytical data, results will be compared to project ROs.

8.2 Post Remediation Groundwater Monitoring

Quarterly groundwater monitoring has been performed at the remediation project site since 1992. Following the completion of the remedial actions at the northwest perimeter of the site, four additional quarterly groundwater monitoring events are anticipated to be completed. Following the fourth quarterly groundwater monitoring event, the final groundwater analytical results will be used for Tier 2 evaluations for modeling the down gradient extent of impact in groundwater.

Continuing with the previous groundwater monitoring events, the groundwater samples will be collected and analyzed for BTEX, PNAs, amenable and total cyanide, and RCRA metals.

The groundwater samples will be collected using dedicated air bladder pumps that are present in each of the monitoring wells. Each monitoring well will be purged of 3 to 5 well-casing volumes prior to sampling collection. The groundwater samples will be placed in containers with appropriate preservatives provided by the laboratory. Samples will be labeled with a unique sample identification; chain of custody forms will be completed; the samples packed in ice; and delivered to the laboratory. Upon receipt of the analytical data, the results will be compared to the Tier 1 ROs or the groundwater quality standards.

9 SUMMARY AND CONCLUSIONS

Subsurface impact remains within the perimeter of the project remediation site. Impact in the northwest perimeter of the site is present at depths less than 10 feet bgs and exceeds project ROs for soil inhalation and soil ingestion. To address this impact, Ameren will remove the impacted soils to a depth of 12 feet bgs. The clean backfill material will serve as an engineered barrier to address impact present underlying the target excavation depth.

Engineered barriers, institutional controls, ELUCs, and HAAs will be implemented as appropriate for the exclusion of impact that remains following the remedial actions.

Upon completion of the remediation activities and the implementation of the barriers, controls, ELUCs, and HAAs, Ameren will have addressed subsurface impact to the requirements of IAC Section 742. The results and approaches for addressing the residual impact along the northwest perimeter will be incorporated into a single RACR for the entire remediation project site.

10 ILLINOIS LICENSED PROFESSIONAL ENGINEER REVIEW

For those portions of the work performed before my involvement:

I have reviewed documentation of the prior investigation activities and believe the documentation is suitable for compliance with 35 Ill. Adm. Code 740.

For those portions of the work performed during my involvement:

I attest that all site investigation activities performed during my involvement were performed with my input and direction and that this document and all attachments were prepared under my direction or reviewed by me; and, to the best of my knowledge and belief, the work described in this report has been completed in accordance with 35 Ill. Adm. Code 740, developed in conjunction with the use of accepted engineering standards, and the information presented is accurate and complete.

Signature: _____

Michael Ray Crutcher, P.E.
Licensed Professional Engineer

Date: 11/2/2016

License No.: 062-057791

License Expiration Date: 11/30/17

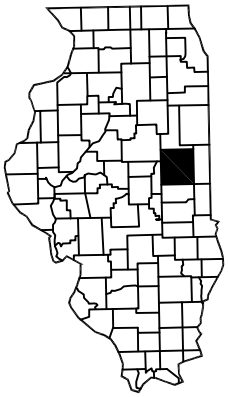
REFERENCES

Berg, Richard C. and John P. Kempton, 1987. *Stack-Unit Mapping of Geologic Materials in Illinois to a Depth of 15 Meters.* Illinois State Geological Survey, Circular 542.

PSC Industrial Outsourcing, LP. 2008. *Comprehensive Site Investigation Report; Former Manufactured Gas Plant; Champaign, Illinois*.

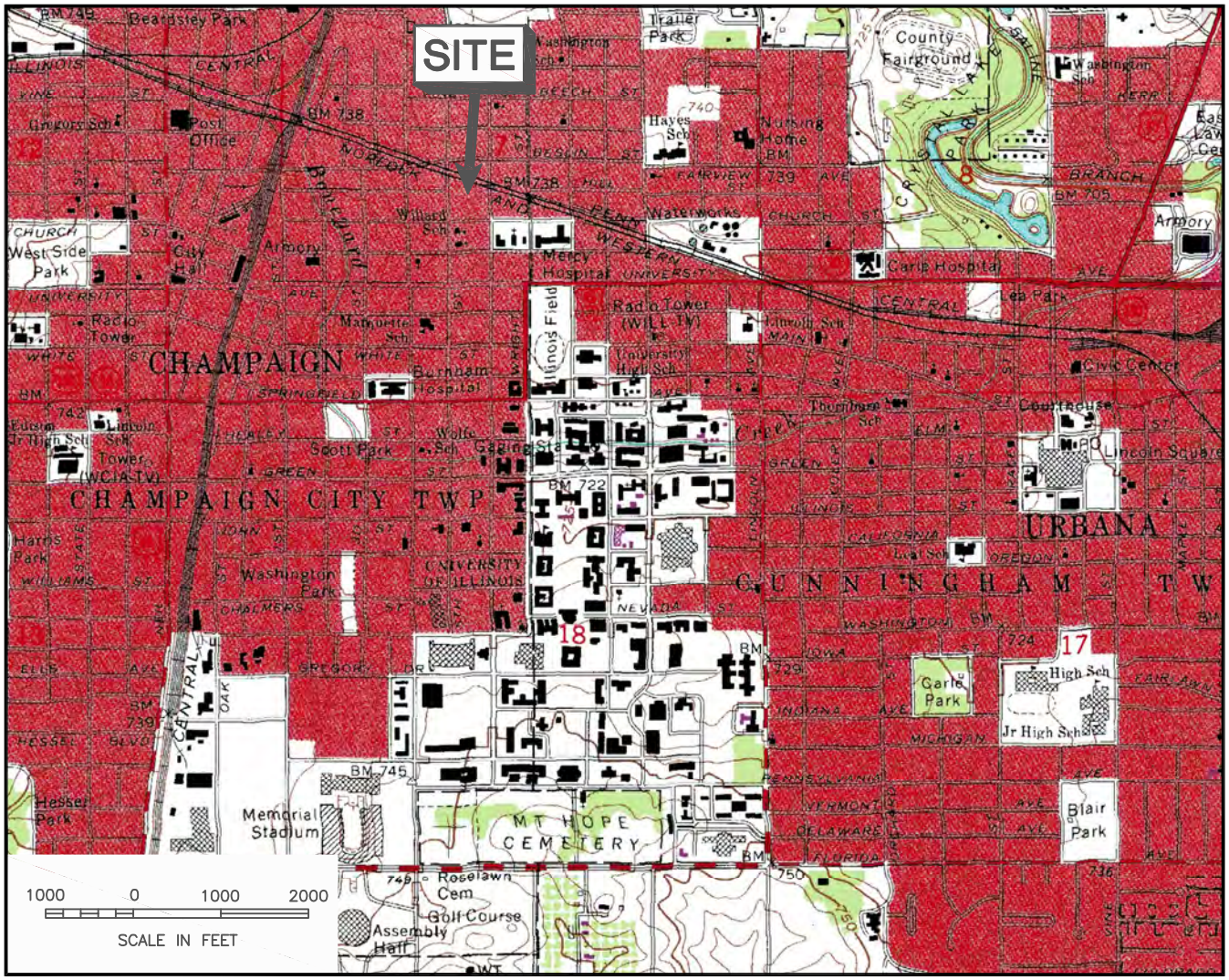
List of Figures

ILLINOIS



CHAMPAIGN COUNTY

AREA IN DETAIL



Modified from U.S. Geological Survey, Urbana, Illinois, quadrangle, Photorevised 1975.

SCALE IS VARIABLE

COL. 624\00345E-001

PSC

TITLE: SITE LOCATION MAP PROJECT STATUS REPORT CHAMPAIGN FORMER MGP SITE	DWN: TMM	DES.: SPB	PROJECT NO.: 62412010008 AMEREN ILLINOIS CHAMPAIGN, ILLINOIS
	CHKD: LH	APPD: MK	FIGURE 1–1
	DATE: 1/30/13	REV.: 2	

LEGEND

- HISTORICAL MANUFACTURED GAS PLANT STRUCTURES
- FORMER GAS PLANT PIPING
- EXISTING STRUCTURES (APPROXIMATE)
- CURRENT AMERENIP PROPERTY BOUNDARY
- REMEDIATION SITE BOUNDARY
- 12 — LOT LINE AND LOT NUMBER
- FENCE

NOTE: THE HISTORICAL MANUFACTURED GAS PLANT STRUCTURES ARE A COMPOSITE FROM SANBORN FIRE INSURANCE MAPS AND HISTORICAL AMERENIP SITE PLANS. THE EXACT LOCATIONS OF THE FEATURES IS NOT KNOWN. STRUCTURES AND BUILDINGS MAY HAVE SERVED MULTIPLE PURPOSES DURING THE OPERATION OF THE PLANT.

SOURCE: THE SOURCE FOR THE PROPERTY BOUNDARY SURVEY IS VEGRZYN, SARVER AND ASSOCIATES.

0 80
FEET

PSC

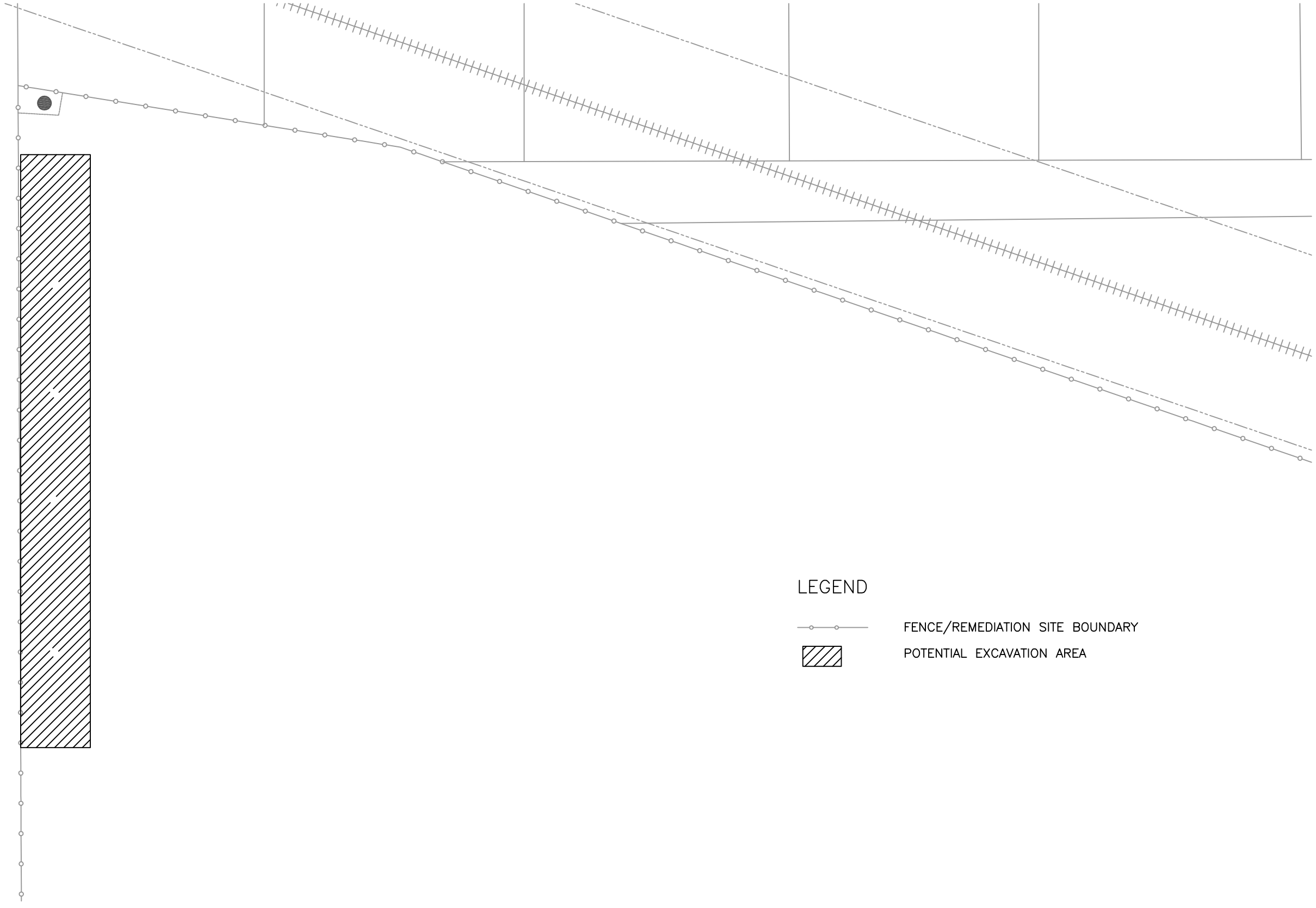
TITLE:
REMEDIATION PROJECT SITE

DWN: TMM	DES: MRC
CHKD:	APPD:
DATE: 10/27/16	REV:

PROJECT NO: 62402647
AMERENIP
CHAMPAIGN, ILLINOIS

FIGURE 2–1

COL. J:\624\026478-194



TITLE:
AREA OF RESIDUAL MGP–IMPACTED TO BE REMEDIATED

DWN: TMM	DES: MRC	PROJECT NO: 62412010008	
CHKD:	APPD:	CHAMPAIGN MGP SITE CHAMPAIGN, ILLINOIS	
DATE: 10/27/16	REV:	FIGURE 2–2	

COL 62412\01008A-011

WASHINGTON STREET

SIXTH STREET

16.5' WIDE PUBLIC ALLEY

5th STREET

21'
28'
24
24'
22'
20-21
25'
24'
20'
25'
25'
22'
21'
25'
22'
19'
18'
16'
20'
23'
16'
3'
10'

16.5' WIDE PUBLIC ALLEY

CHURCH STREET

LEGEND

- EXISTING STRUCTURES (APPROXIMATE)
- NORFOLK SOUTHERN RAILWAY CORPORATION PROPERTY BOUNDARY
- REMEDIATION SITE BOUNDARY
- FENCE
- TENT EXTENT OF EXCAVATION
- OPEN AIR EXTENT OF EXCAVATION
- 25' 25' EXCAVATION DEPTH

source:

THE SOURCE FOR THE PROPERTY BOUNDARY SURVEY IS VEGRZYN, SARVER AND ASSOCIATES.

0 80
FEET

N

COL. J:\624\02647N-141

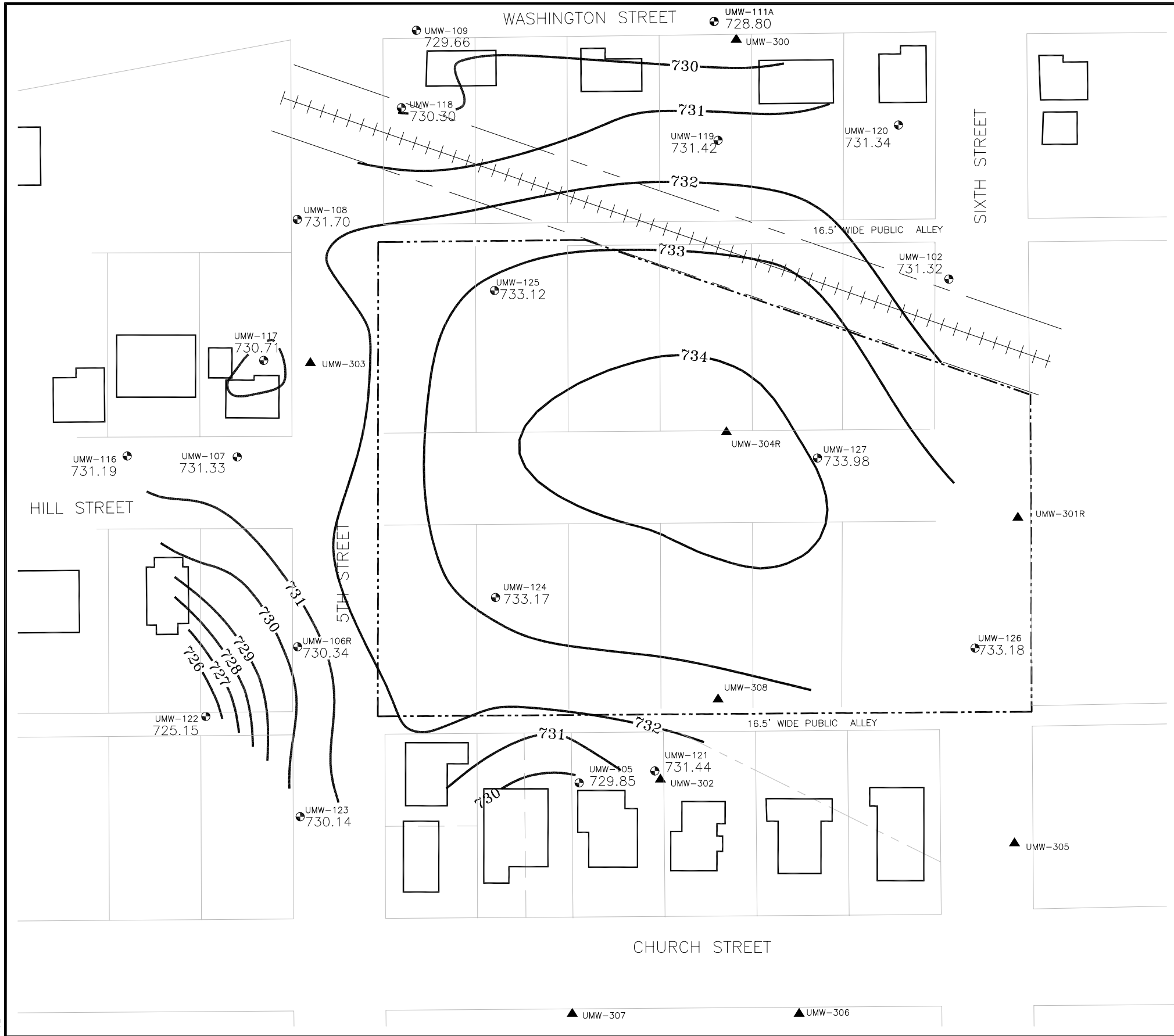
PSC

TITLE:
LIMITS OF 2009 THROUGH 2011 SOIL EXCAVATION
CHAMPAIGN FORMER MGP SITE

DWN: TMM	DES: MRC
CHKD:	APPD:
DATE: 1/30/13	REV: 2

PROJECT NO: 62412010008
AMEREN ILLINOIS
CHAMPAIGN, ILLINOIS

FIGURE 2-3



LEGEND

- EXISTING STRUCTURES (APPROXIMATE)
- AMEREN ILLINOIS PROPERTY (FORMER MGP SITE)
- UMW-100 — SHALLOW GROUNDWATER MONITORING WELLS
- UMW-300 — INTERMEDIATE GROUNDWATER MONITORING WELLS
- 733 — GROUNDWATER CONTOUR (FEET)

SOURCE:
1. The source for the property boundary survey is Vegrzyn, Sarver and Associates.
2. This groundwater elevation contour map is based upon interpolation between widely spaced monitoring locations. Only at the monitoring well location and for the time identified are the elevations actually know.

0 80
FEET

PSC

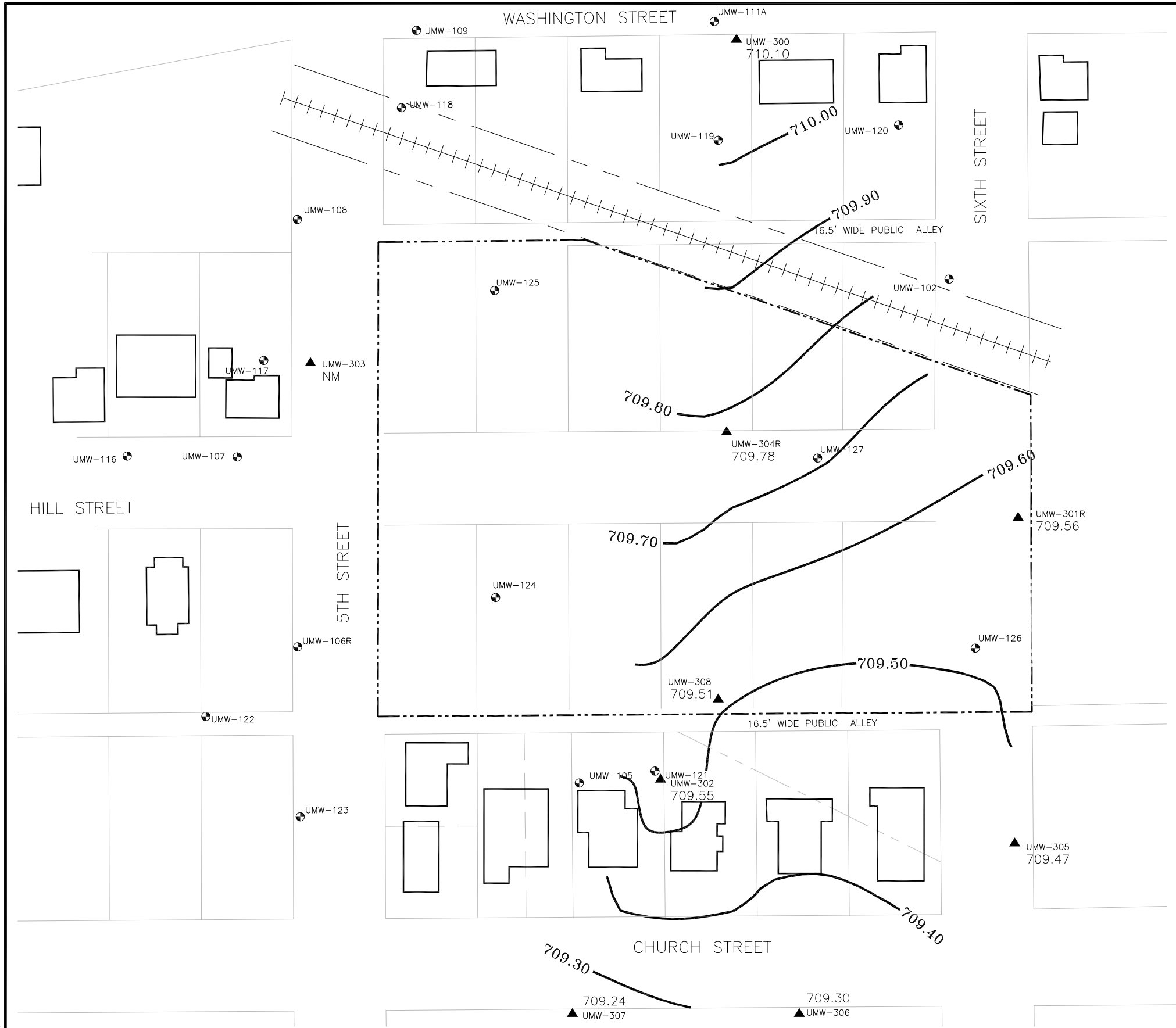
TITLE:
SHALLOW GROUNDWATER LEVEL CONTOUR MAP
SEPTEMBER 2016
CHAMPAIGN, ILLINOIS

DWN: TMM	DES:
CHKD:	APPD:
DATE: 10/10/16	REV:

PROJECT NO: 62412010008
AMEREN ILLINOIS
CHAMPAIGN, ILLINOIS

FIGURE 2-4

COL. J:\624\026478-192



LEGEND

———	EXISTING STRUCTURES (APPROXIMATE)
— - - —	AMEREN ILLINOIS PROPERTY (FORMER MGP SITE)
UMW-100	SHALLOW GROUNDWATER MONITORING WELLS
▲ UMW-300	INTERMEDIATE GROUNDWATER MONITORING WELLS
—710.00—	GROUNDWATER CONTOUR (FEET)
NM	NOT MEASURED

SOURCE:
1. The source for the property boundary survey is Vegrzyn, Sarver and Associates.
2. This groundwater elevation contour map is based upon interpolation between widely spaced monitoring locations. Only at the monitoring well location and for the time identified are the elevations actually know.

0 80
FEET

N

COL. J:\624\026478-191

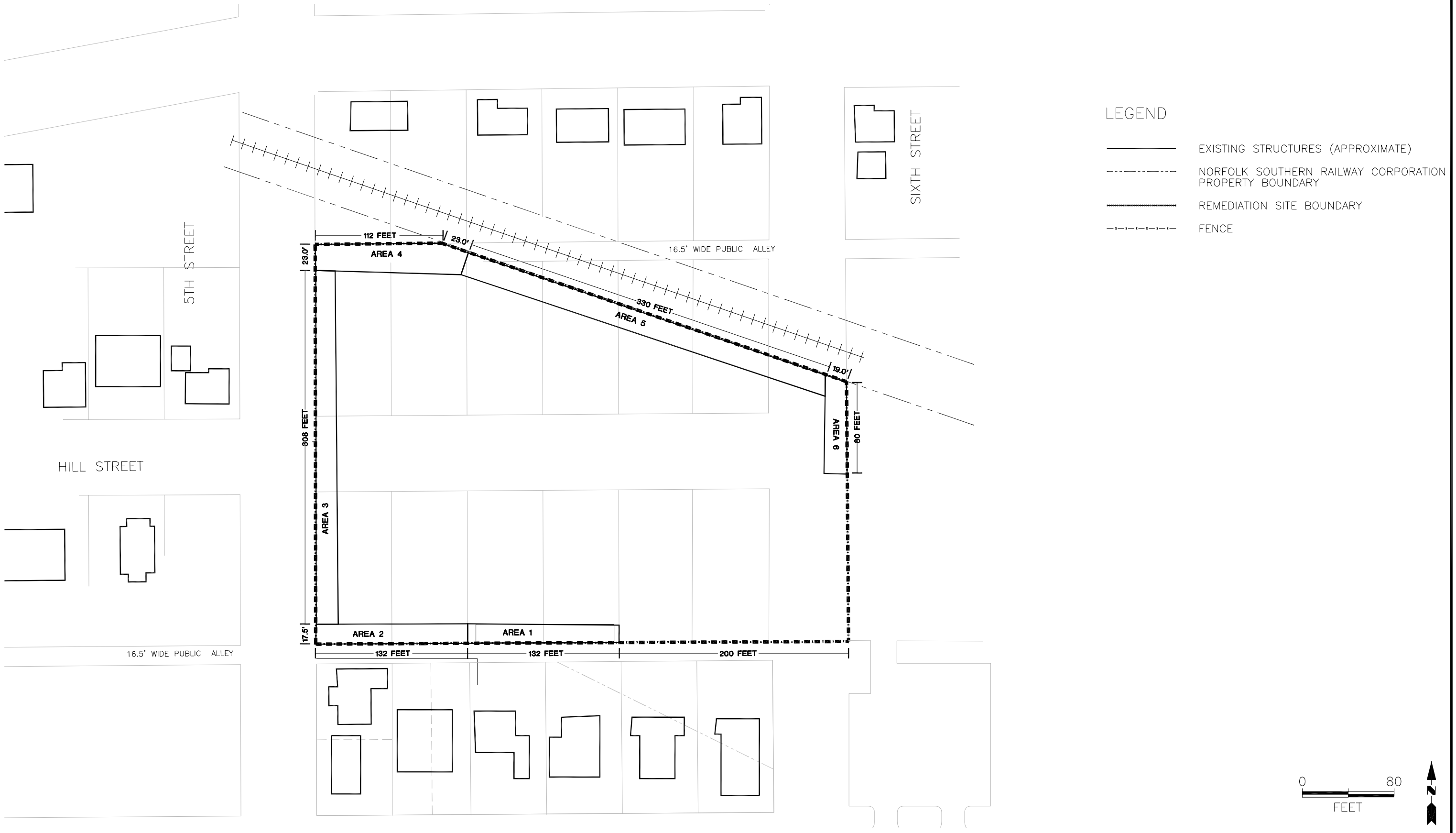
PSC

TITLE:
INTERMEDIATE GROUNDWATER LEVEL CONTOUR MAP
SEPTEMBER 2016
CHAMPAIGN, ILLINOIS

DWN: TMM	DES:
CHKD:	APPD:
DATE: 10/10/16	REV:

PROJECT NO: 62412010008
AMEREN ILLINOIS
CHAMPAIGN, ILLINOIS

FIGURE 2-5



J:\624\026470-013

COL

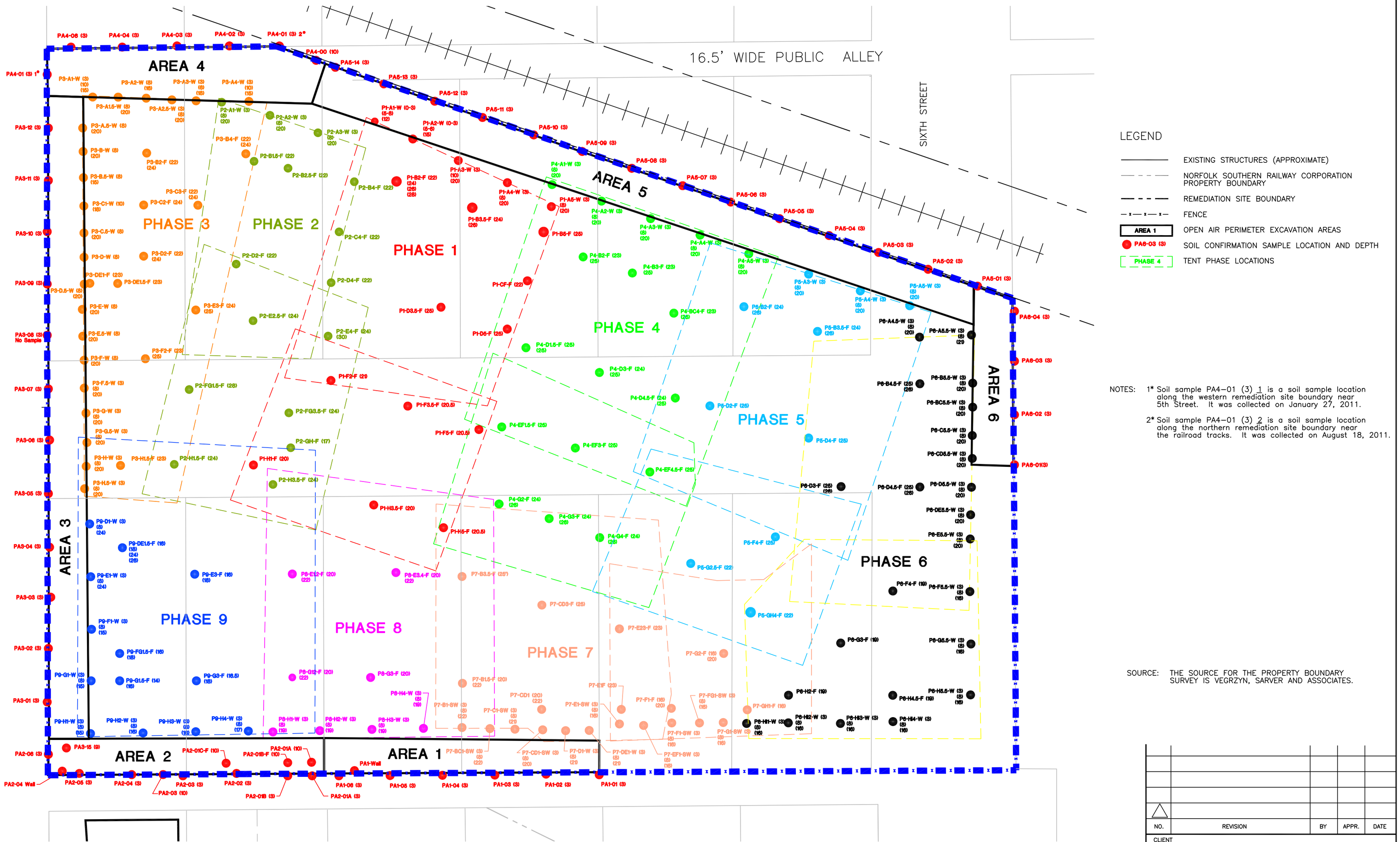
TITLE:

PERMITER EXCAVATION AREAS – 2011
CHAMPAIGN FORMER MGP SITE

DWN: TMM	DES: MRC
CHKD:	APPD:
DATE: 02/06/11	REV:

PROJECT NO: 62403053
AMERENIP
CHAMPAIGN, ILLINOIS

FIGURE 3–1



NOTES:
1* Soil sample PA4-01 (3) 1 is a soil sample location along the western remediation site boundary near 5th Street. It was collected on January 27, 2011.

2* Soil sample PA4-01 (3) 2 is a soil sample location along the northern remediation site boundary near the railroad tracks. It was collected on August 18, 2011.

SOURCE: THE SOURCE FOR THE PROPERTY BOUNDARY SURVEY IS VEGRZYN, SARVER AND ASSOCIATES.

NO.	REVISION	BY	APPR.	DATE

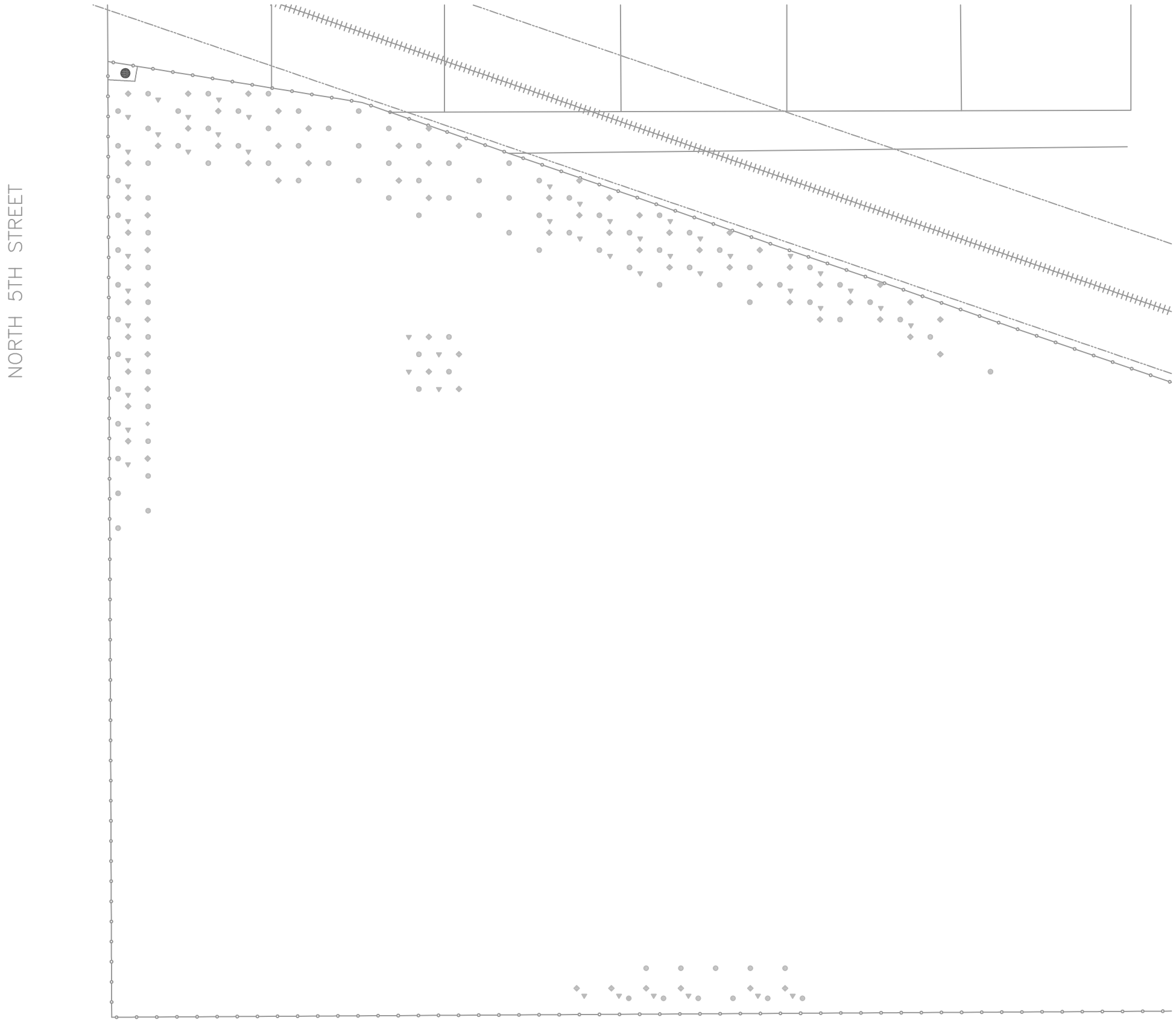
CLIENT
AMEREN ILLINOIS

PROJECT TITLE
CHAMPAIGN FORMER MGP SITE

SHEET TITLE
TENT PHASE LOCATIONS AND PERIMETER EXCAVATION AND SAMPLE LOCATIONS

DATE 11/7/12
PROJECT NUMBER 62412010008
DRAWN BY TMM
DESIGNED BY LH
CHECKED BY PTS
APPROVED BY MK
DRAWING NO. FIGURE 3-2

COL.
624\026470-008



LEGEND

- FENCE/REMEDIATION SITE BOUNDARY
- PHASE 2A INJECTION LOCATION
- PHASE 2B INJECTION LOCATION
- PHASE 2C INJECTION LOCATION

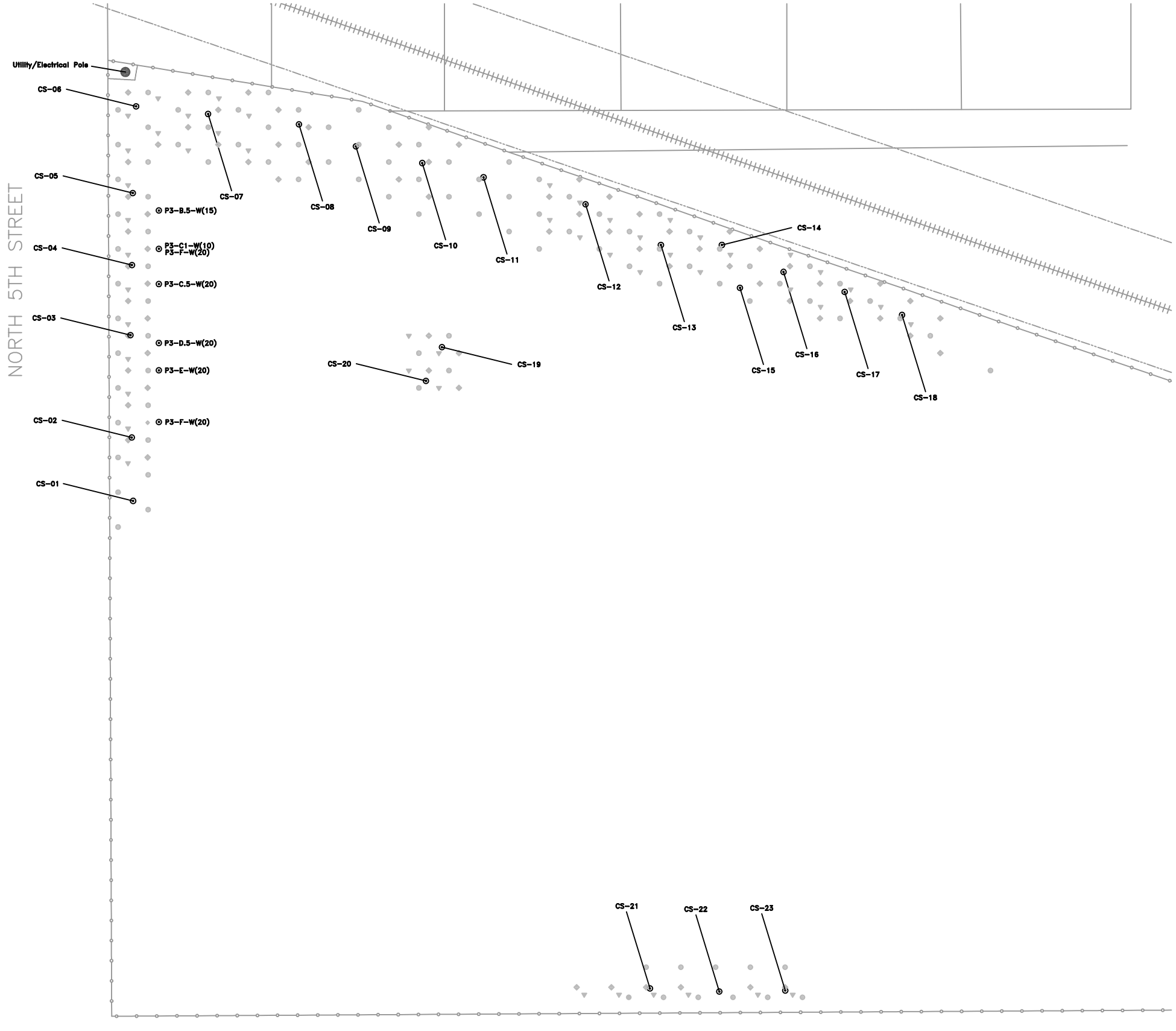
0 50
FEET

N

TITLE:
IN–SITU CHEMICAL OXIDATION REMEDIATION INJECTION POINTS

DWN: TMM	DES: MRC	PROJECT NO: 62412010008	CHAMPAIGN MGP SITE CHAMPAIGN, ILLINOIS
CHKD:	APPD:		
DATE: 10/27/16	REV:		FIGURE 3–3

COL 62412\01008A–012



LEGEND

- FENCE/REMEDIATION SITE BOUNDARY
- PHASE 2A INJECTION LOCATION
- PHASE 2B INJECTION LOCATION
- PHASE 2C INJECTION LOCATION
- CONFIRMATION SOIL SAMPLE LOCATION

0 50
FEET

N

PSC

TITLE:
POST CHEMICAL OXIDATION REMEDIATION INJECTION POINTS

DWN: TMM	DES: MRC	PROJECT NO: 62412010008	CHAMPAIGN MGP SITE CHAMPAIGN, ILLINOIS
CHKD:	APPD:		
DATE: 10/27/16	REV:	FIGURE 3-4	

COL 62412\01008A-013

Appendix A
In-Situ Chemical Oxidation Remediation

Post-ISCO Soil Confirmation Sample Analytical Results
First, Second, and Third Injection Events
Comparison to Tier 2 Remediation Objectives for Inhalation for Residential Property Use
Champaign MGP

	Tier 2 Remediation Objectives		Sample ID:	CS-02 (5-6 ft)					CS-02 (7-8 ft)					CS-03 (5-6 ft)				
	Residential Inhalation	Units	Date:	1st Event 5/23/2013	2nd Event 7/1/2013	3rd Event 8/21/2013	(Re-sample) 9/20/2013	(Re-sample) 2/18/2014	1st Event 5/23/2013	2nd Event 7/1/2013	3rd Event 8/21/2013	(Re-sample) 9/20/13	(Re-sample) 2/18/2014	1st Event 5/23/2013	2nd Event 7/1/2013	3rd Event 8/21/2013	(Re-sample) 9/20/13	(Re-sample) 2/18/2014
BTEX (8260/5035)																		
Benzene	2.65	mg/kg		< 8.24	< 45	93.7	6.97	2.38	< 138	< 51.1	338	52	80.5	< 36.4	44.3	392	47	13.7
PNA (8270 SIM)																		
Naphthalene	257.78	mg/kg		10.6	168	---	---	---	1750	455	340	1010	485	1710	840	410	1030	502
TPH (OA-1, OA-2)																		
Gasoline Range Organics	---	mg/kg		---	---	---	---	<95.2	---	---	---	---	1470	---	---	---	---	1130
Diesel	---	mg/kg		---	---	---	---	372	---	---	---	---	711	---	---	---	---	2450
Kerosene	---	mg/kg		---	---	---	---	<318	---	---	---	---	<153	---	---	---	---	<319
Mineral Spirits	---	mg/kg		---	---	---	---	<318	---	---	---	---	<153	---	---	---	---	<319
Motor Oil	---	mg/kg		---	---	---	---	652	---	---	---	---	236	---	---	---	---	802
Total TPH (1)	4,733 (2)	mg/kg		---	---	---	---	1389	---	---	---	---	2570	---	---	---	---	4701

Notes:

J Analyte detected below quantitation limits.
S Spike recovery outside recovery limits.
Unknown hydrocarbon.
R RPD outside accepted recovery limits.
H Holding times exceeded.
(1) The sum of TPH values, using 50% of non-detects.
(2) Site specific value from soil borings B-806, B-814, and B-817.
Constituent exceeds Tier 2 Remediation Objective.

Post-ISCO Soil Confirmation Sample Analytical Results
First, Second, and Third Injection Events
Comparison to Tier 2 Remediation Objectives for Inhalation for Residential Property Use
Champaign MGP

	Tier 2 Remediation Objectives		Sample ID:	CS-03 (9-10 ft)					CS-04 (5-6 ft)				CS-04 (8-9 ft)				
	Residential Inhalation	Units	Date:	1st Event 5/23/2013	2nd Event 7/1/2013	3rd Event 8/21/2013	(Re-sample) 9/20/13	(Re-sample) 2/18/2014	1st Event 5/23/2013	2nd Event 7/1/2013	3rd Event 8/21/2013	(Re-sample) 2/18/2014	1st Event 5/23/2013	2nd Event 7/1/2013	3rd Event 8/21/2013	(Re-sample) 9/20/13	(Re-sample) 2/18/2014
BTEX (8260/5035)																	
Benzene	2.65	mg/kg		33.3	54	92.8	27.3	176	0.9	3.83	22.5	0.126	< 47.5	< 17.3	803	5.24	10.1
PNA (8270 SIM)																	
Naphthalene	257.78	mg/kg		213	985	583	563	1570	1.55	35.6 S	---	---	300	1260	238	191	---
TPH (OA-1, OA-2)																	
Gasoline Range Organics	---	mg/kg		---	---	---	---	3180	---	---	---	67.9	---	---	---	---	266
Diesel	---	mg/kg		---	---	---	---	12,700	---	---	---	<28	---	---	---	---	765
Kerosene	---	mg/kg		---	---	---	---	<6,060	---	---	---	<28	---	---	---	---	<333
Mineral Spirits	---	mg/kg		---	---	---	---	<6,060	---	---	---	<28	---	---	---	---	<333
Motor Oil	---	mg/kg		---	---	---	---	6870	---	---	---	<28	---	---	---	---	520
Total TPH (1)	4,733 (2)	mg/kg		---	---	---	---	28,810	---	---	---	123.9	---	---	---	---	1884

Notes:

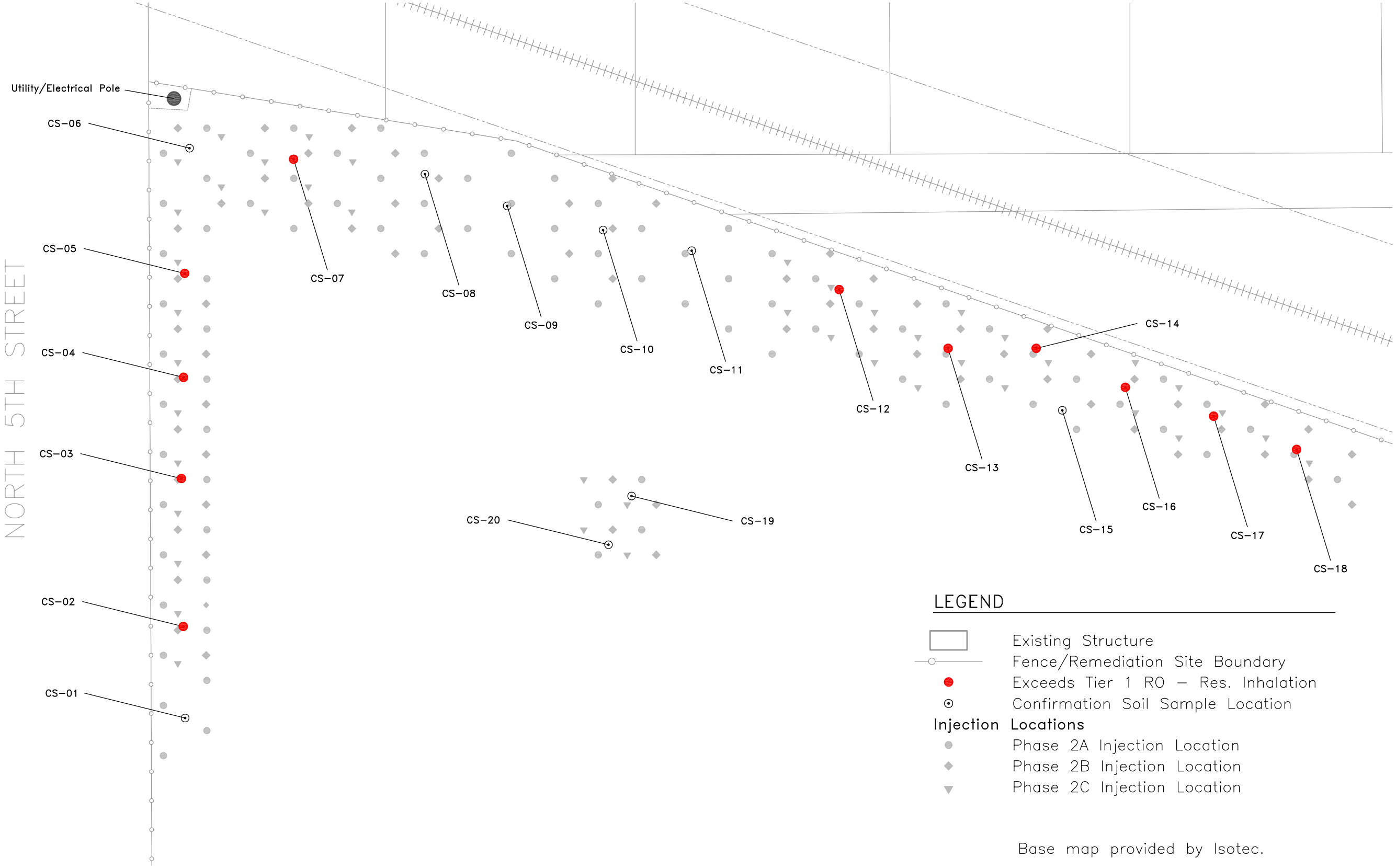
J Analyte detected below quantitation limits.
S Spike recovery outside recovery limits.
Unknown hydrocarbon.
R RPD outside accepted recovery limits.
H Holding times exceeded.
(1) The sum of TPH values, using 50% of non-detects.
(2) Site specific value from soil borings B-806, B-814, and B-817.
Constituent exceeds Tier 2 Remediation Objective.

Post-ISCO Soil Confirmation Sample Analytical Results
First, Second, and Third Injection Events
Comparison to Tier 2 Remediation Objectives for Inhalation for Residential Property Use
Champaign MGP

	Tier 2 Remediation Objectives		Sample ID:	CS-05 (4.5-5.5 ft)		CS-05 (9-10 ft)			
				1st Event	2nd Event	1st Event	2nd Event	3rd Event	(Re-sample)
	Residential Inhalation	Units	Date:	5/23/2013	7/1/2013	5/23/2013	7/1/2013	8/21/2013	2/18/2014
BTEX (8260/5035)									
Benzene	2.65	mg/kg		7.54	0.002	< 189	64.8	10.5	54.2
PNA (8270 SIM)									
Naphthalene	257.78	mg/kg		4.09	31.9	511	355	292	951
TPH (OA-1, OA-2)									
Gasoline Range Organics	---	mg/kg		---	---	---	---	---	1280
Diesel	---	mg/kg		---	---	---	---	---	31,400
Kerosene	---	mg/kg		---	---	---	---	---	<7,160
Mineral Spirits	---	mg/kg		---	---	---	---	---	<7,160
Motor Oil	---	mg/kg		---	---	---	---	---	15,200
Total TPH (1)	4,733 (2)	mg/kg		---	---	---	---	---	55,040

Notes:

J Analyte detected below quantitation limits.
S Spike recovery outside recovery limits.
Unknown hydrocarbon.
R RPD outside accepted recovery limits.
H Holding times exceeded.
(1) The sum of TPH values, using 50% of non-detects.
(2) Site specific value from soil borings B-806, B-814, and B-817.
Constituent exceeds Tier 2 Remediation Objective.



LEGEND

- Existing Structure
- Fence/Remediation Site Boundary
- Exceeds Tier 1 RO – Res. Inhalation
- Confirmation Soil Sample Location

Injection Locations

- Phase 2A Injection Location
- Phase 2B Injection Location
- Phase 2C Injection Location

Base map provided by Isotec.

N

0 30
FEET

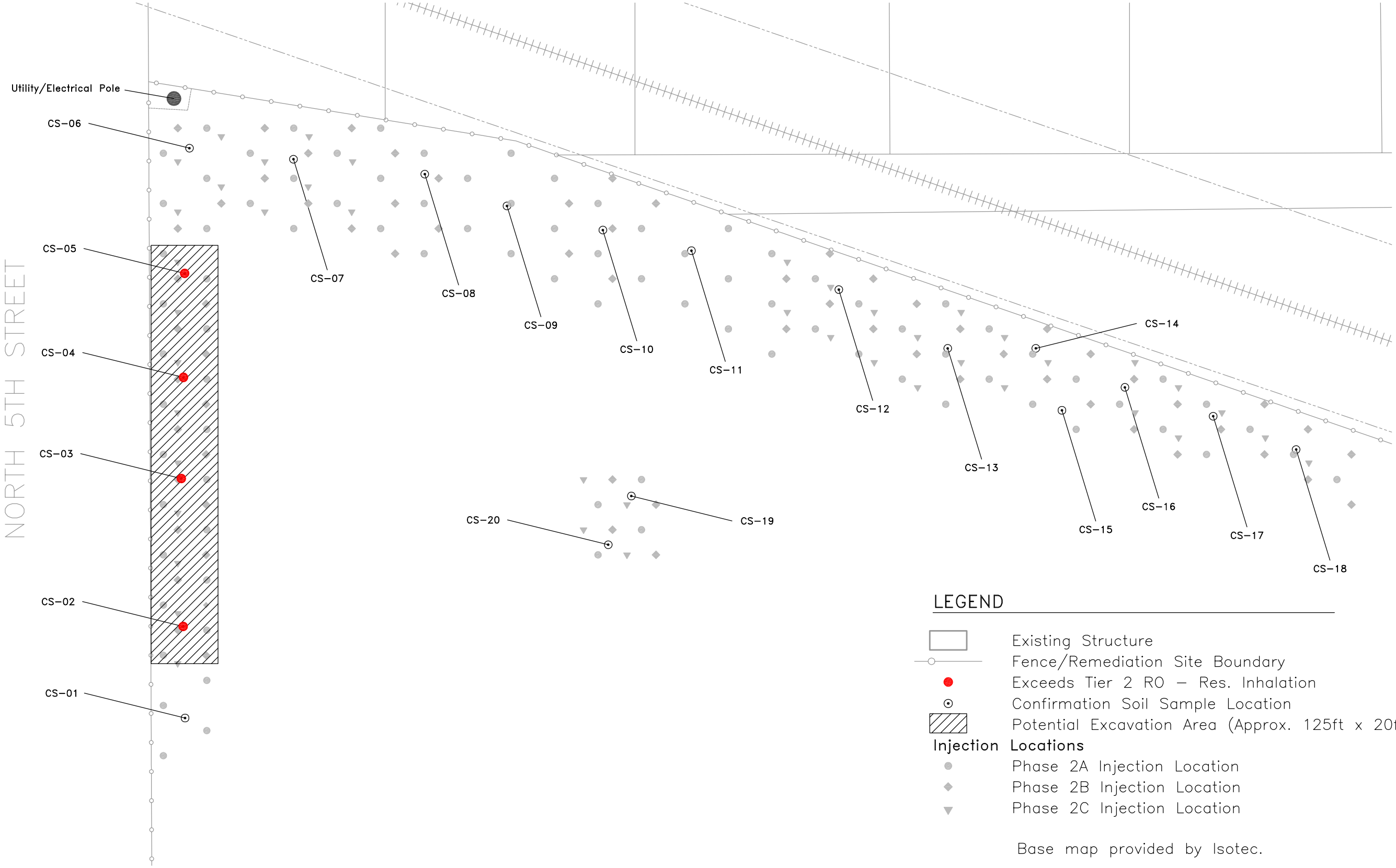
PSC

TITLE:
CONFIRMATION SAMPLES IN EXCEEDANCE OF TIER 1 REMEDIATION OBJECTIVES FOR RESIDENTIAL INHALATION (3 TO 10 FEET)
FORMER CHAMPAIGN MGP SITE – CHAMPAIGN, ILLINOIS

DWN: SLC	DES: LGH
CHKD:	APPD:
DATE: 12-18-13	REV:

PROJECT NO: 62412010008
CHAMPAIGN MGP SITE
CHAMPAIGN, ILLINOIS

FIGURE 1



LEGEND

- Existing Structure
- Fence/Remediation Site Boundary
- Exceeds Tier 2 RO – Res. Inhalation
- Confirmation Soil Sample Location
- Potential Excavation Area (Approx. 125ft x 20ft x 12ft)

Injection Locations

- Phase 2A Injection Location
- Phase 2B Injection Location
- Phase 2C Injection Location

Base map provided by Isotec.

N

0 30

FEET

PSC

TITLE:

CONFIRMATION SAMPLES IN EXCEEDANCE OF TIER 2 REMEDIATION OBJECTIVES FOR RESIDENTIAL INHALATION (3 TO 10 FEET)
FORMER CHAMPAIGN MGP SITE – CHAMPAIGN, ILLINOIS

DWN: SLC	DES: LGH	PROJECT NO: 62412010008	
CHKD:	APPD:	CHAMPAIGN MGP SITE CHAMPAIGN, ILLINOIS	
DATE: 12-18-13	REV:	FIGURE 2	

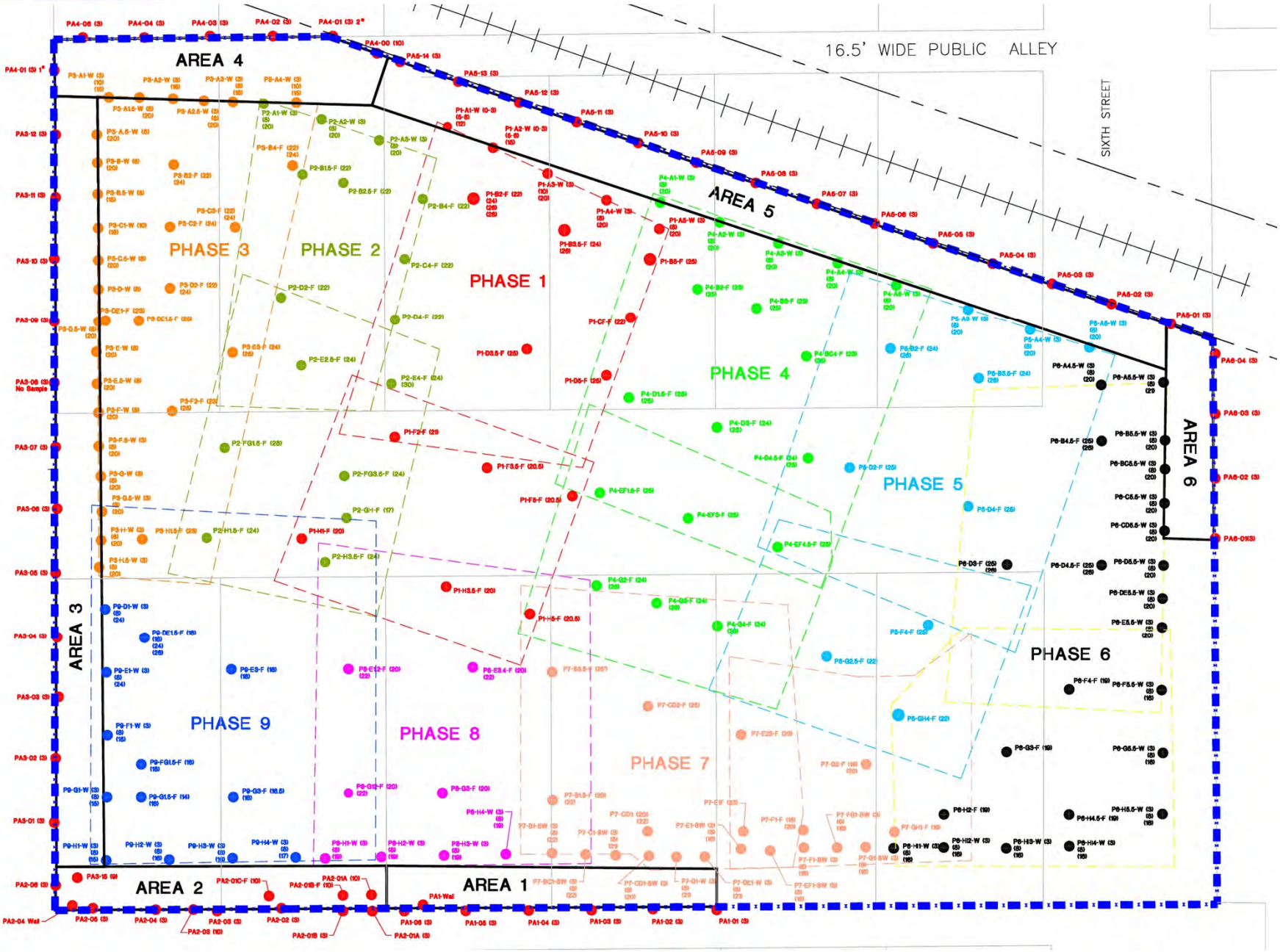
Providing Tomorrow's Solutions Today.™

In-Situ Chemical Oxidation Remediation Results

Champaign MGP Site

Presented: July 17, 2014

Introduction



In-Situ Chemical Oxidation Objectives

Tier 1 Remediation Objectives

- Reduce perimeter BTEX and naphthalene concentrations to meet Tier 1 ROs for the inhalation exposure pathway for residential property use

Soil Attenuation

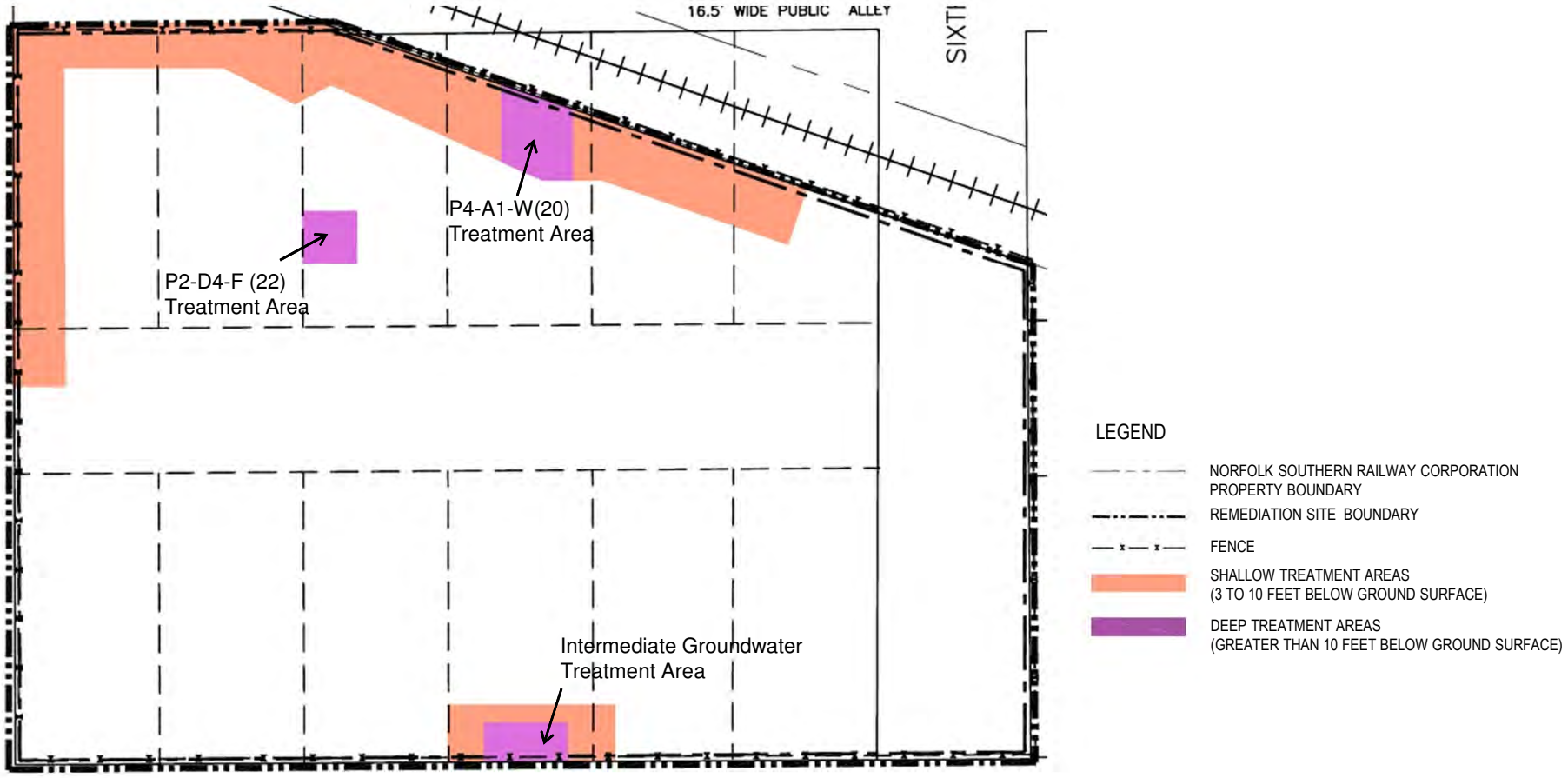
- Treat areas of heavy impact in the vicinity of P2-D4-F(22), P4-A1-W(20), and PA5-08(3) to reduce the organic compound levels to below the soil attenuation levels

Intermediate Groundwater System

- Reduce benzene and naphthalene levels in the intermediate groundwater system in the vicinity of monitoring well UMW-302

In-Situ Chemical Oxidation Treatment Areas

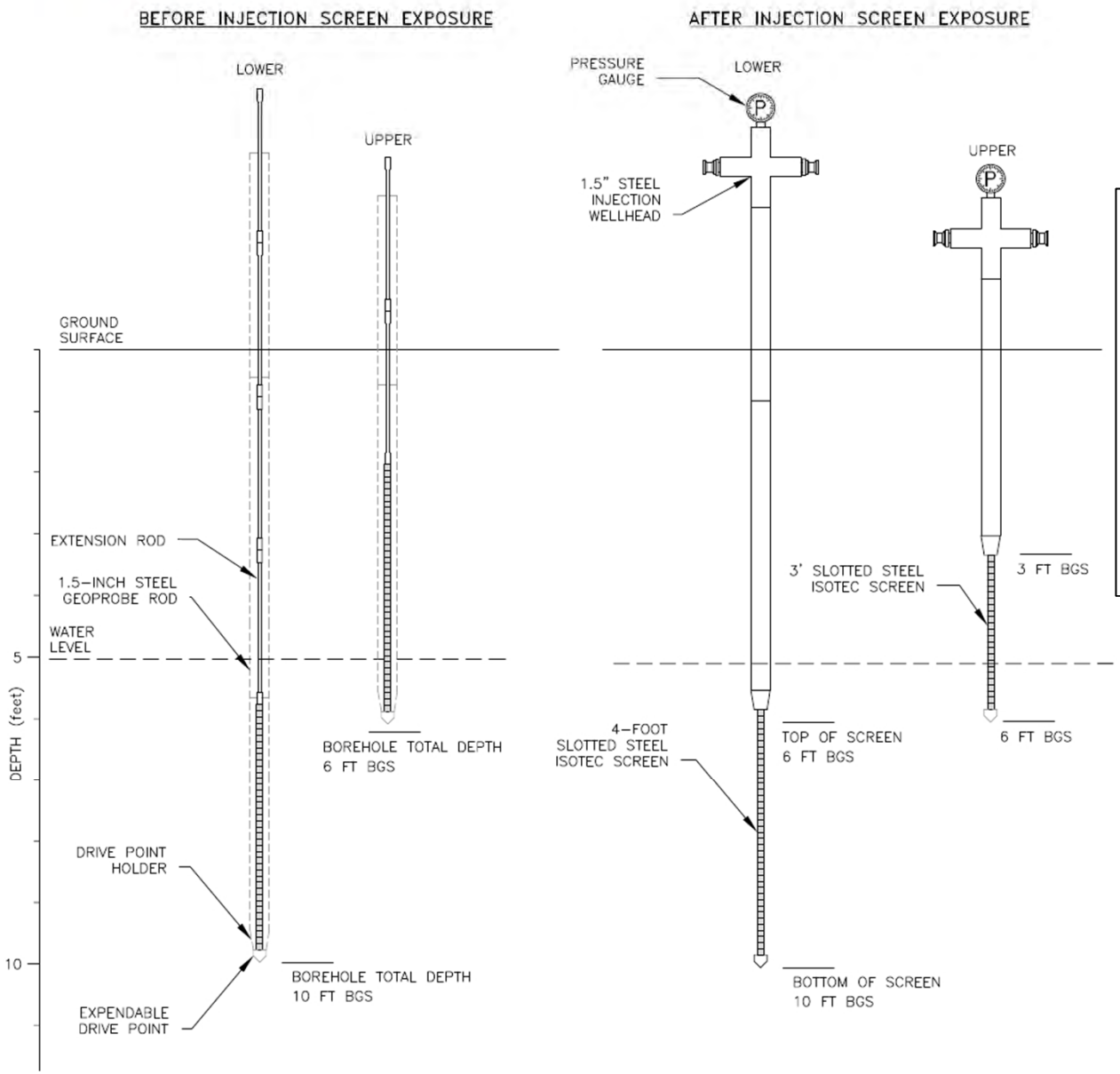
- ISCO Area: 35,000 square feet – northern and western site perimeter
- Primary COCs: BTEX, naphthalene
- Vadose and saturated zone soils (3–10 feet bgs)



In-Situ Chemical Oxidation Method

- Injected Fenton's Reagent
- Utilized direct-push technology (DPT) to introduce reagents into subsurface
- Closely spaced injection locations, two injection screen depths per location, multiple injection events
- Two subsequent injection events shifted laterally from initial locations
- Injection boring locations abandoned with bentonite and hydrated then sealed with concrete

In-Situ Chemical Oxidation Injection Method



INJECTION SCREEN INSTALLATION

1. Two separate borings will be utilized at each injection location. One boring will be the LOWER injection screen and will be installed by advancing probe rod to a depth of 10 feet below ground surface (bgs) by a direct-push subcontractor. The second boring will be the UPPER injection screen and will be installed by advancing probe rod to a depth of 6 feet bgs.
2. Once at the desired depth, a 4-foot injection screen (LOWER) or a 3-foot injectin screnen (UPPER) will be lowered to the bottom of the rod string and held in place with extension rod.
3. The rod string will be extracted 4 feet or 3 feet to expose the screen to impacted soils in the target treatment interval.

In-Situ Chemical Oxidation Remediation Program

Above: DPT installation of injection locations – two screen depths per location.

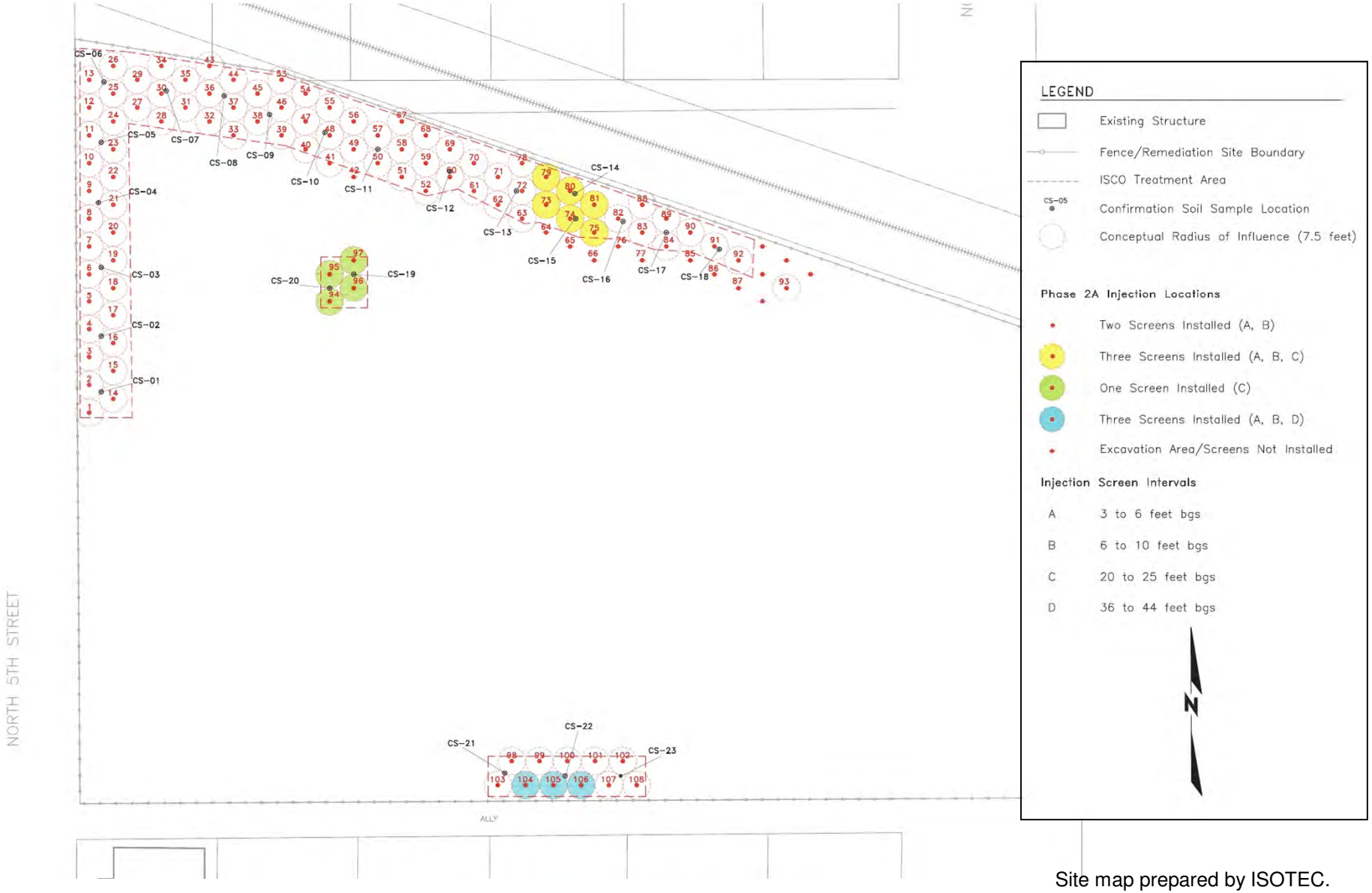
Below: Typical injection location setup included steel wellhead assemblies with pressure gauges and relief valves.

In-Situ Chemical Oxidation Remediation Program

Above: Three air-operated double-diaphragm pumps, flow meters, and PVC reinforced tubing used for injections.

Below: Polyethylene bulk tanks used to dilute hydrogen peroxide from 30% to 8% concentration. The 8% solution was pumped from bulk tanks to injection locations.

First Injection Event

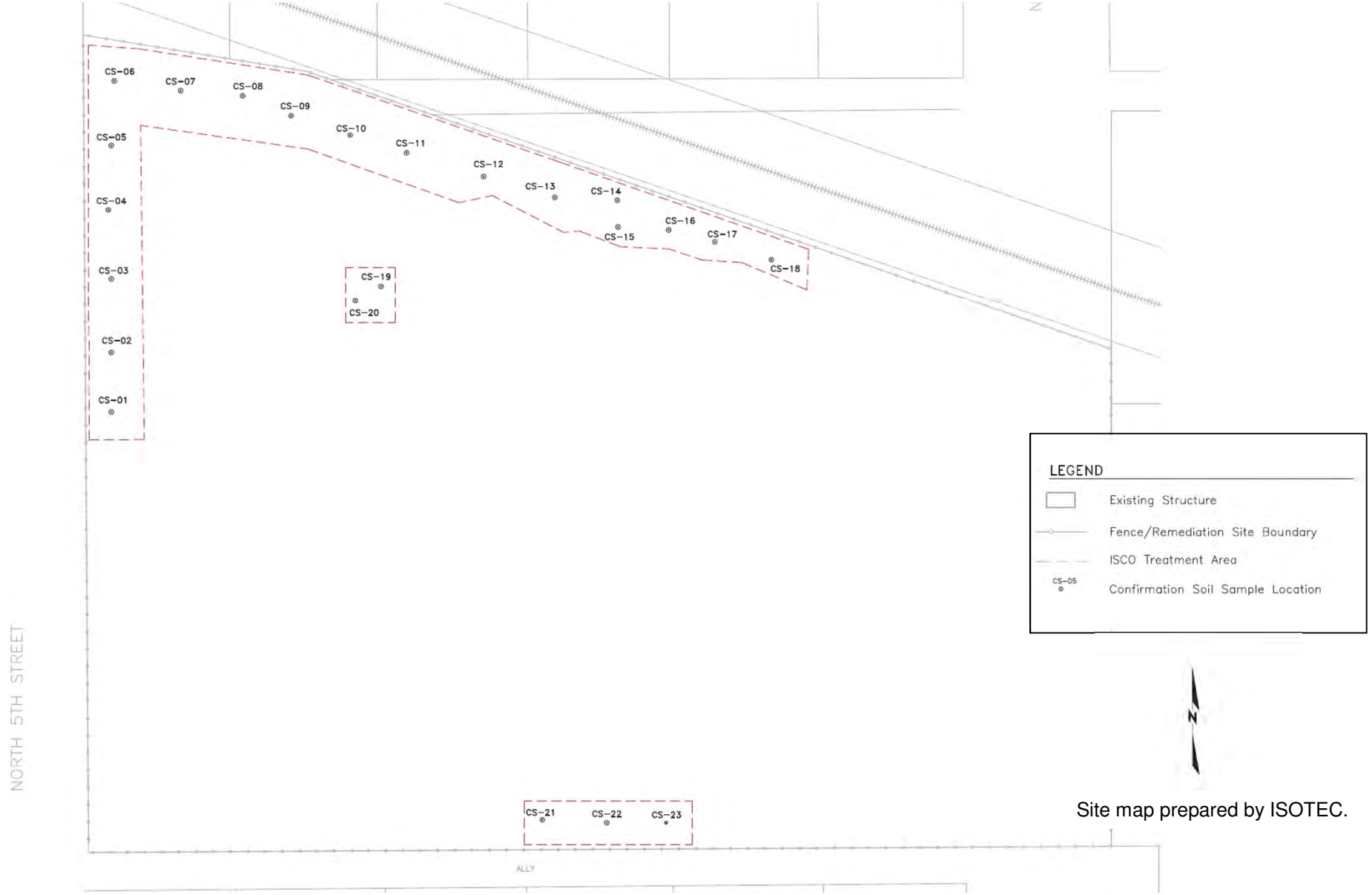


Site map prepared by ISOTEC.

First Injection Event

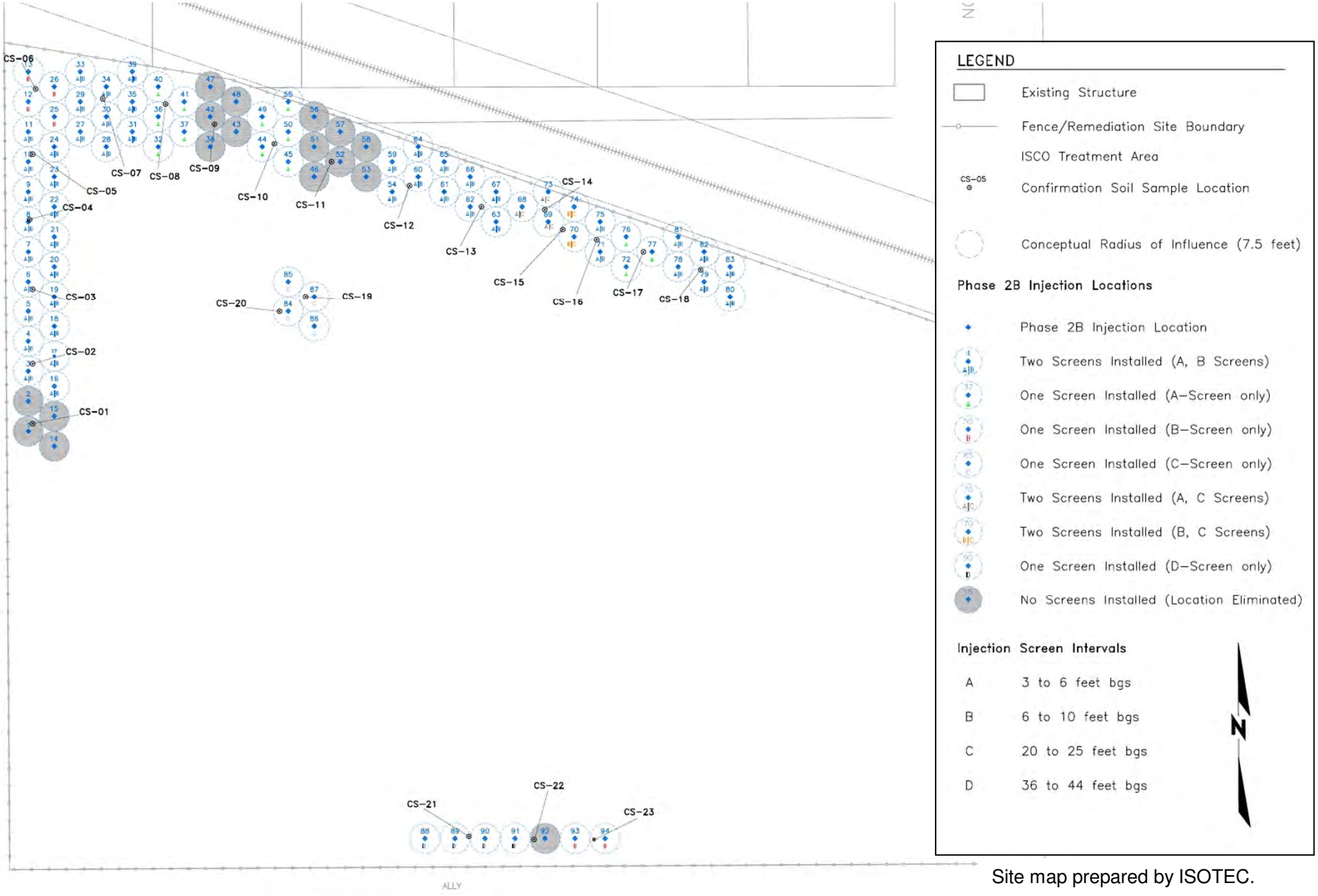
- Performed between April 29 and May 15, 2013
- 98 injection locations
- Injected 9,664 gallons reagent (catalyst and oxidizer)
- Surfacing was limiting factor, injection ceased at locations when surfacing occurred
- Soil confirmation samples collected between May 23 and May 28, 2013
- Analytical results indicated reduction in BTEX and/or naphthalene in portions of the treatment area

Confirmation Sample Locations



Site map prepared by ISOTEC.

Second Injection Event

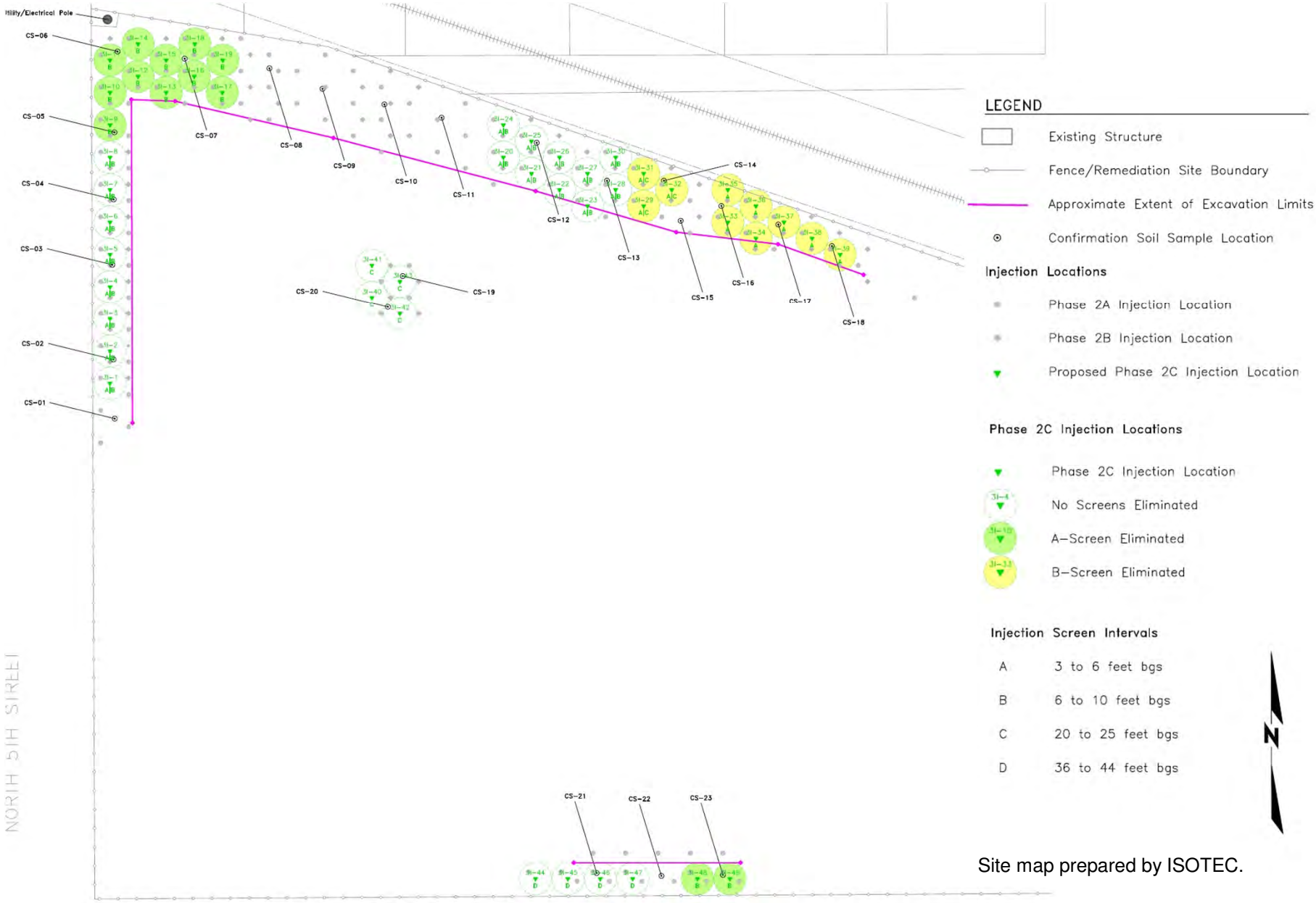


Site map prepared by ISOTEC.

Second Injection Event

- Performed between June 19 and June 26, 2014
- 72 injection locations
- Injected 8,175 gallons reagent (catalyst and oxidizer)
- Surfacing was limiting factor, surfacing outside western property boundary during injection in NW corner - injection ceased at locations when surfacing occurred
- Soil confirmation samples collected July 1 and July 2, 2013
- Analytical results indicated reduction of BTEX and/or naphthalene in some of the treatment area
- Reduction of organic compounds in vicinity of P2-D4-F(22), P4-A1-W(20), and PA5-08(3)

Third Injection Event

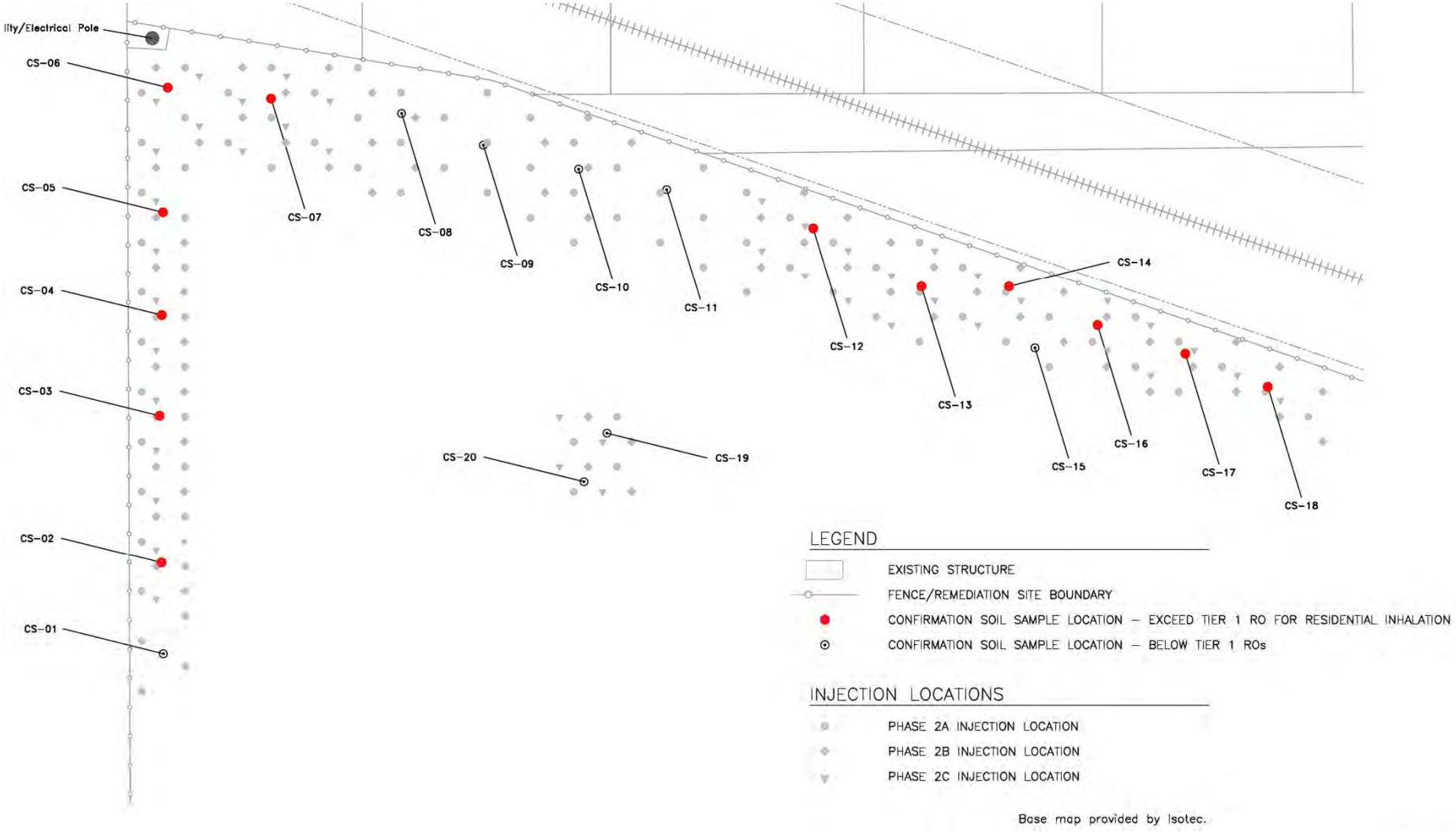


Site map prepared by ISOTEC.

Third Injection Event

- Performed between August 14 and August 20, 2014
- 49 injection locations
- Injected 5,202 gallons reagent (catalyst and oxidizer)
- Surfacing was limiting factor, some injection points were relocated
- Soil confirmation samples collected on August 21, 2013; re-sampled on September 20, 2013
- Analytical data indicated exceedances of Tier 1 ROs for benzene and naphthalene in some soil confirmation samples

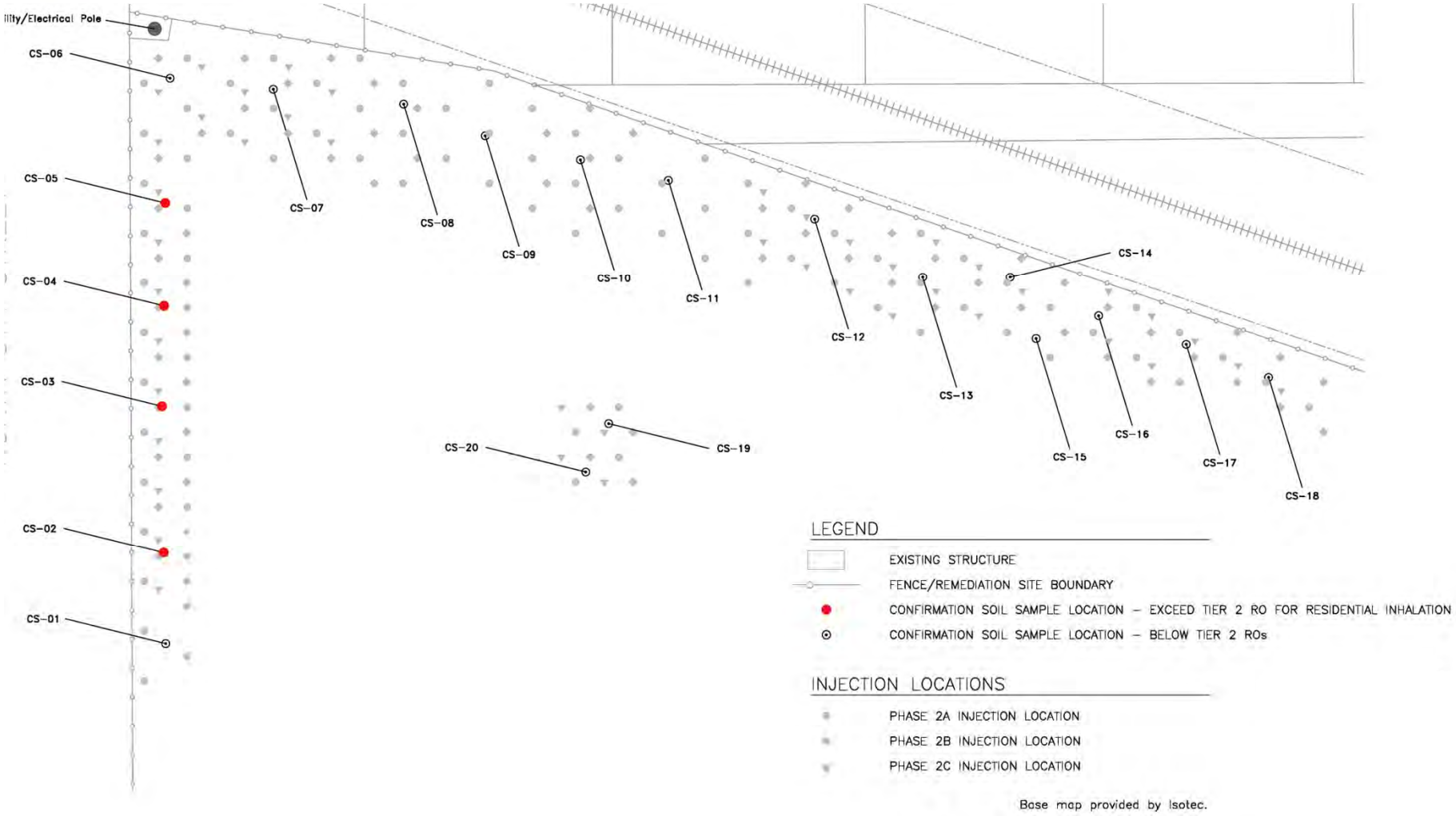
Post-ISCO Tier 1 Exceedances for Soil Inhalation
0 to 10 Feet Below Ground Surface



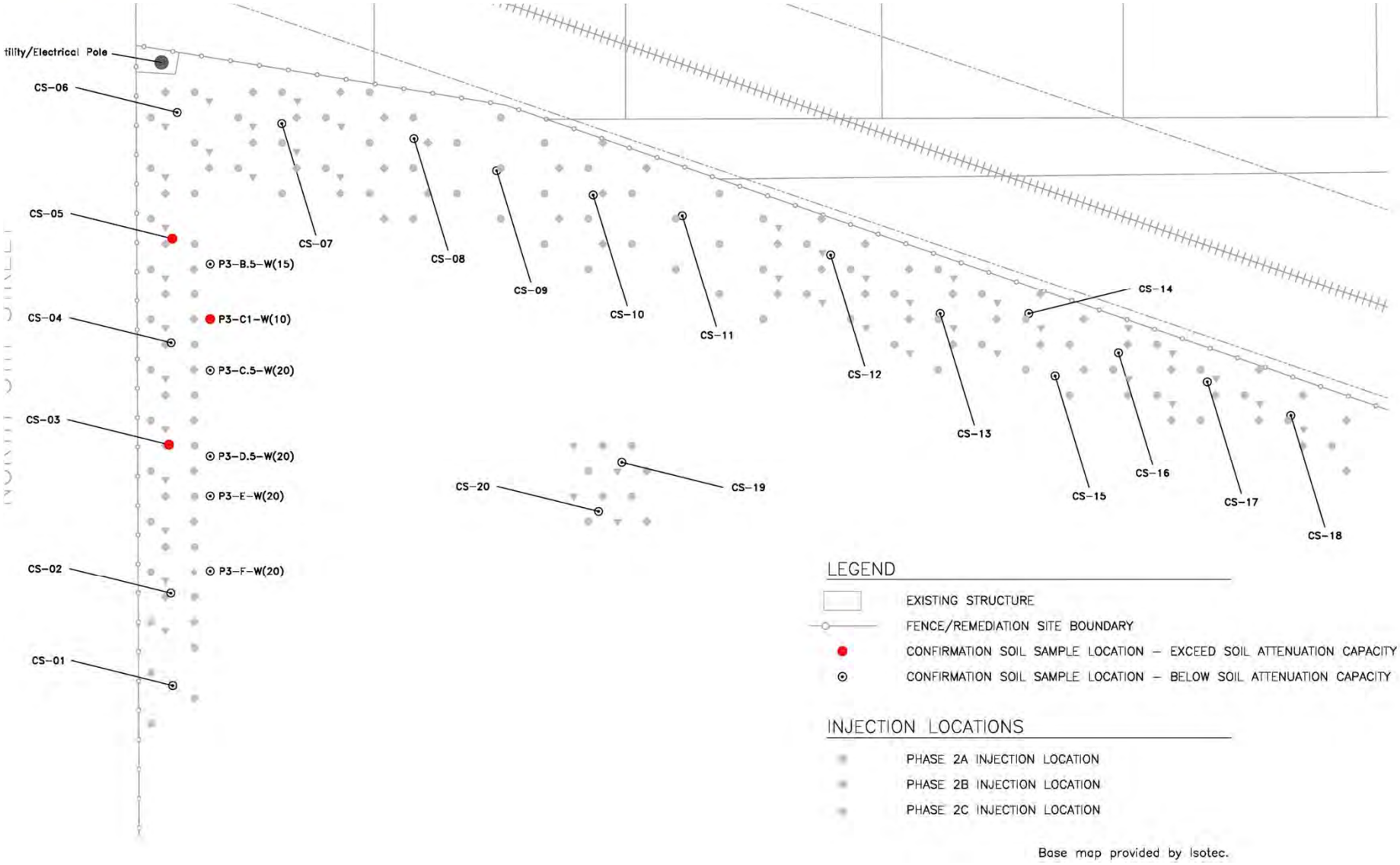
Tier 2 Evaluation

- Calculated Tier 2 ROs for benzene and naphthalene for residential inhalation
- Benzene RO calculated using SSL-S6 equation for carcinogenic compounds
- Naphthalene RO calculated using SSL-S4 equation for non-carcinogenic compounds
- Benzene RO: 2.65 mg/kg
- Naphthalene RO: 257.78 mg/kg
- Default input parameters used for calculations, except f_{oc}
- F_{oc} average from three boring locations (B-806, B-814, and B-817) in 3-10 ft depth interval
- Site-specific f_{oc} value: 4,733 mg/kg

Post-ISCO Tier 2 Exceedances for Soil Inhalation



Post-ISCO Exceedance of Soil Attenuation Capacity



Conclusion

- Request IEPA review of Tier 2 ROs
- Currently evaluating remedial approach to address remaining impact
- Remedial approach will be selected following IEPA review of Tier 2 ROs

IN-SITU CHEMICAL OXIDATION INJECTION PROGRAM FINAL REPORT

SITE:

CHAMPAIGN FORMER MGP SITE
CHAMPAIGN, ILLINOIS

JANUARY 10, 2014

PREPARED FOR:

PSC INDUSTRIAL OUTSOURCING, LP
210 WEST SAND BANK ROAD
COLUMBIA, ILLINOIS 62236

PROJECT NO. 901144

PREPARED BY:

IN-SITU OXIDATIVE TECHNOLOGIES, INC.
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1.0 INTRODUCTION

In-Situ Oxidative Technologies, Inc. (ISOTEC) was retained by PSC Industrial Outsourcing, LP (PSC) to conduct an in-situ chemical oxidation (ISCO) injection program at the former Manufactured Gas Plant (MGP) located at 308 N. 5th Street, in Champaign, Illinois (**Figure 1**). In this report the former Champaign MGP site is also identified as the "site".

The purpose of the ISCO injection program was to address the perimeter of the site where concentrations of organic constituents of concern (COCs) exceeded Tier 1 Remedial Objectives (ROs) for the soil inhalation exposure pathway in the upper 10 feet of soil. The remediation technology chosen for the site was ISOTEC's proprietary modified Fenton's Reagent (MFR) technology.

The field activities conducted by ISOTEC to date have occurred during three separate injection events (Phase 2A, Phase 2B and Phase 2C) between April 29 and August 20, 2013. Field operations completed by ISOTEC during the Phase 2A injection event were detailed in the *In-Situ Chemical Oxidation Remediation Program Interim Report- Phase 2A*, dated June 18, 2013. Field operations completed by ISOTEC during the Phase 2B injection event were detailed in the *In-Situ Chemical Oxidation Remediation Program Interim Report- Phase 2B*, dated July 24, 2013. The field activities were performed in accordance with the *In-Situ Chemical Oxidation Work Plan* that was prepared by PSC and submitted to the Illinois Environmental Protection Agency (IEPA) in March 2013.

This *In-Situ Chemical Oxidation Injection Program Final Report* describes the field activities completed by ISOTEC during all three injection events.

1.1 SITE-SPECIFIC CHARACTERISTICS

The original ISCO treatment area occupied approximately 35,000 square feet (sq. ft.) of the 2.5 acre site and encompassed the western and northern portion of the site perimeter. The extent of the treatment area was determined from post-excavation soil confirmation sample analytical data.

According to data provided by PSC, the remediation site had vadose and saturated zone soils impacted by inorganics, metals, volatile aromatics and polycylic aromatic hydrocarbons (PAHs). The primary COCs at the site were benzene, toluene, ethylbenzene, and xylenes (BTEX) and naphthalene.

The treatment interval for the ISCO injection program was from 3 to 10 feet below ground surface (bgs). Two additional treatment intervals, 20 to 25 feet bgs and 36 to 44 feet bgs, were identified by PSC at three limited areas within the designated ISCO injection treatment area. The first area was located along the northern perimeter and had exceedances in soils from 3 to 10 feet bgs and 20 to 25 feet bgs. The second area was located in the middle portion of the site and had soil exceedances present from 20 to 25 feet bgs. The third area was located along the southern perimeter of the site and had soil

exceedances from 3 to 10 feet bgs and potential groundwater exceedances present at approximately 36 to 44 feet bgs. Injection locations utilized during the injection program are shown on **Figure 2** (Phase 2A), **Figure 3** (Phase 2B) and **Figure 3** (Phase 2C).

Review of lithologic logs for soil borings advanced across the site indicated that the subsurface soils consist of fill material from grade surface to depths of 3 to 4 feet bgs. This surficial fill unit along the perimeter of the site is underlain by a clay and silty-clay unit to a depth of approximately 16 to 20 feet bgs. Below this unit is a weathered till unit present from 16 feet bgs to a maximum depth explored of 33 feet bgs. This weathered till unit is comprised of silty-clay and sandy-clay with some gravel and fine-grained sand. According to PSC, depth to groundwater ranges from 2 to 10 feet bgs.

1.2 ISCO INJECTION PROGRAM OBJECTIVES

The objective of the ISCO injection program was to reduce benzene, ethylbenzene, toluene, xylenes and naphthalene concentrations in the upper 10 feet of soil to their respective Tier 1 ROs for the soil inhalation exposure pathway.

The Tier 1 ROs for the soil inhalation pathway are:

- Benzene - 0.8 mg/kg
- Ethylbenzene - 400 mg/kg
- Toluene - 650 mg/kg
- Xylenes - 320 mg/kg
- Naphthalene - 170 mg/kg

Based on post-excavation soil confirmation data and past experience, it was determined that multiple injection events would be required to reach the injection program objective.

1.3 ISCO REMEDIATION PROGRAM DESIGN

ISOTEC proposed to utilize neutral-pH, chelated iron catalyst and stabilized 8% hydrogen peroxide to implement an MFR ISCO program. ISOTEC was to utilize direct-push technology (DPT) to introduce reagents into the subsurface at the site. The ISCO program was designed to address vadose zone and saturated zone soils within the treatment areas specified by PSC (**Figure 2**).

The design was based upon data supplied by PSC and had several potentially limiting factors to implementation success. Limiting factors at the site included the presence of previous investigative penetrations and the fact that the majority of the target treatment interval is shallow vadose zone soils (3 to 10 feet bgs). These factors, in unison, presented potential problems for the injection of modified Fenton's reagent. The presence of previous penetrations in the treatment area may provide vertical conduits through which produced gas can travel to the surface. Surfacing was a significant issue during the Phase 1 2009 ISCO pilot test and was expected during Phase 2. Chemical oxidation remediation is a dissolved phase/saturated zone technology. Since the majority of the Phase 2 target treatment interval is shallow vadose zone soils, ISOTEC would have

to attempt to saturate the vadose zone soils with reagent in order to achieve the project objectives, which would most likely result in varying amounts of surfacing. In order to achieve project success, the site's limiting factors were taken into account when the injection program was designed.

Based on review of site data provided by PSC, ISOTEC anticipated that two full-scale injection applications and one reduced application would be required. ISOTEC assumed that the full-scale ISCO remediation program would be designated Phase 2 and that each injection event would be given the following alphabetical designations:

- Phase 2A – First Injection Event (Entire Treatment Area)
- Phase 2B – Second Injection Event (Entire Treatment Area)
- Phase 2C – Third Injection Event (50% of the Treatment Area)

During Phase 2A, also referred to as the "first event", temporary injection screens were to be installed at approximately 120 injection locations within the on-site perimeter treatment areas. Two screen installations were to be completed at each location; one screen deployed from approximately 3 to 6 feet bgs to target the upper shallow vadose zone soils and the second screen deployed from approximately 6 to 10 feet bgs to target the lower shallow vadose/saturated zone soils.

The injection locations within the on-site perimeter ISCO treatment areas would be spaced approximately 15 feet apart based on an anticipated 7.5-foot radius of influence (ROI). The actual spacing for the locations were to likely vary due to underground utilities, above-ground impediments and other associated field conditions. The injection locations were to be placed on a triangular grid-like pattern across the treatment areas. The subsequent injection event locations (Phase 2B and Phase 2C) would be shifted laterally from the first event locations.

The effectiveness of the injection program was to be determined by comparing the concentrations of soil samples collected by PSC prior to injection activities with the concentrations of soil samples collected by PSC during post-injection sampling events. The post-injection soil samples were to be collected from the 3 to 6 feet bgs interval and the 6 to 10 feet bgs interval at multiple selected locations within the treatment area(s). The post injection performance soil samples would be collected at locations immediately adjacent to the baseline boring locations and from the same associated depth intervals. This would allow for the most direct comparison possible of concentration reductions as a result of the injection application. In the event that a specific post-injection soil sample reported all of the target COC concentrations at or below the Tier 1 ROs for the soil inhalation exposure pathway, that specific boring location and/or depth interval would no longer be sampled and injections in the immediate vicinity of the boring(s) and/or depth interval(s) would be eliminated from the subsequent injection applications. These soil sampling and evaluation procedures would be repeated following each of the injection applications.

2.0 ISCO INJECTION PROGRAM

ISOTEC conducted three injection events at the site from April 29 to August 20, 2013. Specifically, Phase 2A was conducted from April 29 to May 15, 2013, Phase 2B was conducted from June 19 through 26, 2013 and Phase 2C was conducted from August 14 through 20, 2013. Over the course of the three events, ISOTEC injected 23,041 gallons of reagent (oxidizer and catalyst) through 411 injection screens installed at 219 injection locations. For identification purposes, each injection screen was labeled with an injection event identifier ("1I" for the Phase 2A injection event, "2I" for the Phase 2B injection event and "3I" for the Phase 2C injection event), followed by an injection location number and finally an injection interval identifier ("A", "B", "C" or "D"). The "A" designation indicates a 3 to 6 feet bgs screen, the "B" designation indicates a 6 to 10 feet bgs screen, the "C" designation indicates a 20 to 25 feet bgs screen, and the "D" designation indicates a 36 to 44 feet bgs screen. According to this method the injection screen labeled "2I-31B" indicates a screen installed from 6 to 10 feet bgs at location 31 during the Phase 2B injection event. A total of 192 "A" screens, 183 "B" screens, 25 "C" screens and 11 "D" screens were installed during the injection program. Phase 2A, Phase 2B and Phase 2C injection locations are shown on **Figure 2**, **Figure 3** and **Figure 4**, respectively.

2.1 FIELD METHODS

Field operations completed by ISOTEC during each injection event included equipment mobilization and demobilization, temporary injection screen installations and abandonments, reagent preparation, and reagent injections. The following sections describe in detail the field methods, procedures, and equipment utilized by ISOTEC during implementation of each injection event.

2.1.1 Injection Screen Installation and Abandonment

Temporary injection screens installed with direct-push technology (DPT) were used to deliver ISOTEC's modified Fenton's reagents into the target depth intervals. The injection screens were installed with a DPT drill rig operated by Bulldog Drilling (Bulldog). The equipment and tooling provided by Bulldog included a track-mounted AMS drill rig, 1.25-inch and 1.5-inch diameter direct-push drill rods, extension rods used to deploy injection screens, and decontamination equipment. Tooling provided by ISOTEC included specialized 0.5-inch diameter injection screens designed to pass through the center of the drill rods, specialized point holders designed to hold the injection screens in place within the target injection interval, and 1-inch expendable drive points.

Bulldog began each screen installation by advancing drill rods to the desired depth at each injection location. Once the proper depth was reached, an injection screen was lowered through the center of the rods to the bottom of the rod string and held in place with extension rods. The rod string was then slowly retracted until the desired length of injection screen was exposed across the specific target treatment interval. A direct-push

injection screen schematic illustrating the A- and B-screen installation (3 to 6 and 6 to 10 feet bgs) is included as **Figure 5**.

Following daily injection activities, ISOTEC oversaw the proper abandonment of each injection location by Bulldog. After removing the rod string, each borehole was abandoned by slowing hand pouring 3/8-inch bentonite chips from the bottom of the borehole to approximately 6-inches bgs. The bentonite was hydrated and the borehole was then completed with a concrete patch.

2.1.2 Reagent Preparation

ISOTEC reagents consist of a neutral-pH, chelated ferrous iron solution (catalyst) and dilute stabilized hydrogen peroxide (oxidizer). During each phase of the injection program, ISOTEC utilized an oxidizer concentration of 8%. Hydrogen peroxide at a concentration of 30% was shipped directly to the site immediately prior to field injection activities and stored in DOT-approved 55-gallon drums. The 30% hydrogen peroxide was diluted to an 8% concentration in 300-gallon polyethylene bulk tanks with water obtained from a fire hydrant located in the southwest corner of the site. ISOTEC's proprietary catalyst is a pH buffered (pH of approximately 7) ferrous iron complex. The catalyst components were shipped to the site in dry form and mixed with water in 300-gallon polyethylene bulk tanks. A reagent mixing schematic is included as **Figure 6**.

2.1.3 Injection Method

The injections were accomplished using air-operated double-diaphragm pumps, flow meters, polyvinyl chloride (PVC) reinforced tubing, cam-lock valves & fittings, and steel wellhead assemblies. The wellhead assemblies, with pressure gauges and relief valves, were attached to the uppermost drill rod at each injection screen location. The wellhead assemblies were attached with PVC reinforced tubing to an air-operated diaphragm pump and from the pump to either the oxidizer, catalyst or water tanks with additional PVC tubing. Oxidizer, catalyst and water were conveyed through the PVC tubing using a pneumatic diaphragm pump with air supplied from a portable air compressor.

In general, the injection process was similar for each injection screen. First, water was injected, followed by catalyst, a second water flush to clear the injection equipment of catalyst, then the oxidizer, and a final water flush to clear the injection equipment of oxidizer. An injection method schematic detailing the injection process is included as **Figure 7**.

Reagent volumes, flow rates, and injection pressures were monitored at regular intervals and recorded in a field log during the injection process at each injection screen. Reagent volumes and flow rates were measured with battery-operated turbine flow meters/totalizers. Injection pressures were measured with pressure gauges attached to the wellhead assemblies.

2.2 PHASE 2A INJECTION EVENT FIELD ACTIVITIES

During the Phase 2A injection event, ISOTEC attempted to inject catalyst and oxidizer into 203 injection screens installed at 99 locations (**Figure 2**). As previously noted, screens were not installed at some locations because the locations were within the excavation limits. These locations included 1I-42, 1I-64, 1I-65, 1I-66, 1I-76, 1I-77, 1I-85, 1I-86 and 1I-87, and combined for a total of 21 screens not installed. The Phase 2A treatment area occupied approximately 22,500 sq. ft. At locations where multiple injection screens were required in order to target separate treatment intervals, the individual screens were installed in separate boreholes spaced approximately two feet apart. The majority of the Phase 2A injection locations utilized two injection screens; the A-screen deployed from 3 to 6 feet bgs and the B-screen deployed from 6 to 10 feet bgs. In addition to using two screens to deliver reagents across the 3 to 10 feet bgs interval, six injection locations (1I-73, 1I-74, 1I-75, 1I-79, 1I-80, and 1I-81) utilized an injection screen that was deployed from 20 to 25 feet bgs. Injection locations 1I-104 through 1I-106 also had a screen deployed from 36 to 44 feet bgs. Injection locations 1I-94, 1I-95, 1I-96 and 1I-97 utilized only one injection screen deployed from 20 to 25 feet bgs.

ISOTEC was able to inject 9,664 gallons of reagent (catalyst and oxidizer) into the 203 injection screens (95 A-screens, 95 B-screens, 10 C-screens and 3 D-screens) installed during the Phase 2A injection event. Surfacing of reagent occurred at 40% of the A-screens, 27% of the B-screens and 10% of the C-screens. Surfacing is described as the migration of gasses, groundwater and/or reagent to the ground surface through natural or man-made conduits in the subsurface. When surfacing occurred, the injection process at the screen observed to be surfacing was stopped and no further injection activities were attempted at that particular injection screen location. Surfacing did not occur while injecting into the D-screens.

The average volume of reagent (oxidizer and catalyst) injected into the A-screens (3 to 6 feet bgs) was approximately 41 gallons per screen. The average volume of total reagent injected into the B-screens (6 to 10 feet bgs) was approximately 49 gallons per screen. The average volume of total reagent injected into the C-screens (20 to 25 feet bgs) was approximately 83 gallons per screen. The average volume of total reagent injected into the D-screens (36 to 44 feet bgs) was 100 gallons per screen.

Reagent flow rates ranged from approximately 1.8 to 2.8 gallons per minute (gpm). Injection pressures ranged from approximately 0 to 30 pounds per square inch (psi) during injection activities. A summary of the volumes injected at each location during the first event is presented in **Table 1**.

2.3 PHASE 2B INJECTION EVENT FIELD ACTIVITIES

Post-Phase 2A soil confirmation sampling data provided by PSC showed that several sampling intervals and locations met the Tier 1 ROs for the injection program. Injection locations immediately adjacent to these intervals and/or sampling locations were omitted

from the Phase 2B injection event. As a result, the Phase 2B treatment area was reduced from the first event size of approximately 22,500 to approximately12,750 sq. ft.

During the Phase 2B injection event, ISOTEC attempted to inject catalyst and oxidizer into 128 injection screens installed at 72 locations (2I-2 through 2I-13, 2I-16 through 2I-23, 2I-25, 2I-29 through 2I-37, 2I-39 through 2I-41, 2I-44, 2I-45, 2I-49, 2I-50, 2I-54, 2I-55, 2I-59 through 2I-91, 2I-93 and 2I-94, **Figure 3**). At locations where multiple injection screens were required in order to target separate treatment intervals, the individual screens were installed in separate boreholes spaced approximately two feet apart. The majority of the Phase 2B injection locations utilized two injection screens; the A-screen deployed from 3 to 6 feet bgs and the B-screen deployed from 6 to 10 feet bgs. In addition to utilizing either an A-screen or a B-screen, five injection locations (2I-68, 2I-69, 2I-70, 2I-73, and 2I-74) utilized an injection screen that was deployed from 20 to 25 feet bgs (C-screen). Injection locations 2I-84 through 2I-87 utilized only one injection screen deployed from 20-25 feet bgs (C-screen). Injection locations 2I-88 through 2I-91 utilized only one injection screen deployed from 36 to 44 feet bgs (D-screen).

ISOTEC was able to inject 8,175 gallons of reagent (catalyst and oxidizer) into the 128 injection screens (61 A-screens, 53 B-screens, 10 C-screens and 4 D-screens) installed during the Phase 2B injection event. Surfacing of reagent occurred at approximately 56% of the A-screens, approximately 55% of the B-screens and 60% of the C-screens. When surfacing occurred, the injection process at the screen observed to be surfacing was stopped and no further injection activities were attempted at that particular injection screen location. Surfacing did not occur while injecting into the D-screens. It is important to note that in some instances a "redo" screen was installed at locations where surfacing occurred after relatively little reagent was injected. These screens were installed within 5 feet of the original location and were designated with an "-R" at the end of the screen identifier (i.e. 2I-50A-R). A total of 9 "redo" screens were installed during Phase 2B.

The average volume of total reagent (oxidizer and catalyst) injected into the A-screens was approximately 47 gallons per screen. The average volume of total reagent injected into the B-screens was approximately 59 gallons per screen. The average volume of total reagent injected into the C-screens was approximately 93 gallons per screen. The average volume of total reagent injected into the D-screens was 315 gallons per screen.

Reagent flow rates ranged from approximately 1.8 to 2.8 gallons per minute (gpm). Injection pressures ranged from approximately 0 to 30 pounds per square inch (psi) during injection activities. A summary of the volumes injected at each location during the second event is presented in **Table 2**.

2.4 PHASE 2C INJECTION EVENT FIELD ACTIVITIES

Post-Phase 2B soil confirmation sampling showed that additional sampling intervals and locations met the Tier 1 ROs for the injection program. Injection locations immediately

adjacent to these intervals and/or sampling locations as well as those that had previously met Tier 1 ROs were omitted from the Phase 2C injection event. The reduced Phase 2C treatment area covered approximately 8,650 sq. ft.

During the Phase 2C injection event, ISOTEC attempted to inject catalyst and oxidizer into 84 injection screens installed at 49 locations (3I-1 through 3I-49, **Figure 4**). At locations where multiple injection screens were required in order to target separate treatment intervals, the individual screens were installed in separate boreholes spaced approximately two feet apart. The majority of the Phase 2C injection locations utilized two injection screens; the A-screen deployed from 3 to 6 feet bgs and the B-screen deployed from 6 to 10 feet bgs. In addition to utilizing either an A-screen or a B-screen, seven injection locations (3I-29, 3I-31, 3I-32 and 3I-40 through 3I-43) utilized an injection screen that was deployed from 20 to 25 feet bgs (C-screen). Injection locations 3I-44 through 3I-47 utilized only one injection screen deployed from 36 to 44 feet bgs (D-screen).

ISOTEC was able to inject 5,202 gallons of reagent (catalyst and oxidizer) into the 84 injection screens (36 A-screens, 35 B-screens, 9 C-screens and 4 D-screens) installed during the Phase 2C injection event. Surfacing of reagent occurred at approximately 69% of the A-screens, approximately 66% of the B-screens and 44% of the C-screens. When surfacing occurred, the injection process at the screen observed to be surfacing was stopped and no further injection activities were attempted at that particular injection screen location. Surfacing did not occur while injecting into the D-screens. It is important to note that in some instances a "redo" screen was installed at locations where surfacing occurred after relatively little reagent was injected. These screens were installed within 5 feet of the original location and were designated with an "-R" at the end of the screen identifier (i.e. 3I-18B-R). A total of 14 "redo" screens were installed during Phase 2C.

The average volume of total reagent (oxidizer and catalyst) injected into the A-screens was approximately 36 gallons per screen. The average volume of total reagent injected into the B-screens was approximately 44 gallons per screen. The average volume of total reagent injected into the C-screens was approximately 119 gallons per screen. The average volume of total reagent injected into the D-screens was 325 gallons per screen.

Reagent flow rates ranged from approximately 2 to 4 gallons per minute (gpm). Injection pressures ranged from approximately 0 to 80 pounds per square inch (psi) during injection activities. A summary of the volumes injected at each location during the third event is presented in **Table 3**.

3.0 CONCLUSIONS

The objective of the ISCO injection program was to reduce COCs in soil to below Tier 1 ROs for the soil inhalation pathway in the upper 10 feet of soil. To achieve this goal, ISOTEC estimated that three separate injection mobilizations would be required. To date, ISOTEC has completed three injection events at the site.

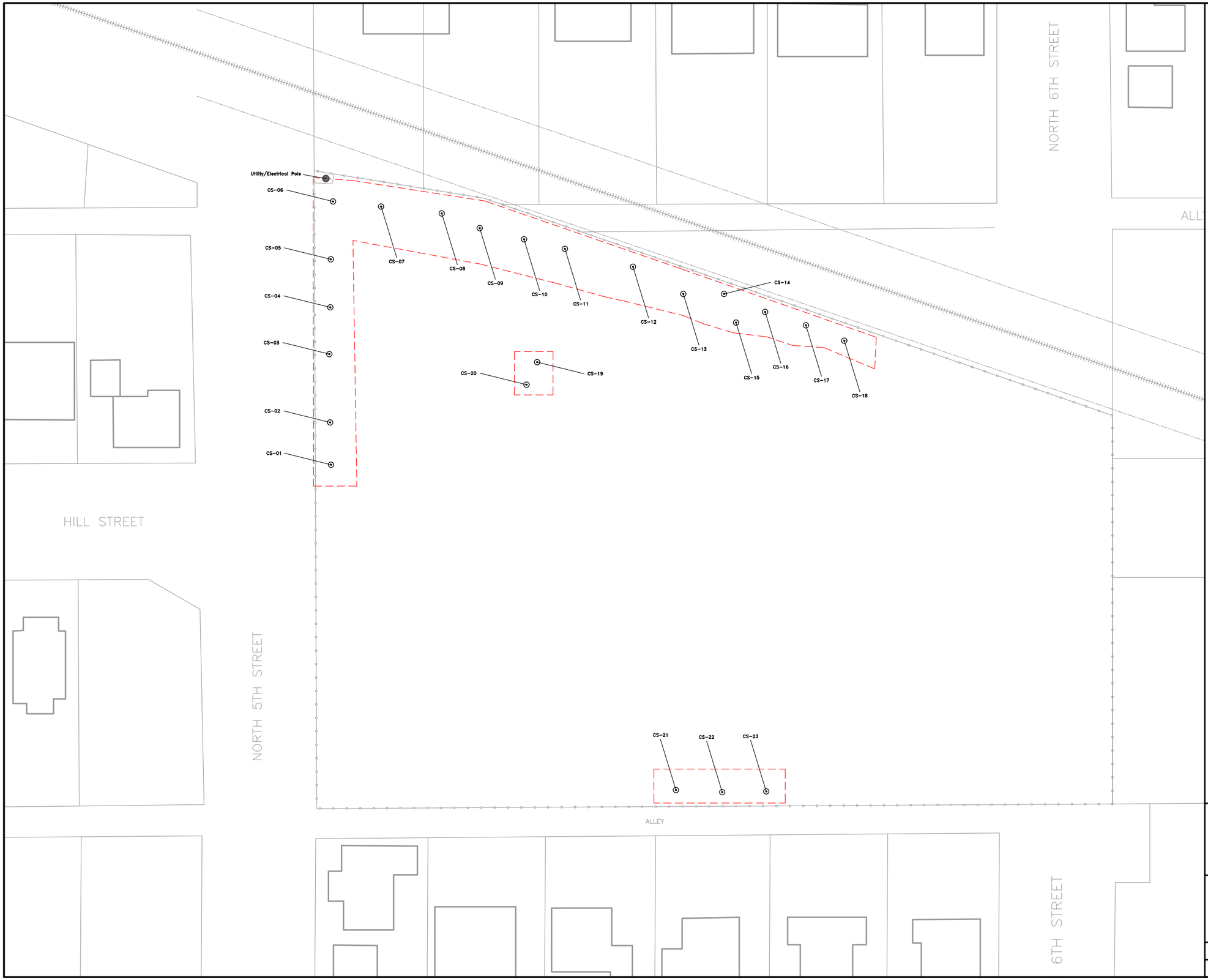
As stated in **Section 1.3**, the effectiveness of the injection program was to be determined by comparing the concentrations of soil samples collected prior to injection activities with the concentrations of soil samples collected during post-injection sampling events. If a specific post-injection soil sample reports all of the target COC concentrations at or below the Tier 1 ROs for the soil inhalation exposure pathway, that specific boring location and/or depth interval would no longer be sampled and injections in the immediate vicinity of the boring(s) and/or depth interval(s) would be eliminated from the subsequent injection applications.

During the Post-Phase 2A sampling event a total of 46 samples were taken from 23 confirmation soil sampling locations. During the Post-Phase 2B and Post-Phase 2C sampling events these numbers were reduced to 29 samples taken from 18 locations and 23 samples taken from 16 locations, respectively.

Post-injection event sampling results translate directly to the size of the treatment area for the subsequent injection event. During Phase 2A, the treatment area for the A and B intervals (3 to 6 and 6 to 10 feet bgs) covered approximately 22,500 sq. ft. During Phase 2B, injections took place across an area that was approximately 12,750 sq. ft., a treatment area reduction of 43%. The third injection event (Phase 2C) treatment area covered approximately 8,650 sq. ft.; which represents 32% reduction when compared to Phase 2B, and an overall ISCO treatment area reduction of 62% when compared to the first event (Phase 2A). Following the third event, the upper 10 feet treatment area was reduced to approximately 7,950 sq. ft., a reduction of 65% when compared to baseline.

Comparison of the number of sampling locations and size of the ISCO treatment area before injections to the post-third injection event (Phase 2C) site conditions indicates that the ISOTEC process was effective at reducing COC concentrations in the upper 10 feet of soil across approximately 65% of the ISCO treatment area.

FIGURES



LEGEND

- Existing Structure
- Fence/Remediation Site Boundary
- Approximate Extent of ISCO Treatment Area
- Confirmation Soil Sample Location

N

0 30 60

1 INCH = 60 FEET

Base map provided by PSC Industrial Outsourcing, LP.

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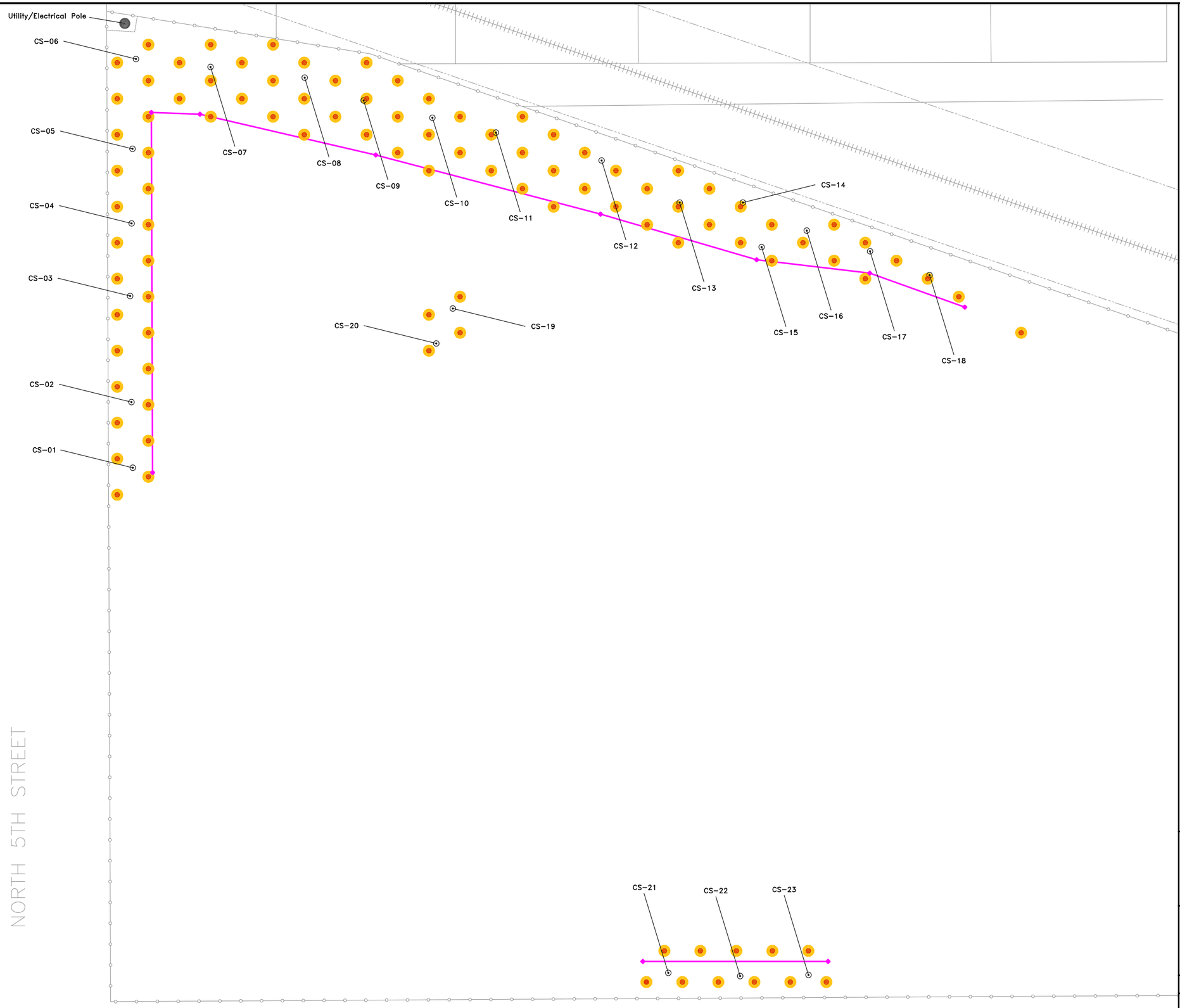
SITE MAP
ISCO INJECTION PROGRAM
Former Champaign MGP Site
Champaign, Illinois

DRAWN BY: TE	DATE: 7/23/2013	FIGURE 1
CHECKED BY: SH	PROJECT NO: 901144	



LEGEND

- Existing Structure
- Fence/Remediation Site Boundary
- Approximate Extent of Excavation Limits
- Confirmation Soil Sample Location

Injection Locations

- Phase 2A Injection Location

Injection Screen Intervals

A	3 to 6 feet bgs
B	6 to 10 feet bgs
C	20 to 25 feet bgs
D	36 to 44 feet bgs

N

0 20 40

1 INCH = 40 FEET

Base map provided by PSC Industrial Outsourcing, LP.

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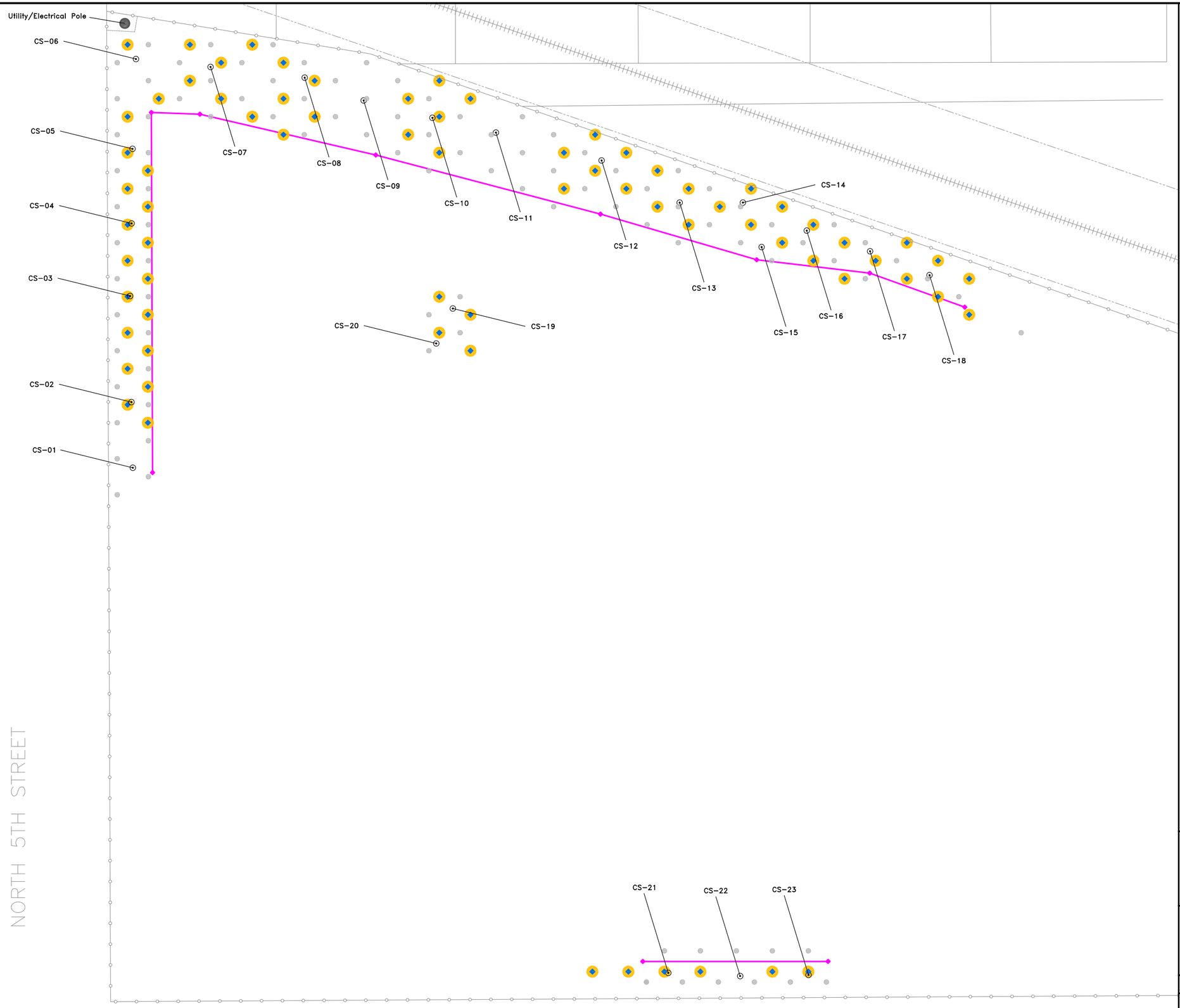
PHASE 2A INJECTION LOCATION MAP
ISCO INJECTION PROGRAM
Former Champaign MGP Site
Champaign, Illinois

DRAWN BY: TE	DATE: 9/26/2013	FIGURE 2
CHECKED BY: SH	PROJECT NO: 901144	



LEGEND

- Existing Structure
- Fence/Remediation Site Boundary
- Approximate Extent of Excavation Limits
- Confirmation Soil Sample Location

Injection Locations

- Phase 2A Injection Location
- Phase 2B Injection Location

Injection Screen Intervals

A	3 to 6 feet bgs
B	6 to 10 feet bgs
C	20 to 25 feet bgs
D	36 to 44 feet bgs

N

0 20 40

1 INCH = 40 FEET

Base map provided by PSC Industrial Outsourcing, LP.

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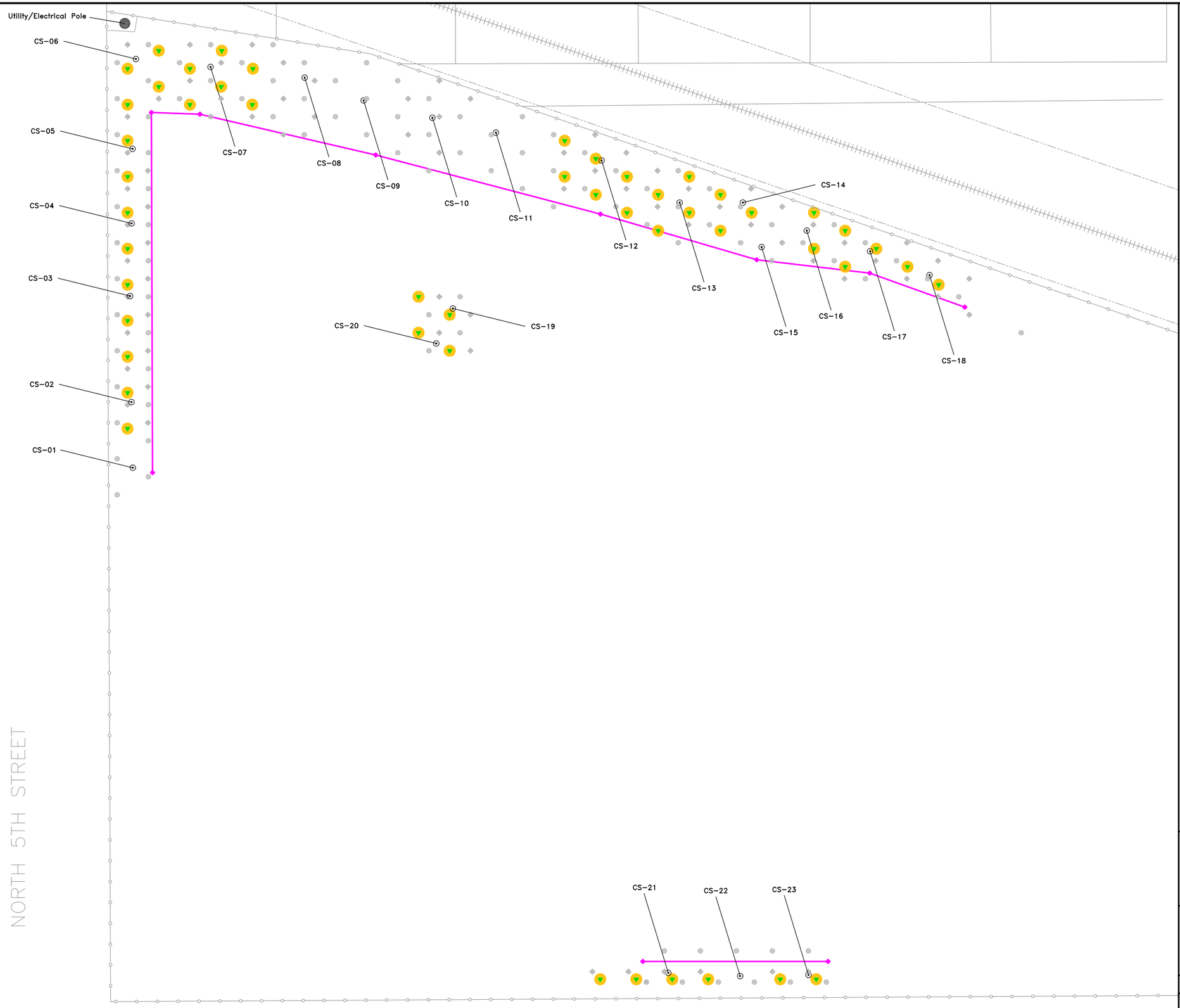
PHASE 2B INJECTION LOCATION MAP
ISCO INJECTION PROGRAM
Former Champaign MGP Site
Champaign, Illinois

DRAWN BY: TE	DATE: 9/26/2013	FIGURE 3
CHECKED BY: SH	PROJECT NO: 901144	



LEGEND

- Existing Structure
- Fence/Remediation Site Boundary
- Approximate Extent of Excavation Limits
- Confirmation Soil Sample Location

Injection Locations

- Phase 2A Injection Location
- Phase 2B Injection Location
- Phase 2C Injection Location

Injection Screen Intervals

A	3 to 6 feet bgs
B	6 to 10 feet bgs
C	20 to 25 feet bgs
D	36 to 44 feet bgs

N

0 20 40

1 INCH = 40 FEET

Base map provided by PSC Industrial Outsourcing, LP.

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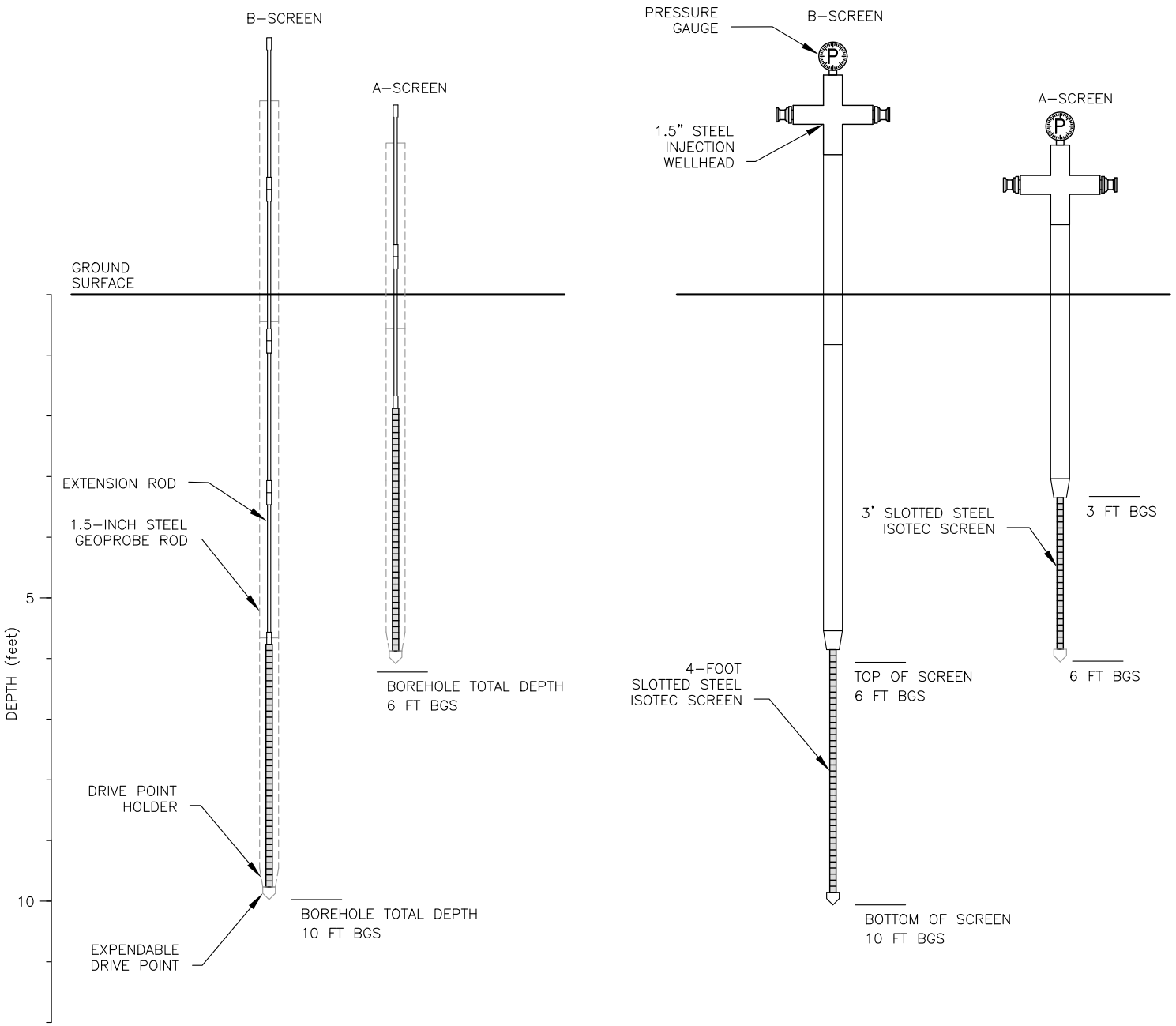
PHASE 2C INJECTION LOCATION MAP
ISCO INJECTION PROGRAM
Former Champaign MGP Site
Champaign, Illinois

DRAWN BY: TE	DATE: 9/26/2013	FIGURE 4
CHECKED BY: SH	PROJECT NO: 901144	



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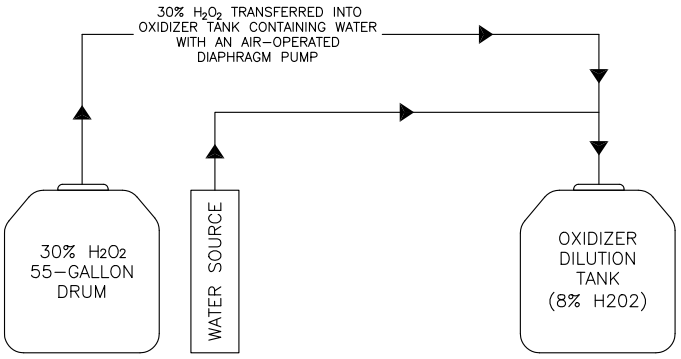
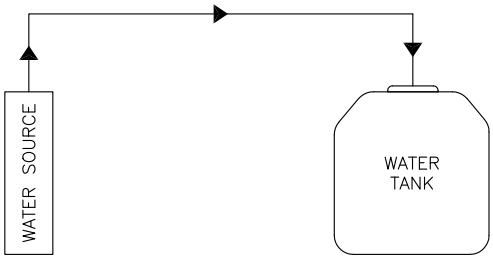
DIRECT–PUSH INJECTION SCHEMATIC
"A" AND "B" INTERVALS
ISCO INJECTION PROGRAM
Former Champaign MGP Site
Champaign, Illinois

DRAWN BY: KH	DATE: 5/21/2013	FIGURE 5
CHECKED BY: SH	PROJECT NO: 901144	

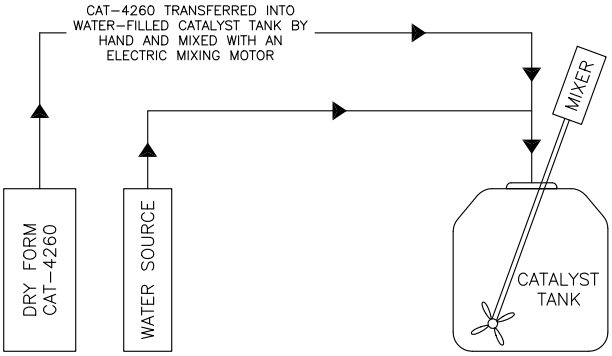
OXIDIZER TANK POCEDURES



WATER TANK PROCEDURES



CATALYST TANK PROCEDURES



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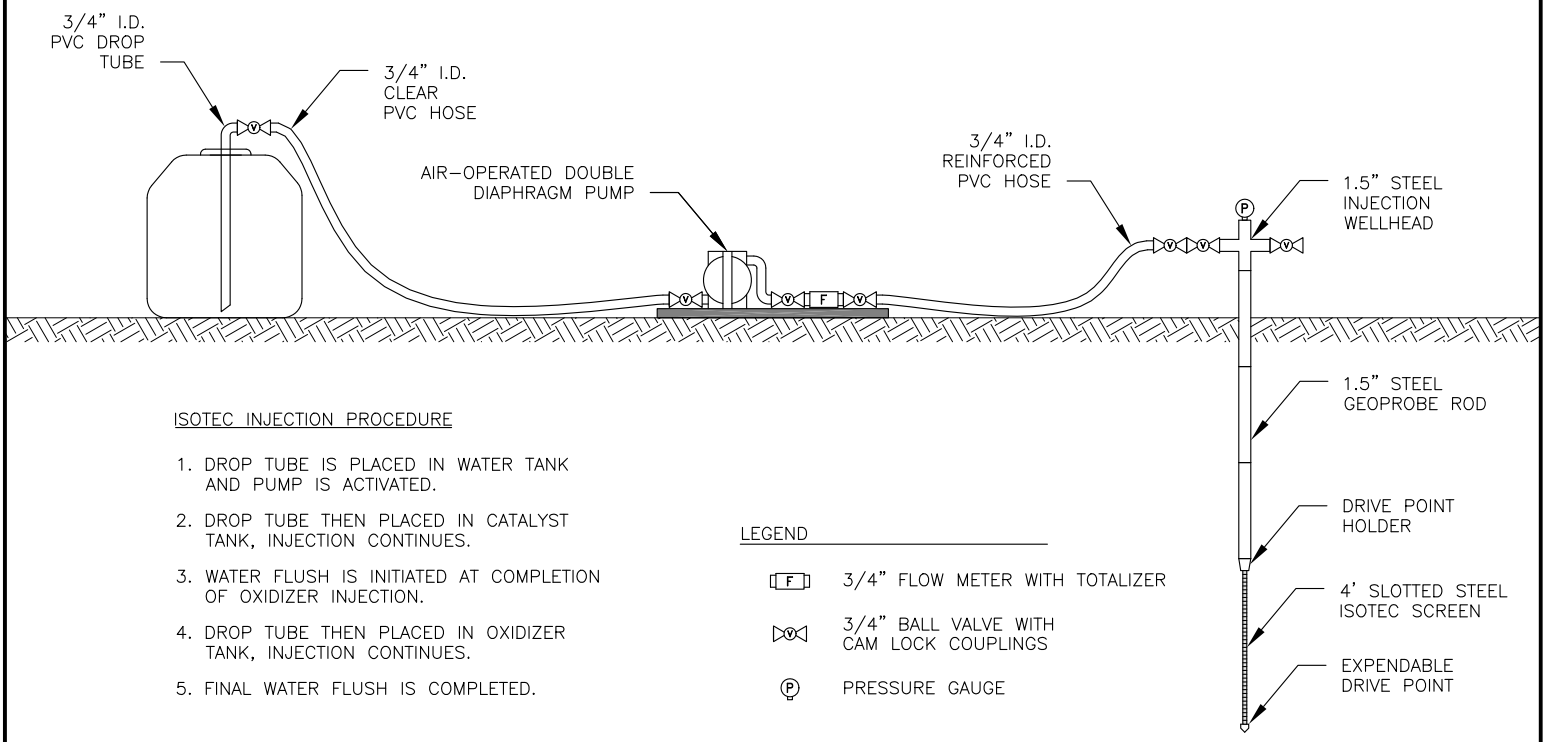
REAGENT MIXING SCHEMATIC
ISCO INJECTION PROGRAM
Former Champaign MGP Site
Champaign, Illinois

DRAWN BY: KH	DATE: 5/21/2013	FIGURE 6
CHECKED BY: SH	PROJECT NO: 901144	

REAGENT INJECTION DIAGRAM



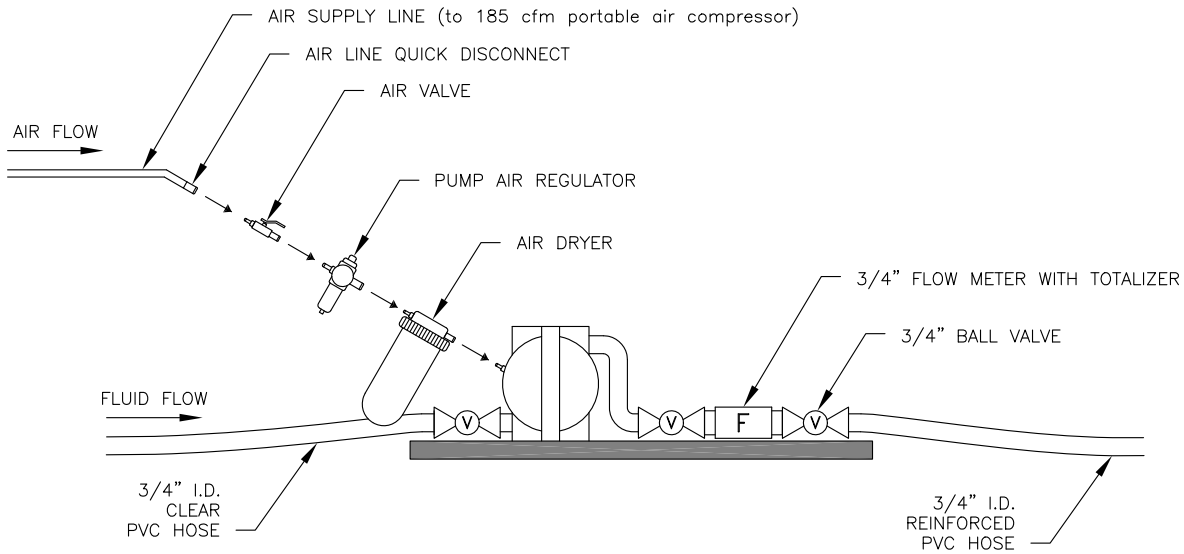
ISOTEC INJECTION PROCEDURE

1. DROP TUBE IS PLACED IN WATER TANK AND PUMP IS ACTIVATED.
2. DROP TUBE THEN PLACED IN CATALYST TANK, INJECTION CONTINUES.
3. WATER FLUSH IS INITIATED AT COMPLETION OF OXIDIZER INJECTION.
4. DROP TUBE THEN PLACED IN OXIDIZER TANK, INJECTION CONTINUES.
5. FINAL WATER FLUSH IS COMPLETED.

LEGEND

- F — 3/4" FLOW METER WITH TOTALIZER
- 3/4" BALL VALVE WITH CAM LOCK COUPLINGS
- P — PRESSURE GAUGE

INJECTION PUMP INSTALLATION



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INJECTION METHOD SCHEMATIC
ISCO INJECTION PROGRAM
Former Champaign MGP Site
Champaign, Illinois

DRAWN BY: KH	DATE: 5/21/2013	FIGURE 7
CHECKED BY: SH	PROJECT NO: 901144	

TABLES

Table 1
PHASE 2A INJECTION LOG

ISCO Injection Program
Former Champaign MGP Site
Champaign, Illinois 61820

Inj. Date	Injection Point	Injection Interval (feet bgs)	ISOTEC REAGENT			FIELD OBSERVATIONS		
			H_2O_2 (gallons)	Catalyst (gallons)	Total (gallons)	Rate (gpm)	Pressure (psi)	Notes (surfacing, refusal, pressure or flow rate changes, etc.)
5/1/13	1I-35A	3-6	0	0	0	-	-	Surfaced 11 ft southeast
	1I-35B	6-10	20	25	45	2.0	5-10	Surfaced 11 ft southeast
	1I-37A	3-6	25	25	50	2.0	0-35	
	1I-37B	6-10	25	25	50	2.0	0-25	
	1I-39A	3-6	25	25	50	2.0	0-5	Surfaced 30 ft southeast
	1I-39B	6-10	25	25	50	2.0	0-5	
	1I-41A	3-6	0	12	12	2.0	0-5	Surfaced 9 ft northeast
	1I-41B	6-10	25	25	50	2.0	5-15	
	1I-55A	3-6	25	25	50	2.0	0-10	
	1I-55B	6-10	25	25	50	2.0	5-15	
	1I-57A	3-6	0	25	25	2.0	0-5	Surfaced 12 ft southwest
	1I-57B	6-10	25	25	50	2.0	5-10	Surfaced 12 ft southwest
	1I-59A	3-6	0	10	10	2.0	0-5	Surfaced 15 ft southwest
	1I-59B	6-10	25	25	50	2.0	0-10	Surfaced 15 ft southwest
	1I-61A	3-6	25	25	50	2.0	10-12	Surfaced 9 ft east
	1I-61B	6-10	25	25	50	2.0	10-15	
	1I-63B	6-10	25	25	50	2.0	15-35	
5/2/13	1I-4A	3-6	25	25	50	2.0	0-5	
	1I-4B	6-10	25	25	50	2.0	5-10	
	1I-20A	3-6	25	25	50	2.0	0-5	
	1I-20B	6-10	25	25	50	2.0	0-5	
	1I-23A	3-6	25	25	50	2.0	10-15	
	1I-23B	6-10	25	25	50	2.0	0-10	
	1I-26A	3-6	25	25	50	2.0	0-5	
	1I-26B	6-10	25	25	50	2.0	5-10	
	1I-46A	3-6	5	25	30	2.0	0-5	Surfaced 21 ft southwest
	1I-46B	6-10	25	25	50	2.0	15-20	
	1I-49A	3-6	0	10	10	2.0	0-5	Surfaced 15 ft east
	1I-49B	6-10	25	25	50	2.0	10-20	Surfaced 15 ft east
	1I-52B	6-10	5	25	30	2.0	0-5	Surfaced 4 ft north
	1I-63A	3-6	15	25	40	2.0	5-25	Surfaced 1 ft west
	1I-81B	6-10	0	25	25	2.0	0-5	
	1I-84B	6-10	0	25	25	2.0	5-10	
5/3/13	1I-2A	3-6	20	25	45	2.0	5-10	Surfaced 7 ft west
	1I-2B	6-10	25	25	50	2.0	10-15	
	1I-6A	3-6	25	25	50	2.0	0-5	
	1I-6B	6-10	20	25	45	2.0	5-15	Surfaced 12 ft east
	1I-9A	3-6	25	25	50	2.0	0-5	

Table 1
PHASE 2A INJECTION LOG

ISCO Injection Program
Former Champaign MGP Site
Champaign, Illinois 61820

Inj. Date	Injection Point	Injection Interval (feet bgs)	ISOTEC REAGENT			FIELD OBSERVATIONS		
			H_2O_2 (gallons)	Catalyst (gallons)	Total (gallons)	Rate (gpm)	Pressure (psi)	Notes (surfacing, refusal, pressure or flow rate changes, etc.)
	1I-9B	6-10	12	25	37	2.0	10-15	Surfaced along annulus
	1I-12A	3-6	2	25	27	2.0	10-12	Surfaced along annulus
	1I-12B	6-10	25	25	50	2.0	5-10	
	1I-43A	3-6	25	25	50	2.0	10-15	
	1I-43B	6-10	25	25	50	2.0	10-20	
	1I-52A	3-6	6	25	31	2.0	5-10	Surfaced 4 ft north
	1I-78A	3-6	10	25	35	2.0	0-5	Surfaced 10 ft southwest
	1I-78B	6-10	20	25	45	2.0	10-20	Surfaced 10 ft southwest
	1I-81A	3-6	25	25	50	2.0	10-15	
	1I-81B	6-10	25	25	50	2.0	0-15	
	1I-84A	3-6	8	25	33	2.0	20-60	Injection stopped due to high pressure
	1I-84B	6-10	25	25	50	2.0	5-10	
	1I-88A	3-6	0	15	15	2.0	0	Surfaced 12 ft southwest
	1I-88B	6-10	25	25	50	2.0	0-5	
	1I-91A	3-6	21	25	46	2.0	0-12	Surfaced 2 ft northwest
	1I-91B	6-10	20	25	45	2.0	10-20	Surfaced 9 ft south
	1I-93A	3-6	0	0	0	-	-	Injection stopped due to high pressure
	1I-93B	6-10	15	25	40	2.0	10-50	Injection stopped due to high pressure
	1I-97C	20-25	25	25	50	2.0	10-25	
5/4/13	1I-18A	3-6	25	25	50	2.0	5-15	
	1I-18B	6-10	25	25	50	2.0	10-15	
	1I-21A	3-6	25	25	50	2.0	10-25	
	1I-21B	6-10	25	25	50	2.0	0-10	
	1I-24A	3-6	25	25	50	2.0	0-5	
	1I-24B	6-10	25	25	50	2.0	0-5	
	1I-34A	3-6	25	25	50	2.0	0-5	
	1I-34B	6-10	25	25	50	2.0	10-15	
	1I-38A	3-6	25	25	50	2.0	0-5	
	1I-38B	6-10	25	25	50	2.0	0-5	
	1I-67A	3-6	25	25	50	2.0	0-5	
	1I-67B	6-10	25	25	50	2.0	10-15	
	1I-70A	3-6	25	25	50	2.0	5-12	
	1I-70B	6-10	25	25	50	2.0	2-10	
	1I-73A	3-6	25	25	50	2.0	5-60	
	1I-73B	6-10	25	25	50	2.0	5-15	
	1I-73C	20-25	25	25	50	2.0	5-15	
	1I-89A	3-6	15	25	40	2.0	0-5	Surfaced 23 ft southwest
	1I-89B	6-10	15	25	40	2.0	10-35	Surfaced 23 ft southwest

Table 1
PHASE 2A INJECTION LOG

ISCO Injection Program
Former Champaign MGP Site
Champaign, Illinois 61820

Inj. Date	Injection Point	Injection Interval (feet bgs)	ISOTEC REAGENT			FIELD OBSERVATIONS		
			H_2O_2 (gallons)	Catalyst (gallons)	Total (gallons)	Rate (gpm)	Pressure (psi)	Notes (surfacing, refusal, pressure or flow rate changes, etc.)
	1I-92A	3-6	25	25	50	2.0	15-22	
	1I-92B	6-10	25	25	50	2.0	0-12	
5/5/13	1I-7A	3-6	25	25	50	2.0	0-25	
	1I-7B	6-10	25	25	50	2.0	10-20	
	1I-10A	3-6	25	25	50	2.0	0-5	
	1I-10B	6-10	25	25	50	2.0	10-15	
	1I-13A	3-6	0	1	1	2.0	0-5	Surfaced 9 ft southeast
	1I-13B	6-10	25	25	50	2.0	2-15	Surfaced 9 ft southeast
	1I-16A	3-6	25	25	50	2.0	0-10	
	1I-16B	6-10	25	25	50	2.0	0-30	
	1I-28A	3-6	25	25	50	2.0	0-15	
	1I-28B	6-10	25	25	50	2.0	20-25	
	1I-44A	3-6	8	25	33	2.0	15-20	Surfaced 12 ft southwest
	1I-44B	6-10	25	25	50	2.0	0-15	Surfaced 12 ft southwest
	1I-47A	3-6	25	25	50	2.0	0-15	
	1I-47B	6-10	25	25	50	2.0	20-25	
	1I-50A	3-6	25	25	50	2.0	0-5	Surfaced 12 ft southeast
	1I-50B	6-10	10	25	35	2.0	10-15	Surfaced 3 ft west
	1I-79A	3-6	25	25	50	2.0	0-5	Surfaced 4 ft southeast
	1I-79B	6-10	25	25	50	2.0	15-20	
	1I-82A	3-6	25	25	50	2.0	0-15	
	1I-82B	6-10	25	25	50	2.0	0-5	
5/6/13	1I-5A	3-6	25	25	50	2.0	5-10	
	1I-5B	6-10	25	25	50	2.0	5-10	
	1I-14A	3-6	25	25	50	2.0	10.20	
	1I-14B	6-10	25	25	50	2.0	5-20	
	1I-29A	3-6	25	25	50	2.0	5-15	
	1I-29B	6-10	25	25	50	2.0	5-15	Surfaced 18 ft southwest
	1I-32A	3-6	25	25	50	2.0	5-20	Surfaced 4 ft east
	1I-32B	6-10	25	25	50	2.0	5-45	
	1I-53A	3-6	15	25	40	2.0	5-10	Surfaced 12 ft southeast
	1I-53B	6-10	14	25	39	2.0	5-15	Surfaced 12 ft southeast
	1I-56A	3-6	15	25	40	2.0	0-10	
	1I-56B	6-10	25	25	50	2.0	0-5	
	1I-68A	3-6	25	25	50	2.0	10-15	
	1I-68B	6-10	25	25	50	2.0	0-10	
	1I-71A	3-6	15	25	40	2.0	0-10	Surfaced 6 ft north
	1I-71B	6-10	25	25	50	2.0	10-20	

Table 1
PHASE 2A INJECTION LOG

ISCO Injection Program
Former Champaign MGP Site
Champaign, Illinois 61820

Inj. Date	Injection Point	Injection Interval (feet bgs)	ISOTEC REAGENT			FIELD OBSERVATIONS		
			H_2O_2 (gallons)	Catalyst (gallons)	Total (gallons)	Rate (gpm)	Pressure (psi)	Notes (surfacing, refusal, pressure or flow rate changes, etc.)
	1I-74A	3-6	5	25	30	2.0	10-80	Injection stopped due to high pressure
	1I-74B	6-10	25	25	50	2.0	30-50	
	1I-74C	20-25	25	25	50	2.0	10-40	
	1I-90A	3-6	25	25	50	2.0	5-10	
	1I-90B	6-10	25	25	50	2.0	0-10	
5/7/13	1I-15A	3-6	25	25	50	2.0	5-15	
	1I-15B	6-10	25	25	50	2.0	10-35	
	1I-19A	3-6	25	25	50	2.0	0-30	
	1I-19B	6-10	25	25	50	2.0	0-10	
	1I-22A	3-6	25	25	50	2.0	0-15	
	1I-22B	6-10	25	25	50	2.0	0-10	
	1I-40A	3-6	25	25	50	2.0	0-15	
	1I-40B	6-10	25	25	50	2.0	0-15	
	1I-60A	3-6	25	25	50	2.0	0-5	
	1I-60B	6-10	15	25	40	2.0	10-12	Surfaced 30 ft west
	1I-80A	3-6	25	25	50	2.0	0-15	
	1I-80B	6-10	25	25	50	2.0	0-20	
	1I-80C	20-25	50	50	100	2.0	20-50	
	1I-83A	3-6	3	25	28	2.0	50-80	Injection stopped due to high pressure
	1I-83B	6-10	25	25	50	2.0	10-35	
	1I-100A	3-6	0	0	0	2.0	0-80	Injection stopped due to high pressure
	1I-100B	6-10	25	25	50	2.0	0-5	
	1I-103A	3-6	25	25	50	2.0	5-15	Surfaced 6 ft southeast
	1I-103B	6-10	25	25	50	2.0	0-5	
	1I-108A	3-6	15	25	40	2.0	0-5	Surfaced 3 ft northwest
	1I-108B	6-10	25	25	50	2.0	0-8	
5/8/13	1I-17A	3-6	25	25	50	2.0	0-20	
	1I-17B	6-10	25	25	50	2.0	15-20	
	1I-30A	3-6	25	25	50	2.0	0-10	Surfaced 12 ft south
	1I-30B	6-10	25	25	50	2.0	5-10	
	1I-58A	3-6	15	25	40	2.0	0-10	Surfaced 22 ft west
	1I-58B	6-10	12	25	37	2.0	5-10	Surfaced 22 ft west
	1I-62A	3-6	0	16	16	2.0	0-5	Surfaced 14 ft southeast
	1I-62B	6-10	15	30	45	2.0	0-12	Surfaced 14 ft southeast
	1I-98A	3-6	6	25	31	2.0	0-80	Injection stopped due to high pressure
	1I-98B	6-10	25	25	50	2.0	0-30	
	1I-101A	3-6	6	25	31	2.0	0-80	Injection stopped due to high pressure
	1I-101B	6-10	25	25	50	2.0	0-15	

Table 1
PHASE 2A INJECTION LOG

ISCO Injection Program
Former Champaign MGP Site
Champaign, Illinois 61820

Inj. Date	Injection Point	Injection Interval (feet bgs)	ISOTEC REAGENT			FIELD OBSERVATIONS		
			H_2O_2 (gallons)	Catalyst (gallons)	Total (gallons)	Rate (gpm)	Pressure (psi)	Notes (surfacing, refusal, pressure or flow rate changes, etc.)
5/14/13	1I-3A	3-6	25	25	50	2.0	0-10	
	1I-3B	6-10	25	25	50	2.0	5-15	
	1I-25A	3-6	24	25	49	2.0	20-25	Surfaced 10 ft south
	1I-25B	6-10	25	25	50	2.0	5-20	
	1I-36A	3-6	0	4	4	2.0	-	Surfaced 20 ft southwest
	1I-36B	6-10	25	25	50	2.0	5-10	
	1I-54A	3-6	0	15	15	2.0	5-10	Surfaced 15 ft southeast
	1I-54B	6-10	17	25	42	2.0	10-20	Surfaced 15 ft southeast
	1I-69A	3-6	25	25	50	2.0	5-20	
	1I-69B	6-10	25	25	50	2.0	0-5	
	1I-72A	3-6	25	25	50	2.0	0-5	
	1I-72B	6-10	25	25	50	2.0	0-5	
	1I-75A	3-6	5	25	30	2.0	40-80	Injection stopped due to high pressure
	1I-75B	6-10	3	25	28	2.0	0-80	Injection stopped due to high pressure
	1I-75C	20-25	50	25	75	2.0	20-30	Surfaced 18 ft west
	1I-94C	20-25	50	50	100	2.0	5-35	
	1I-99A	3-6	5	25	30	2.0	45-80	Injection stopped due to high pressure
	1I-99B	6-10	10	25	35	2.0	0-80	Injection stopped due to high pressure
	1I-107A	3-6	12	25	37	2.0	0-5	Surfaced 2 ft east
	1I-107B	6-10	25	25	50	2.0	0-5	
5/15/13	1I-8A	3-6	0	0	0	2.0	-	Surfaced along annulus
	1I-8B	6-10	17	25	42	2.0	0-10	Surfaced along annulus
	1I-11A	3-6	25	25	50	2.0	5-10	
	1I-11B	6-10	25	25	50	2.0	0-10	
	1I-31A	3-6	25	25	50	2.0	0-5	
	1I-31B	6-10	25	25	50	2.0	0-10	
	1I-45A	3-6	0	25	25	2.0	5-10	Surfaced 20 ft east
	1I-45B	6-10	25	25	50	2.0	5-15	
	1I-48A	3-6	15	25	40	2.0	15-25	Surfaced 6 ft north
	1I-48B	6-10	25	25	50	2.0	5-10	Surfaced 6 ft north
	1I-51A	3-6	25	25	50	2.0	10-15	Surfaced 16 ft south
	1I-51B	6-10	25	25	50	2.0	10-25	
	1I-72A	3-6	0	20	20	2.0	-	Surfaced 10 ft south
	1I-72B	6-10	25	25	50	2.0	5-10	
	1I-81C	20-25	50	50	100	2.0	0-25	
	1I-96C	20-25	50	50	100	2.0	10-20	
	1I-104A	3-6	25	25	50	2.0-3.0	4	
	1I-104B	6-10	25	25	50	2.0	0-5	

Table 1
PHASE 2A INJECTION LOG

ISCO Injection Program
Former Champaign MGP Site
Champaign, Illinois 61820

Inj. Date	Injection Point	Injection Interval (feet bgs)	ISOTEC REAGENT			FIELD OBSERVATIONS		
			H_2O_2 (gallons)	Catalyst (gallons)	Total (gallons)	Rate (gpm)	Pressure (psi)	Notes (surfacing, refusal, pressure or flow rate changes, etc.)
	1I-104D	36-44	50	50	100	3.0	4	
	1I-105B	6-10	25	25	50	2.0	0-5	
	1I-106A	3-6	25	25	50	2.0	0-2	
	1I-106B	6-10	25	25	50	2.0	0-5	
	1I-106D	36-44	50	50	100	3.0-3.2	0-5	
5/16/13	1I-1A	3-6	25	25	50	2.0	0-5	
	1I-1B	6-10	25	25	50	2.0	5-10	
	1I-27A	3-6	25	25	50	2.0	0-15	
	1I-27B	6-10	25	25	50	2.0	0-15	
	1I-33A	3-6	25	25	50	2.0	0-15	
	1I-33B	6-10	25	25	50	1.5-2.0	10-30	
	1I-79C	20-25	50	50	100	2.0	5-45	
	1I-95C	20-25	50	50	100	2.0	0	
	1I-102A	3-6	25	25	50	2.0	0-2	Surfaced 9 ft south
	1I-102B	6-10	25	25	50	2.0	5-10	
	1I-105A	3-6	25	25	50	2.0	8-10	
	1I-105D	36-44	50	50	100	3.2	0-5	
PHASE 2A REAGENT TOTAL			**4,481**	**5,183**	**9,664**			

Table 2
PHASE 2B INJECTION LOG

ISCO Injection Program
Former Champaign MGP Site
Champaign, Illinois 61820

Inj. Date	Injection Point	Injection Interval (feet bgs)	ISOTEC REAGENT			FIELD OBSERVATIONS		
			H_2O_2 (gallons)	Catalyst (gallons)	Total (gallons)	Rate (gpm)	Pressure (psi)	Notes (surfacing, refusal, pressure or flow rate changes, etc.)
6/19/13	2I-4A	3-6	25	25	50	2.0	0-30	
	2I-4B	6-10	25	25	50	2.0-3.0	10-15	
	2I-7A	3-6	20	25	45	2.0-3.0	0-12	Surfaced along annulus
	2I-7B	6-10	25	25	50	2.0-3.0	10-15	
	2I-10A	3-6	25	25	50	2.0-3.0	0-2	
	2I-10B	6-10	40	40	80	2.0-3.0	0-15	
	2I-13B	6-10	15	25	40	2.0-3.0	0-5	Surfaced 25 ft east
	2I-16A	3-6	30	30	60	2.0-3.0	0-5	
	2I-16B	6-10	30	30	60	2.0-3.0	0-5	
	2I-30A	3-6	30	30	60	2.0-3.0	0-20	
	2I-30B	6-10	25	25	50	2.0-3.0	0-10	
	2I-40A	3-6	25	25	50	2.0-3.0	0-15	
	2I-44A	3-6	25	25	50	2.0-3.0	5-20	
	2I-60A	3-6	15	25	40	2.0-3.0	0-5	Surfaced 12 ft south
	2I-60B	6-10	33	40	73	2.0-3.0	5-20	Surfaced 12 ft south
	2I-63A	3-6	2	25	27	2.0-3.0	50-80	Injection stopped due to high pressure
	2I-63B	6-10	25	25	50	2.0-3.0	10-30	
	2I-73A	3-6	11	25	36	2.0-3.0	5-15	Surfaced 1 ft north
	2I-73C	20-25	50	50	100	2.0-3.0	0-30	
	2I-76A	3-6	12	25	37	2.0	0-15	Surfaced 12 ft southwest
	2I-79A	3-6	0	0	0	-	80	Injection stopped due to high pressure
	2I-79B	6-10	25	25	50	2.0-3.0	0-5	Surfaced 13 ft southwest
6/20/13	2I-10A	3-6	30	30	60	2.0-3.0	0-5	
	2I-10B	6-10	15	15	30	3.0	0-15	
	2I-19A	3-6	30	30	60	2.0-3.0	0-10	
	2I-19B	6-10	30	30	60	2.0-3.0	5-15	
	2I-22A	3-6	7	15	22	3.0	5-10	Surfaced 12 ft south
	2I-22B	6-10	30	30	60	3.0	15-25	Surfaced 12 ft south
	2I-25B	6-10	25	25	50	3.0	5-15	
	2I-34B	6-10	30	30	60	3.0	5-15	Surfaced 24 ft east
	2I-37A	3-6	30	30	60	3.0	0-10	Surfaced 18 ft south
	2I-55A	3-6	30	30	60	3.0	0-5	
	2I-56A	3-6	30	30	60	3.0	2-4	
	2I-65A	3-6	15	15	30	3.0	10-15	Surfaced 30 ft south
	2I-65B	6-10	15	30	45	3.0	0-5	Surfaced 30 ft south
	2I-68A	3-6	15	15	30	3.0	12-14	Surfaced at CS-14
	2I-68C	20-25	0	5	5	3.0	0-5	Surfaced at CS-14
	2I-71A	3-6	0	0	0	-	-	Injection stopped due to high pressure

Table 2
PHASE 2B INJECTION LOG

ISCO Injection Program
Former Champaign MGP Site
Champaign, Illinois 61820

Inj. Date	Injection Point	Injection Interval (feet bgs)	ISOTEC REAGENT			FIELD OBSERVATIONS		
			H_2O_2 (gallons)	Catalyst (gallons)	Total (gallons)	Rate (gpm)	Pressure (psi)	Notes (surfacing, refusal, pressure or flow rate changes, etc.)
	2I-71B	6-10	0	0	0	-	-	Injection stopped due to high pressure
	2I-81A	3-6	30	30	60	3.0	5-10	Surfaced 11 ft west
	2I-81B	6-10	30	30	60	3.0	5-17	Surfaced 11 ft west
	2I-85C	20-25	50	50	100	3.0	15-40	
6/21/13	2I-17A	3-6	45	45	90	2.0-3.0	05	
	2I-17B	6-10	45	45	90	2.0-3.0	0-15	
	2I-20A	3-6	45	45	90	2.0-3.0	5-20	
	2I-20B	6-10	45	45	90	2.0-3.0	0-10	
	2I-23A	3-6	45	45	90	2.0-3.0	0-5	
	2I-23B	6-10	45	45	90	2.0-3.0	0-5	
	2I-34A	3-6	0	7	7	3.0	0-5	Surfaced 12 ft southwest
	2I-34B	6-10	15	15	30	2.0-3.0	0-5	Surfaced 12 ft southwest
	2I-45A	3-6	15	15	30	2.0-3.0	0-5	Surfaced 15 ft northwest
	2I-54A	3-6	0	13	13	3.0	0-2	Surfaced 10 ft southeast
	2I-54B	6-10	13	15	28	2.0-3.0	0-5	Surfaced 10 ft southeast
	2I-68A	3-6	15	15	30	2.0-3.0	0-5	Surfaced 9 ft southwest
	2I-68C	20-25	0	15	15	3.0	0-5	Surfaced 9 ft southwest
	2I-75A	3-6	30	30	60	2.0-3.0	0-5	
	2I-75B	6-10	30	30	60	2.0-3.0	10-15	
	2I-78A	3-6	45	45	90	2.0-3.0	0-30	Surfaced 6 ft southeast
	2I-78B	6-10	45	45	90	2.0-3.0	0-15	
	2I-88D	36-44	150	150	300	4.0-5.0	0-5	
	2I-90D	36-44	150	150	300	3.0-4.5	0-5	
	2I-93B	6-10	15	15	30	2.0-3.0	10-12	Surfaced 3 ft east
6/22/13	2I-3B	6-10	30	30	60	2.0-3.0	5-15	
	2I-5A	3-6	15	15	30	2.0-3.0	4-6	
	2I-5B	6-10	30	30	60	2.0-3.0	0-15	
	2I-8A	3-6	11	15	26	2.0-3.0	0-5	Surfaced 5 ft south
	2I-8B	6-10	30	30	60	2.0-3.0	0-10	
	2I-33B	6-10	30	30	60	2.0-3.0	0-5	
	2I-36A	3-6	28	30	58	2.0-3.0	8-30	Surfaced 14 ft south
	2I-49A	3-6	15	15	30	2.0-3.0	8-12	Surfaced 6 ft northwest
	2I-64B	6-10	30	30	60	2.0-3.0	5-12	
	2I-67B	6-10	25	30	55	2.0-3.0	2-24	Surfaced 12 ft west
	2I-72A	3-6	30	30	60	2.0-3.0	0-10	
	2I-74B	6-10	30	30	60	2.0-3.0	2-4	
	2I-75B	6-10	15	15	30	2.0-3.0	10-12	Surfaced 12 ft south
	2I-83B	6-10	15	15	30	2.0-3.0	0-5	

Table 2
PHASE 2B INJECTION LOG

ISCO Injection Program
Former Champaign MGP Site
Champaign, Illinois 61820

Inj. Date	Injection Point	Injection Interval (feet bgs)	ISOTEC REAGENT			FIELD OBSERVATIONS		
			H_2O_2 (gallons)	Catalyst (gallons)	Total (gallons)	Rate (gpm)	Pressure (psi)	Notes (surfacing, refusal, pressure or flow rate changes, etc.)
	2I-86C	20-25	50	50	100	2.5-3.0	10-30	
6/23/13	2I-3A	3-6	45	45	90	2.0-3.0	0-15	
	2I-3B	6-10	30	30	60	2.0-3.0	0-10	
	2I-5A	3-6	15	15	30	2.0-3.0	0-10	
	2I-8B	6-10	15	15	30	2.0-3.0	0-5	
	2I-11A	3-6	30	30	60	2.0-3.0	0-5	
	2I-11B	6-10	45	45	90	2.0-3.0	0-5	
	2I-31A	3-6	30	30	60	2.0-3.0	2-50	
	2I-31B	6-10	30	30	60	2.0-3.0	0-20	
	2I-33A	3-6	15	30	45	2.0-3.0	0-10	Surfaced 3 ft southeast
	2I-39B	6-10	10	15	25	2.0-3.0	2-4	Surfaced 25 ft west
	2I-50A	3-6	13	15	28	2.0-3.0	5-10	Surfaced 8 ft southwest
	2I-61A	3-6	15	15	30	2.0-3.0	0-5	Surfaced 15 ft north
	2I-61B	6-10	30	30	60	2.0-3.0	2-10	
	2I-64A	3-6	15	15	30	2.0-3.0	2-12	
	2I-67A	3-6	15	15	30	2.0-3.0	10-12	
	2I-74C	20-25	50	50	100	2.0-3.0	5-25	Surfaced 12 ft south
	2I-75A	3-6	15	15	30	2.0-3.0	0-2	
	2I-82A	3-6	0	4	4	3.0	0-5	Surfaced 1 ft north
	2I-82B	6-10	15	15	30	2.0-3.0	2-4	Surfaced 1 ft north
	2I-83A	3-6	30	30	60	2.0-3.0	10-14	
	2I-83B	6-10	15	15	30	2.0-3.0	5-10	
	2I-84C	20-25	50	50	100	2.0-3.0	5-10	
6/24/13	2I-6A	3-6	45	45	90	2.5-3.0	0-10	
	2I-6B	6-10	15	15	30	2.0-3.0	5-10	Surfaced 2 ft north
	2I-9A	3-6	10	15	25	2.5-3.0	0-5	Surfaced 12 ft south
	2I-9B	6-10	15	15	30	2.0	10-14	Surfaced 12 ft south
	2I-11A	3-6	15	15	30	2.0-3.0	0-5	
	2I-29B	6-10	30	30	60	2.0-3.0	0-6	Surfaced 30 ft west
	2I-32A	3-6	30	30	60	2.0-3.0	0-19	Surfaced 12 ft south
	2I-55B	6-10	15	15	30	2.5-3.0	0-5	Surfaced 2 ft north
	2I-59A	3-6	30	30	60	2.5-3.0	0-5	
	2I-59B	6-10	30	30	60	2.0-3.0	10-15	
	2I-62A	3-6	0	6	6	3.0	-	Surfaced 6 ft south
	2I-62B	6-10	15	15	30	3.0	10-20	Surfaced 6 ft south
	2I-70B	6-10	15	15	30	2.0-3.0	0-15	Surfaced 6 ft northwest
	2I-70C	20-25	50	50	100	2.5	10-30	
	2I-77A	3-6	15	15	30	2.0-3.0	15-20	Surfaced 20 ft west

Table 2
PHASE 2B INJECTION LOG

ISCO Injection Program
Former Champaign MGP Site
Champaign, Illinois 61820

Inj. Date	Injection Point	Injection Interval (feet bgs)	ISOTEC REAGENT			FIELD OBSERVATIONS		
			H_2O_2 (gallons)	Catalyst (gallons)	Total (gallons)	Rate (gpm)	Pressure (psi)	Notes (surfacing, refusal, pressure or flow rate changes, etc.)
	2I-80A	3-6	15	15	30	2.5-3.0	20-22	Surfaced 8 ft south
	2I-80B	6-10	30	30	60	2.0-3.0	0-5	
	2I-87C	20-25	50	50	100	3.5	10-25	
6/25/13	2I-18A	3-6	15	15	30	3.0	0-5	Surfaced 7 ft northwest
	2I-18B	6-10	30	30	60	2.5-3.0	2-10	
	2I-21A	3-6	15	15	30	2.5-3.0	5-12	Surfaced 2 ft west
	2I-21B	6-10	29	30	59	2.5-3.0	0-5	Surfaced 2 ft west
	2I-35A	3-6	4	15	19	3.0	2-4	Surfaced 20 ft southwest
	2I-35B	6-10	15	15	30	2.5-3.0	10-12	Surfaced 18 ft southwest
	2I-41A	3-6	15	15	30	2.5-3.0	2-4	Surfaced 8 ft west
	2I-66A	3-6	0	15	15	3.0	5-10	Surfaced 6 ft north
	2I-66B	6-10	30	30	60	2.5-3.0	10-15	Surfaced 6 ft northwest
	2I-69B	6-10	30	30	60	2.5-3.0	2-15	Surfaced 12 ft west
	2I-69C	20-25	30	25	55	2.5-3.0	5-20	Surfaced 4 ft east
	2I-89D	36-44	150	150	300	4.0-5.0	0	
	2I-91D	36-44	150	150	300	4.0-5.0	0	
	2I-94B	6-10	4	15	19	2.5-3.0	14-15	Surfaced along annulus
6/26/13	2I-6B-R	6-10	59	60	119	2.5-3.0	5-20	Surfaced 24 ft northeast
	2I-50A-R	3-6	45	45	90	2.0-3.0	0-5	Surfaced 12 ft west
	2I-60A-R	3-6	15	15	30	2.5-3.0	0-5	Surfaced 12 ft south
	2I-68C-R	20-25	75	75	150	2.5-3.0	2-10	Surfaced 6 ft southwest
	2I-69B	6-10	15	15	30	2.0-3.0	2-4	Surfaced 15 ft east
	2I-69C	20-25	0	9	9	3.0	-	Surfaced 10 and 25 ft west
	2I-71A-R	3-6	30	30	60	3.0	15-20	
	2I-71B-R	6-10	30	45	75	2.5-3.0	0-2	Surfaced 8 ft south
	2I-77A-R	3-6	15	15	30	2.5-3.0	2-4	Surfaced 18 ft west
	2I-79A-R	3-6	30	30	60	3.0	2-22	
	2I-89D	34-44	35	25	60	5.0	0	
	2I-94B-R	6-10	15	15	30	2.5-3.0	2-4	Surfaced 3 ft east
PHASE 2B REAGENT TOTAL			**3,966**	**4,209**	**8,175**			

Table 3
PHASE 2C INJECTION LOG

ISCO Injection Program
Former Champaign MGP Site
Champaign, Illinois 61820

Inj. Date	Injection Point	Injection Interval (feet bgs)	ISOTEC REAGENT			FIELD OBSERVATIONS		
			H_2O_2 (gallons)	Catalyst (gallons)	Total (gallons)	Rate (gpm)	Pressure (psi)	Notes (surfacing, refusal, pressure or flow rate changes, etc.)
8/14/13	3I-1A	3-6	30	30	60	2.0-3.0	0-5	
	3I-1B	6-10	30	30	60	2.0-3.0	0-5	
	3I-4A	3-6	30	30	60	2.0-3.0	0-5	
	3I-4B	6-10	30	30	60	2.0-3.0	0-10	
	3I-7A	3-6	13	15	28	2.0-3.0	0-5	Surfaced 12 feet southeast
	3I-7B	6-10	30	30	60	2.0-3.0	0-5	
	3I-28A	3-6	7	15	22	2.0-3.0	15-80	Injection stopped due to high pressure
	3I-28B	6-10	15	15	30	2.0-3.0	5-10	Surfaced 12 feet southeast
	3I-34A	3-6	2	15	17	2.0-3.0	0-80	Injection stopped due to high pressure
	3I-34A-R	3-6	30	30	60	2.0-3.0	0-5	Surfaced 20 feet southwest
	3I-40C	20-25	50	50	100	2.0-3.0	0-5	
8/15/13	3I-2A	3-6	30	30	60	2.0-3.0	0-10	
	3I-2B	6-10	30	30	60	2.0-3.0	0-5	
	3I-5A	3-6	25	30	55	2.0-3.0	0-5	Surfaced 2 feet southwest
	3I-5B	6-10	25	30	55	2.0-3.0	0-10	Surfaced 17 feet northeast
	3I-7B	6-10	15	15	30	2.0-3.0	0-5	
	3I-22A	3-6	15	15	30	2.0-3.0	0-5	Surfaced 9 feet east
	3I-22B	6-10	30	30	60	2.0-3.0	0-20	Surfaced 5 and 9 feet northeast
	3I-29A	3-6	30	30	60	2.0-3.0	0-20	
	3I-29C	20-25	25	40	65	2.0-3.0	0-10	Surfaced 9 feet west
	3I-36A	3-6	18	30	48	2.0-3.0	0-10	Surfaced 12 feet south
	3I-38A	3-6	30	30	60	2.0-3.0	0-10	Surfaced 15 feet northeast
	3I-41C	20-25	50	50	100	2.0-3.0	5-20	
8/16/13	3I-8A	3-6	30	30	60	2.0-3.0	0-5	
	3I-8B	6-10	30	30	60	2.0-3.0	0-20	
	3I-17B	6-10	30	30	60	2.0-3.0	0-5	
	3I-21A	3-6	10	15	25	2.0-3.0	0-5	Surfaced 5 feet south
	3I-21B	6-10	24	15	39	2.0-3.0	5-10	Surfaced 5 feet south
	3I-23A	3-6	0	9	9	2.0-3.0	10-15	Surfaced 7 feet southwest
	3I-23B	6-10	13	15	28	2.0-3.0	0-5	Surfaced 7 feet southwest
	3I-24A	3-6	30	30	60	2.0-3.0	0-5	
	3I-24B	6-10	30	30	60	2.0-3.0	0-5	
	3I-30A	3-6	15	15	30	2.0-3.0	0-10	
	3I-30B	6-10	15	15	30	2.0-3.0	0-15	Surfaced 20 feet east
	3I-32A	3-6	2	15	17	2.0-3.0	0-5	Surfaced 11 feet southeast
	3I-32C	20-25	28	25	53	2.0-3.0	20-30	Surfaced 9 feet southeast
	3I-42C	20-25	50	50	100	2.0-3.0	0-15	

Table 3
PHASE 2C INJECTION LOG

ISCO Injection Program
Former Champaign MGP Site
Champaign, Illinois 61820

Inj. Date	Injection Point	Injection Interval (feet bgs)	ISOTEC REAGENT			FIELD OBSERVATIONS		
			H_2O_2 (gallons)	Catalyst (gallons)	Total (gallons)	Rate (gpm)	Pressure (psi)	Notes (surfacing, refusal, pressure or flow rate changes, etc.)
8/17/13	3I-9B	6-10	30	30	60	2.0-3.0	0-15	
	3I-16B	6-10	10	13	23	2.0-3.0	10-20	Surfaced 8 feet south
	3I-20A	3-6	1	15	16	2.0-3.0	0-5	Surfaced 12 feet southwest
	3I-20B	6-10	13	15	28	2.0-3.0	0-5	Surfaced 15 feet southwest
	3I-26A	3-6	10	15	25	2.0-3.0	0-5	Surfaced 17 feet southwest
	3I-26B	6-10	15	15	30	2.0-3.0	0-5	Surfaced 20 feet southwest
	3I-30A	3-6	15	15	30	2.0-3.0	0-5	
	3I-35A	3-6	30	30	60	2.0-3.0	0-5	Surfaced 1 foot north
	3I-37A	3-6	5	10	15	2.0-3.0	0-5	Surfaced at historic probe hole
	3I-39A	3-6	10	10	20	2.0-3.0	10-16	
	3I-42C	20-25	25	25	50	2.0-3.0	0-5	
	3I-44D	36-44	150	150	300	3.0-4.0	0-5	
	3I-46D	36-44	150	150	300	3.0-4.0	0-5	
	3I-49B	6-10	15	25	40	2.0-3.0	0-5	Surfaced 2 feet north
8/18/13	3I-9B	6-10	15	15	30	2.0-3.0	0-5	
	3I-12B	6-10	20	20	40	2.0-3.0	0-5	
	3I-19B	6-10	20	20	40	2.0-3.0	0-5	Surfaced 20 feet southwest
	3I-25A	3-6	10	10	20	2.0-3.0	0-5	Surfaced 15 feet south
	3I-25B	6-10	18	30	48	2.0-3.0	5-10	Surfaced 15 and 20 feet south
	3I-27A	3-6	10	10	20	2.0-3.0	0-5	Surfaced 15 feet northwest
	3I-27B	6-10	10	10	20	2.0-3.0	0-15	Surfaced 17 feet northwest
	3I-31A	3-6	10	10	20	2.0-3.0	0-5	Surfaced 12 feet southwest
	3I-31C	20-25	23	25	48	2.0-3.0	10-30	Surfaced 12 feet southwest
	3I-37A	3-6	10	20	30	2.0-3.0	0-5	Surfaced 18 feet southwest
	3I-39A	3-6	12	10	22	2.0-3.0	0-12	Surfaced 10 feet southwest
	3I-45D	36-44	150	150	300	3.0-4.0	0-5	
	3I-47D	36-44	150	150	300	3.0-4.0	0-5	
	3I-48B	6-10	30	30	60	2.0-3.0	0-15	
	3I-49B	6-10	10	4	14	2.0-3.0	0-5	Surfaced 2 feet north
8/19/13	3I-3A	3-6	20	20	40	2.0-3.0	0-15	
	3I-3B	6-10	10	20	30	2.0-3.0	0-20	Surfaced 6 feet southeast
	3I-6A	3-6	18	20	38	2.0-3.0	0-5	Surfaced 6 feet north
	3I-6B	6-10	30	30	60	2.0-3.0	0-5	
	3I-10B	6-10	15	15	30	2.0-3.0	0-15	
	3I-13B	6-10	20	20	40	2.0-3.0	0-22	
	3I-14B	6-10	15	15	30	2.0-3.0	0-5	Surfaced 5 feet northwest
	3I-18B	6-10	10	10	20	2.0-3.0	2-5	Surfaced 12 feet south
	3I-32C-R	20-25	27	25	52	2.0-3.0	10-15	Surfaced 15 feet southwest

Table 3
PHASE 2C INJECTION LOG

ISCO Injection Program
Former Champaign MGP Site
Champaign, Illinois 61820

Inj. Date	Injection Point	Injection Interval (feet bgs)	ISOTEC REAGENT			FIELD OBSERVATIONS		
			H_2O_2 (gallons)	Catalyst (gallons)	Total (gallons)	Rate (gpm)	Pressure (psi)	Notes (surfacing, refusal, pressure or flow rate changes, etc.)
	3I-33A	3-6	10	10	20	2.0-3.0	5-10	Surfaced 15 feet south
	3I-43C	20-25	150	150	300	2.0-3.0	0-35	
8/20/13	3I-5A-R	3-6	10	10	20	2.0-3.0	0-5	Surfaced 10 feet southwest
	3I-5B-R	6-10	20	20	40	2.0-3.0	0-10	Surfaced 19 feet northeast
	3I-7A-R	3-6	30	30	60	2.0-3.0	0-5	
	3I-7B-R	6-10	20	20	40	2.0-3.0	0-10	Surfaced 8 feet south
	3I-11B	6-10	10	10	20	2.0-3.0	0-5	Surfaced 12 feet south
	3I-15B	6-10	10	10	20	2.0-3.0	0-5	Surfaced 12 feet south
	3I-18B-R	6-10	15	15	30	2.0-3.0	0-5	Surfaced 12 feet south
	3I-27A-R	3-6	10	10	20	2.0-3.0	0-5	
	3I-27B-R	6-10	20	20	40	2.0-3.0	0-5	Surfaced 18 feet southwest
	3I-31A-R	3-6	10	10	20	2.0-3.0	0-5	Surfaced 12 feet southwest
	3I-35A-R	3-6	10	2	12	2.0-3.0	0-5	Surfaced 1 foot north
	3I-37A-R	3-6	10	10	20	2.0-3.0	10-22	Surfaced 18 feet southwest
	3I-39A-R	3-6	10	10	20	2.0-3.0	0-5	Surfaced 10 feet southwest
	3I-42C-R	20-25	100	100	200	2.0-3.0	5-20	
	3I-47D	36-44	50	50	100	2.0-3.0	0-5	
PHASE 2C REAGENT TOTAL			**2,534**	**2,668**	**5,202**			

Appendix B
Tier 2 Evaluation Data Sheets

TABLE 1
TIER 2 INHALATION REMEDIATION OBJECTIVES BY EXPOSURE PATHWAY
AMEREN ILLINOIS FORMER MANUFACTURED GAS PLANT
CHAMPAIGN, ILLINOIS

Constituents	Units	Calculated Tier 2 Inhalation (Outdoor Air) Remediation Objective Residential	Calculated Tier 2 Inhalation (Outdoor Air) Remediation Objective Industrial/Commercial	Calculated Tier 2 Inhalation (Outdoor Air) Remediation Objective Construction Worker
Volatile Organic Compounds				
benzene	mg/kg	2.65	5.070	7.120
Semivolatile Organic Compounds				
naphthalene	mg/kg	257.78	410.41	2.65

Notes:
1. Tier 2 values for benzene inhalation were calculated using the SSL-S6 and SSL-S7 equations (IAC 35 Part 742, Appendix C, Table A)
2. Tier 2 values for naphthalene inhalation were calculated using the SSL-S4 and SSL-S5 equations (IAC 35 Part 742, Appendix C, Table A)

Input Parameters
Champaign Post-ISCO Tier 2 Calculations
Outdoor Inhalation Exposure Pathway

Parameter	Value	Units	Source
Fraction organic carbon f_{oc}	0.00473	gm/gm	(3 to 10 feet) Average foc from B-806 (8.5-9.5), B-814 (7.0-8.0), and B-817 (8.0-9.0)
Soil bulk density ρ_b	1.7	gm/cm^3	Default Value (TACO 742 Appendix C, Table B)
Soil particle density ρ_s	2.65	gm/cm^4	Default Value (TACO 742 Appendix C, Table B)
Air-filled soil porosity θ_a	0.13	unitless	Default Value for Clay (TACO 742 Appendix C, Table B)
Water-filled porosity θ_w	0.3	unitless	Default Value for Clay (TACO 742 Appendix C, Table B)
Total soil porosity η	0.43	unitless	Default Value (TACO 742 Appendix C, Table B)
Saturated hydraulic conductivity K_s	8	m/yr	(TACO parameter from Appendix C Table K, silty clay)
Exponential parameter 1/(2b=3)	0.042	unitless	(TACO parameter from Appendix C Table K, silty clay)
Benzene Specific Input Parameters			
Organic Carbon Partition Coefficient K_{oc}	50	cm^3/g	Default Value (TACO 742 Appendix C, Table E)
Henry's Constant H'	0.23	l/gm	Default Value (TACO 742 Appendix C, Table E)
Solubility S	1800	mg/l	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Air D^i	0.088	cm^2/sec	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Water D_w	1.02E-05	cm^2/sec	Default Value (TACO 742 Appendix C, Table E)
Inhalation Unit Risk Factor	7.80E-06	(ug/m^3)$^{-1}$	Integrated Risk Information System (IRIS) EPA Database
Naphthalene Specific Input Parameters			
Organic Carbon Partition Coefficient K_{oc}	500	cm^3/g	Default Value (TACO 742 Appendix C, Table E)
Henry's Constant H'	0.0197	l/gm	Default Value (TACO 742 Appendix C, Table E)
Solubility S	31	mg/l	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Air D^i	0.059	cm^2/sec	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Water D_w	7.50E-06	cm^2/sec	Default Value (TACO 742 Appendix C, Table E)
Inhalation Unit Risk Factor	3.00E-03	(ug/m^3)$^{-1}$	Integrated Risk Information System (IRIS) EPA Database

DATA INPUT PARAMETERS			UNITS	SOURCE
Constituent		Benzene		
Site Name		Champaign MGP		
Site Location		Champaign, Illinois		
Constituent based parameters				
Organic-carbon partition coefficient	K_{oc}	50	cm^3/g	Default Value (TACO 742 Appendix C, Table E)
Henry's Constant	H'	0.23	l/gm	Default Value (TACO 742 Appendix C, Table E)
Solubility	S	1800	mg/l	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Air	D_i	0.088	cm2/sec	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Water	D_w	1.02E-05	cm2/sec	Default Value (TACO 742 Appendix C, Table E)
Inhalation Unit Risk Factor	URF	7.80E-06	$(\mu g/m^3)^{-1}$	Integrated Risk Information System (IRIS) EPA Database
FOR SSL EQUATIONS - S6, S7, S8, S10, S19, S20, S21, and S24				
Site Specific Data				
Site Setting - Residential/Commercial/Construction Worker		1		**Enter 1 for residential, 2 for commercial, 3 for construction worker**
Fraction organic carbon content	f_{oc}	0.00473	gm/gm	Site Specific (Average of foc from B-800, B-814, B-817)
Soil bulk density	ρ_b	1.7	gm/cm^3	Default Value (TACO 742 Appendix C, Table B)
Soil particle density	ρ_s	2.65	gm/cm^3	Default Value (TACO 742 Appendix C, Table B)
Air-filled soil porosity	θ_a	0.13	unitless	Default Value (TACO 742 Appendix C, Table B)
Water-filled soil porosity	θ_w	0.3	unitless	Default Value (TACO 742 Appendix C, Table B)
Total porosity [2]	η	0.43	unitless	Default Value (TACO 742 Appendix C, Table B)
Conditions [2] :	Use equation S24 for calculating total soil porosity?			2 1 = YES 2 = NO
Soil Type Specific				
Saturated hydraulic conductivity	K_s	8	m/yr	Default Value (TACO 742 Appendix C, Table K)
Exponential parameter	1/(2b+3)	0.042	unitless	Default Value (TACO 742 Appendix C, Table K)

EQUATION FOR REMEDIATION OBJECTIVE - CARCINOGENICS
EQUATION S6 AND S7 WORKSHEET - REMEDIATION OBJECTIVES
Benzene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
RESIDENTIAL

$RO = TR * AT_c * 365 / [URF * 1000 * EF * ED * (1/VF))]$

Site Setting Code **1** (residential=1; commercial=2; construction worker=3)

URF = **0.0000078** $(\mu g/m^3)^{-1}$

RO Remediation Objective (mg/kg)	Interim Calculated Value β_1 =TR*AT$_c$*365	Interim Calculated Value β_2 =URF*EF*ED*1000*(1/VF)	Target Cancer Risk TR (unitless)	Average Time AT_c (year)	Exposure Frequent EF (day/year)	Exposure Duration ED (year)	Inhalation Unit Risk Factor URF $(\mu g/m^3)^{-1}$	Volatilization Factor for Construction Worker VF' (m^3/kg)	Volatilization Factor VF (m^3/kg)
2.6530	**0.0255500**	**0.00963078**	0.000001	70	350	30	**0.0000078**	850.398	8503.984

EQUATION FOR REMEDIATION OBJECTIVE - CARCINOGENICS
EQUATION S8 WORKSHEET - VOLATILIZATION FACTOR
Benzene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
RESIDENTIAL

$VF = Q/C * [(3.14*D_A*T)^{1/2}/(2*\rho_b*D_A)]*10^{-4}$

Site Setting Code **1** (residential=1; commercial=2; construction worker=3)

Q/C	=	**68.810**	$(gm/m^2\text{-}s)/(kg/m^3)$
ρ_b	=	**1.7**	gm/cm^3 (site specific)

Volatilization Factor VF (mg^3/kg)	Interim Calculated Value β_1 $=(3.14*D_A*T)^{1/2}$	Interim Calculated Value β_2 $=(2*\rho_b*D_A)$	Q/C (unitless)	Apparent Diffusivity D_A (cm^2/s)	Exposure Interval T (sec)	Exposure Duration ED (year)	Soil Bulk Density ρ_b (gm/cm^3)
8503.983958	**709.9102748**	**0.000574424**	**68.81**	**0.000168948**	950000000	30	**1.700**

EQUATION FOR REMEDIATION OBJECTIVE - CARCINOGENICS
EQUATION S10 WORKSHEET - APPARENT DIFFUSIVITY
Benzene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
RESIDENTIAL

$$D_A = [[(\theta_a^{3.33} * D_i * H') + (\theta_w^{3.33} * D_w)]/\eta^2] * [1/((\rho_b * K_d) + \theta_w + (\theta_a * H'))]$$

Henry's constant	H'		0.23	unitless (default value)
Diffusivity in Air	D_i	=	0.088	cm^2/sec
Diffusivity in Water	D_w	=	0.0000102	cm^2/sec
soil bulk density	ρ_b	=	1.7	gm/cm^3 (site specific)
total soil porosity	η	=	0.358	unitless (calculated value based on site-specific bulk density and soil particle density)
water filled soil porosity	θ_w	=	0.312	unitless (calculated value based on calculated total soil porosity and soil density (equation S24))
air filled soil porosity	θ_a	=	0.046	unitless (calculated value based on calculated total soil porosity and soil density (equation S24))
default total soil porosity	$\eta_{(default)}$	=	0.43	unitless (default value from Appendix C; Table B)
default water filled soil porosity	θ_w	=	0.300	unitless (calculated value using default total soil porosity η)
default air filled soil porosity	θ_a	=	0.130	unitless (calculated value using default total soil porosity η)

Apparent Diffusivity D_A (cm^2/s)	Interim Calculated Value $\beta_1 = (\theta_a^{3.33} * D_i * H)$	Interim Calculated Value $\beta_2 = (\theta_w^{3.33} * D_w)$	Interim Calculated Value β_3 $1/[(\rho_b * K_d) + \theta_w + (\theta_a * H'$	Air-Filled Soil Porosity θ_a (unitless)	Water-Filled Soil Porosity θ_w (unitless)	Soil-Water Partition K_d (cm^3/g)	Soil Porosity η (unitless)	Soil Bulk Density ρ_b (gm/cm^3)	Diffusivity in Air D_i (cm^2/sec)	Henry's Constant H' (unitless)	Diffusivity in Water D_w (cm^2/sec)
0.000168948	2.26799E-05	1.85103E-07	1.366213539	0.130	0.300	0.237	0.430	1.700	0.088	0.23	0.0000102

EQUATION FOR AIR-FILLED POROSITY (θ_a), WATER-FILLED SOIL POROSITY (θ_w), PARTITION COEFFICIENT (K_d)
EQUATION S19, S20, S21, AND S24 WORKSHEET - SOIL PROPERTIES
Benzene
Champaign MGP
Champaign, Illinois
RESIDENTIAL

$\eta = 1-(\rho_b)/(\rho_s)$

$\theta_a = \eta - \theta_w$

$\theta_w = \eta * (I/K_s)^{(1/(2b+3))}$

$Kd = K_{oc} * f_{oc}$

K_s	=	**8**	m/yr (by soil type)	saturated hydraulic conductivity
$1/(2b+3)$	=	**0.042**	unitless (by soil type)	exponential parameter
ρ_s	=	**2.65**	gm/cm^3 (default value)	soil particle density
f_{oc}	=	**0.00473**	gm/gm (site specific)	fraction organic carbon content
ρ_b	=	**1.7**	gm/cm^3 (site specific)	soil bulk density
η	=	**0.43**	unitless (by soil type)	total soil porosity (default)
θ_a	=	**0.13**	unitless (by soil type)	air-filled soil porosity (default)
θ_w	=	**0.3**	unitless (by soil type)	water-filled soil porosity (default)
K_{oc}	=	**50**	cm^3/g	Organic Carbon Partition Coefficient
I	=	0.3	meters/year (default value)	infiltration rate

Use Equation S24 for total soil porosity (η)	Calculated Water-Filled Soil Porosity θ_w unitless	Calculated Air-Filled Soil Porosity θ_a unitless	Default Water-Filled Soil Porosity θ_w unitless	Default Air-Filled Soil Porosity θ_a unitless	Constant Value 1/(2b+3) (unitless)	Saturated Hydraulic Conductivity K_s (m/yr)	Infiltration Rate I (m/yr)	Soil-Water Partition K_d (cm^3/g)	Organic Carbon Partition Coefficient K_{oc} (cm^3/g)	Fraction Organic Carbon f_{oc} (gm/gm)	Default Porosity Soil $\eta_{(default)}$ (unitless)	Calculated Soil Porosity η (unitless)	ρ_b (gm/cm^3)	ρ_s (gm/cm^3)
YES	**0.312**	**0.046**			**0.042**	**8**	0.3	**0.2365**	**50**	**0.00473**		**0.358**	**1.7**	**2.65**
NO			**0.300**	**0.130**							**0.43**			

DATA INPUT PARAMETERS			UNITS	SOURCE
Constituent		**Benzene**		
Site Name		**Champaign MGP**		
Site Location		**Champaign, Illinois**		
Constituent based parameters				
Organic-carbon partition coefficient	K_{oc}	50	cm^3/g	Default Value (TACO 742 Appendix C, Table E)
Henry's Constant	H'	0.23	l/gm	Default Value (TACO 742 Appendix C, Table E)
Solubility	S	1800	mg/l	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Air	D_i	0.088	cm2/sec	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Water	D_w	1.02E-05	cm2/sec	Default Value (TACO 742 Appendix C, Table E)
Inhalation Unit Risk Factor	URF	7.80E-06	$(\mu g/m^3)^{-1}$	Integrated Risk Information System (IRIS) EPA Database
FOR SSL EQUATIONS - S6, S7, S8, S10, S19, S20, S21, and S24				
Site Specific Data				
Site Setting - Residential/Commercial/Construction Worker		**2**	**Enter 1 for residential, 2 for commercial, 3 for construction worker**	
Fraction organic carbon content	f_{oc}	0.00473	gm/gm	Site Specific (Average of foc from B-800, B-814, B-817)
Soil bulk density	ρ_b	1.7	gm/cm^3	Default Value (TACO 742 Appendix C, Table B)
Soil particle density	ρ_s	2.65	gm/cm^3	Default Value (TACO 742 Appendix C, Table B)
Air-filled soil porosity	θ_a	0.13	unitless	Default Value (TACO 742 Appendix C, Table B)
Water-filled soil porosity	θ_w	0.3	unitless	Default Value (TACO 742 Appendix C, Table B)
Total porosity [2]	η	0.43	unitless	Default Value (TACO 742 Appendix C, Table B)
Conditions [2] :	Use equation S24 for calculating total soil porosity?			**2** 1 = YES 2 = NO
Soil Type Specific				
Saturated hydraulic conductivity	K_s	8	m/yr	Default Value (TACO 742 Appendix C, Table K)
Exponential parameter	1/(2b+3)	0.042	unitless	Default Value (TACO 742 Appendix C, Table K)

EQUATION FOR REMEDIATION OBJECTIVE - CARCINOGENICS
EQUATION S6 AND S7 WORKSHEET - REMEDIATION OBJECTIVES
Benzene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
COMMERCIAL/INDUSTRIAL

$RO = TR * AT_c * 365 / [URF * 1000 * EF * ED * (1/VF))]$

Site Setting Code **2** (residential=1; commercial=2; construction worker=3)

URF = **0.0000078** $(\mu g/m^3)^{-1}$

RO Remediation Objective (mg/kg)	Interim Calculated Value β_1 =TR*AT$_c$*365	Interim Calculated Value β_2 =URF*EF*ED*1000*(1/VF)	Target Cancer Risk TR (unitless)	Average Time AT_c (year)	Exposure Frequent EF (day/year)	Exposure Duration ED (year)	Inhalation Unit Risk Factor URF $(\mu g/m^3)^{-1}$	Volatilization Factor for Construction Worker VF' (m^3/kg)	Volatilization Factor VF (m^3/kg)
5.0685	**0.0255500**	**0.00504097**	0.000001	70	250	25	**0.0000078**	967.076	9670.758

EQUATION FOR REMEDIATION OBJECTIVE - CARCINOGENICS
EQUATION S8 WORKSHEET - VOLATILIZATION FACTOR
Benzene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
COMMERCIAL/INDUSTRIAL

$VF = Q/C * [(3.14*D_A*T)^{1/2}/(2*\rho_b*D_A)]*10^{-4}$

Site Setting Code **2** (residential=1; commercial=2; construction worker=3)

Q/C	=	**85.810**	$(gm/m^2\text{-}s)/(kg/m^3)$
ρ_b	=	**1.7**	gm/cm^3 (site specific)

Volatilization Factor VF (mg^3/kg)	Interim Calculated Value β_1 **$=(3.14*D_A*T)^{1/2}$**	Interim Calculated Value β_2 **$=(2*\rho_b*D_A)$**	Q/C (unitless)	Apparent Diffusivity D_A (cm^2/s)	Exposure Interval T (sec)	Exposure Duration ED (year)	Soil Bulk Density ρ_b (gm/cm^3)
9670.758082	**647.3739281**	**0.000574424**	**85.81**	**0.000168948**	790000000	25	**1.700**

EQUATION FOR REMEDIATION OBJECTIVE - CARCINOGENICS
EQUATION S10 WORKSHEET - APPARENT DIFFUSIVITY
Benzene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
COMMERCIAL/INDUSTRIAL

$$D_A = [[(\theta_a^{3.33} * D_i * H') + (\theta_w^{3.33} * D_w)]/\eta^2] * [1/((\rho_b * K_d) + \theta_w + (\theta_a * H'))]$$

Henry's constant	H'		0.23	unitless (default value)
Diffusivity in Air	D_i	=	0.088	cm^2/sec
Diffusivity in Water	D_w	=	0.0000102	cm^2/sec
soil bulk density	ρ_b	=	1.7	gm/cm^3 (site specific)
total soil porosity	η	=	0.358	unitless (calculated value based on site-specific bulk density and soil particle density)
water filled soil porosity	θ_w	=	0.312	unitless (calculated value based on calculated total soil porosity and soil density (equation S24))
air filled soil porosity	θ_a	=	0.046	unitless (calculated value based on calculated total soil porosity and soil density (equation S24))
default total soil porosity	$\eta_{(default)}$	=	0.43	unitless (default value from Appendix C; Table B)
default water filled soil porosity	θ_w	=	0.300	unitless (calculated value using default total soil porosity η)
default air filled soil porosity	θ_a	=	0.130	unitless (calculated value using default total soil porosity η)

Apparent Diffusivity D_A (cm^2/s)	Interim Calculated Value $\beta_1 = (\theta_a^{3.33} * D_i * H)$	Interim Calculated Value $\beta_2 = (\theta_w^{3.33} * D_w)$	Interim Calculated Value β_3 $1/[(\rho_b * K_d) + \theta_w + (\theta_a * H'$	Air-Filled Soil Porosity θ_a (unitless)	Water-Filled Soil Porosity θ_w (unitless)	Soil-Water Partition K_d (cm^3/g)	Soil Porosity η (unitless)	Soil Bulk Density ρ_b (gm/cm^3)	Diffusivity in Air D_i (cm^2/sec)	Henry's Constant H' (unitless)	Diffusivity in Water D_w (cm^2/sec)
0.000168948	2.26799E-05	1.85103E-07	1.366213539	0.130	0.300	0.237	0.430	1.700	0.088	0.23	0.0000102

EQUATION FOR AIR-FILLED POROSITY (θ_a), WATER-FILLED SOIL POROSITY (θ_w), PARTITION COEFFICIENT (K_d)
EQUATION S19, S20, S21, AND S24 WORKSHEET - SOIL PROPERTIES
Benzene
Champaign MGP
Champaign, Illinois
COMMERCIAL/INDUSTRIAL

$\eta = 1-(\rho_b)/(\rho_s)$

$\theta_a = \eta - \theta_w$

$\theta_w = \eta * (I/K_s)^{(1/(2b+3))}$

$Kd = K_{oc} * f_{oc}$

K_s	=	**8**	m/yr (by soil type)	saturated hydraulic conductivity
$1/(2b+3)$	=	**0.042**	unitless (by soil type)	exponential parameter
ρ_s	=	**2.65**	gm/cm^3 (default value)	soil particle density
f_{oc}	=	**0.00473**	gm/gm (site specific)	fraction organic carbon content
ρ_b	=	**1.7**	gm/cm^3 (site specific)	soil bulk density
η	=	**0.43**	unitless (by soil type)	total soil porosity (default)
θ_a	=	**0.13**	unitless (by soil type)	air-filled soil porosity (default)
θ_w	=	**0.3**	unitless (by soil type)	water-filled soil porosity (default)
K_{oc}	=	**50**	cm^3/g	Organic Carbon Partition Coefficient
I	=	0.3	meters/year (default value)	infiltration rate

Use Equation S24 for total soil porosity (η)	Calculated Water-Filled Soil Porosity θ_w unitless	Calculated Air-Filled Soil Porosity θ_a unitless	Default Water-Filled Soil Porosity θ_w unitless	Default Air-Filled Soil Porosity θ_a unitless	Constant Value 1/(2b+3) (unitless)	Saturated Hydraulic Conductivity K_s (m/yr)	Infiltration Rate I (m/yr)	Soil-Water Partition K_d (cm^3/g)	Organic Carbon Partition Coefficient K_{oc} (cm^3/g)	Fraction Organic Carbon f_{oc} (gm/gm)	Default Porosity Soil $\eta_{(default)}$ (unitless)	Calculated Soil Porosity η (unitless)	ρ_b (gm/cm^3)	ρ_s (gm/cm^3)
YES	**0.312**	**0.046**			**0.042**	**8**	0.3	**0.2365**	**50**	**0.00473**		**0.358**	**1.7**	**2.65**
NO			**0.300**	**0.130**							**0.43**			

DATA INPUT PARAMETERS			UNITS	SOURCE
Constituent		Benzene		
Site Name		Champaign MGP		
Site Location		Champaign, Illinois		
Constituent based parameters				
Organic-carbon partition coefficient	K_{oc}	50	cm^3/g	Default Value (TACO 742 Appendix C, Table E)
Henry's Constant	H'	0.23	l/gm	Default Value (TACO 742 Appendix C, Table E)
Solubility	S	1800	mg/l	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Air	D_i	0.088	cm2/sec	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Water	D_w	1.02E-05	cm2/sec	Default Value (TACO 742 Appendix C, Table E)
Inhalation Unit Risk Factor	URF	7.80E-06	$(\mu g/m^3)^{-1}$	Integrated Risk Information System (IRIS) EPA Database
FOR SSL EQUATIONS - S6, S7, S8, S10, S19, S20, S21, and S24				
Site Specific Data				
Site Setting - Residential/Commercial/Construction Worker		3	Enter 1 for residential, 2 for commercial, 3 for construction worker	
Fraction organic carbon content	f_{oc}	0.00473	gm/gm	Site Specific (Average of foc from B-806, B-814, B-817)
Soil bulk density	ρ_b	1.7	gm/cm^3	Default Value (TACO 742 Appendix C, Table B)
Soil particle density	ρ_s	2.65	gm/cm^3	Default Value (TACO 742 Appendix C, Table B)
Air-filled soil porosity	θ_a	0.13	unitless	Default Value (TACO 742 Appendix C, Table B)
Water-filled soil porosity	θ_w	0.3	unitless	Default Value (TACO 742 Appendix C, Table B)
Total porosity [2]	η	0.43	unitless	Default Value (TACO 742 Appendix C, Table B)
Conditions [2] :	Use equation S24 for calculating total soil porosity?			2 1 = YES 2 = NO
Soil Type Specific				
Saturated hydraulic conductivity	K_s	8	m/yr	Default Value (TACO 742 Appendix C, Table K)
Exponential parameter	1/(2b+3)	0.042	unitless	Default Value (TACO 742 Appendix C, Table K)

EQUATION FOR REMEDIATION OBJECTIVE - CARCINOGENICS
EQUATION S6 AND S7 WORKSHEET - REMEDIATION OBJECTIVES
Benzene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
CONSTRUCTION WORKER

$RO = TR * AT_c * 365 / [URF * 1000 * EF * ED * (1/VF))]$

Site Setting Code **3** (residential=1; commercial=2; construction worker=3)

URF = **0.0000078** $(\mu g/m^3)^{-1}$

RO Remediation Objective (mg/kg)	Interim Calculated Value β_1 =TR*AT$_c$*365	Interim Calculated Value β_2 =URF*EF*ED*1000*(1/VF)	Target Cancer Risk TR (unitless)	Average Time AT_c (year)	Exposure Frequent EF (day/year)	Exposure Duration ED (year)	Inhalation Unit Risk Factor URF $(\mu g/m^3)^{-1}$	Volatilization Factor for Construction Worker VF' (m^3/kg)	Volatilization Factor VF (m^3/kg)
7.1281	**0.0255500**	**0.00358441**	0.000001	70	30	1	**0.0000078**	65.283	652.827

EQUATION FOR REMEDIATION OBJECTIVE - CARCINOGENICS
EQUATION S8 WORKSHEET - VOLATILIZATION FACTOR
Benzene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
CONSTRUCTION WORKER

$VF = Q/C * [(3.14*D_A*T)^{1/2}/(2*\rho_b*D_A)]*10^{-4}$

Site Setting Code **3** (residential=1; commercial=2; construction worker=3)

Q/C	=	**85.810**	$(gm/m^2\text{-}s)/(kg/m^3)$
ρ_b	=	**1.7**	gm/cm^3 (site specific)

Volatilization Factor VF (mg^3/kg)	Interim Calculated Value β_1 **$=(3.14*D_A*T)^{1/2}$**	Interim Calculated Value β_2 **$=(2*\rho_b*D_A)$**	Q/C (unitless)	Apparent Diffusivity D_A (cm^2/s)	Exposure Interval T (sec)	Exposure Duration ED (year)	Soil Bulk Density ρ_b (gm/cm^3)
652.8271747	**43.70115443**	**0.000574424**	**85.81**	**0.000168948**	3600000	1	**1.700**

EQUATION FOR REMEDIATION OBJECTIVE - CARCINOGENICS
EQUATION S10 WORKSHEET - APPARENT DIFFUSIVITY
Benzene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
CONSTRUCTION WORKER

$$D_A = [[(\theta_a^{3.33} * D_i * H') + (\theta_w^{3.33} * D_w)]/\eta^2] * [1/((\rho_b * K_d) + \theta_w + (\theta_a * H'))]$$

Henry's constant	H'		0.23	unitless (default value)
Diffusivity in Air	D_i	=	0.088	cm^2/sec
Diffusivity in Water	D_w	=	0.0000102	cm^2/sec
soil bulk density	ρ_b	=	1.7	gm/cm^3 (site specific)
total soil porosity	η	=	0.358	unitless (calculated value based on site-specific bulk density and soil particle density)
water filled soil porosity	θ_w	=	0.312	unitless (calculated value based on calculated total soil porosity and soil density (equation S24))
air filled soil porosity	θ_a	=	0.046	unitless (calculated value based on calculated total soil porosity and soil density (equation S24))
default total soil porosity	$\eta_{(default)}$	=	0.43	unitless (default value from Appendix C; Table B)
default water filled soil porosity	θ_w	=	0.300	unitless (calculated value using default total soil porosity η)
default air filled soil porosity	θ_a	=	0.130	unitless (calculated value using default total soil porosity η)

Apparent Diffusivity D_A (cm^2/s)	Interim Calculated Value $\beta_1 = (\theta_a^{3.33} * D_i * H)$	Interim Calculated Value $\beta_2 = (\theta_w^{3.33} * D_w)$	Interim Calculated Value $\beta_3 = 1/[(\rho_b * K_d) + \theta_w + (\theta_a * H'$	Air-Filled Soil Porosity θ_a (unitless)	Water-Filled Soil Porosity θ_w (unitless)	Soil-Water Partition K_d (cm^3/g)	Soil Porosity η (unitless)	Soil Bulk Density ρ_b (gm/cm^3)	Diffusivity in Air D_i (cm^2/sec)	Henry's Constant H' (unitless)	Diffusivity in Water D_w (cm^2/sec)
0.000168948	2.26799E-05	1.85103E-07	1.366213539	0.130	0.300	0.237	0.430	1.700	0.088	0.23	0.0000102

EQUATION FOR AIR-FILLED POROSITY (θ_a), WATER-FILLED SOIL POROSITY (θ_w), PARTITION COEFFICIENT (K_d)
EQUATION S19, S20, S21, AND S24 WORKSHEET - SOIL PROPERTIES
Benzene
Champaign MGP
Champaign, Illinois
CONSTRUCTION WORKER

$\eta = 1-(\rho_b)/(\rho_s)$

$\theta_a = \eta - \theta_w$

$\theta_w = \eta * (I/K_s)^{(1/(2b+3))}$

$Kd = K_{oc} * f_{oc}$

K_s	=	**8**	m/yr (by soil type)	saturated hydraulic conductivity
$1/(2b+3)$	=	**0.042**	unitless (by soil type)	exponential parameter
ρ_s	=	**2.65**	gm/cm^3 (default value)	soil particle density
f_{oc}	=	**0.00473**	gm/gm (site specific)	fraction organic carbon content
ρ_b	=	**1.7**	gm/cm^3 (site specific)	soil bulk density
η	=	**0.43**	unitless (by soil type)	total soil porosity (default)
θ_a	=	**0.13**	unitless (by soil type)	air-filled soil porosity (default)
θ_w	=	**0.3**	unitless (by soil type)	water-filled soil porosity (default)
K_{oc}	=	**50**	cm^3/g	Organic Carbon Partition Coefficient
I	=	0.3	meters/year (default value)	infiltration rate

Use Equation S24 for total soil porosity (η)	Calculated Water-Filled Soil Porosity θ_w unitless	Calculated Air-Filled Soil Porosity θ_a unitless	Default Water-Filled Soil Porosity θ_w unitless	Default Air-Filled Soil Porosity θ_a unitless	Constant Value 1/(2b+3) (unitless)	Saturated Hydraulic Conductivity K_s (m/yr)	Infiltration Rate I (m/yr)	Soil-Water Partition K_d (cm^3/g)	Organic Carbon Partition Coefficient K_{oc} (cm^3/g)	Fraction Organic Carbon f_{oc} (gm/gm)	Default Porosity Soil $\eta_{(default)}$ (unitless)	Calculated Soil Porosity η (unitless)	ρ_b (gm/cm^3)	ρ_s (gm/cm^3)
YES	**0.312**	**0.046**			**0.042**	**8**	0.3	**0.2365**	**50**	**0.00473**		**0.358**	**1.7**	**2.65**
NO			**0.300**	**0.130**							**0.43**			

DATA INPUT PARAMETERS		INPUT VALUES BELOW	UNITS	SOURCE
Constituent		**Naphthalene**		
Site Name		**Champaign MGP**		
Site Location		**Champaign, Illinois**		
Sample Location				
Sample Depth				
Constituent based parameters				
Organic-carbon partition coefficient	K_{oc}	500	cm^3/g	Default Value (TACO 742 Appendix C, Table E)
Henry's Constant	H'	0.0197	l/gm	Default Value (TACO 742 Appendix C, Table E)
Solubility	S	31	mg/l	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Air	D_i	0.059	cm2/sec	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Water	D_w	7.50E-06	cm2/sec	Default Value (TACO 742 Appendix C, Table E)
Inhalation Reference Concentration	RfC	3.00E-03	mg/m3	Integrated Risk Information System (IRIS) EPA Database
FOR SSL EQUATIONS - S4, S5, S8, S10, S19, S20, S21, and S24				
Site Specific Data				
Site Setting - Residential/Commercial/Construction Worker		**1**	**Enter 1 for residential, 2 for commercial, 3 for construction worker**	
Fraction organic carbon content	f_{oc}	0.00473	gm/gm	Site Specific (Average of foc from B-800, B-814, B-817)
Soil bulk density	ρ_b	1.7	gm/cm^3	Default Value (TACO 742 Appendix C, Table B)
Soil particle density	ρ_s	2.65	gm/cm^3	Default Value (TACO 742 Appendix C, Table B)
Air-filled soil porosity	θ_a	0.13	unitless	Site Specific Value from B845 (0.5 - 1.0 ft bgs)
Water-filled soil porosity	θ_w	0.3	unitless	Site Specific Value from B-845 (14.5 - 15.0, 19.5 - 20.0 ft bgs)
Total porosity (2)	η	0.43	unitless	Default Value (TACO 742 Appendix C, Table B)
Conditions (2) :	Use equation S24 for calculating total soil porosity?			**2** 1 = YES 2 = NO
Soil Type Specific				
Saturated hydraulic conductivity	K_s	8	m/yr	Default Value (TACO 742 Appendix C, Table K)
Exponential parameter	1/(2b+3)	0.042	unitless	Default Value (TACO 742 Appendix C, Table K)

EQUATION FOR REMEDIATION OBJECTIVE - NONCARCINOGENICS
EQUATION S4 AND S5 WORKSHEET - REMEDIATION OBJECTIVES
Naphthalene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
RESIDENTIAL

$$RO = THQ * AT * 365 / [EF * ED * ((1/RfC) * (1/VF))]$$

Site Setting Code = **1** (residential=1; commercial=2; construction worker=3)

RfC = **0.003** mg/m^3 **Inhalation Reference Concentration**

Borehole Location	Depth Interval (feet)	**RO** Remediation Objective (mg/kg)	Target Hazard Quotient THQ (unitless)	Average Time AT (year)	Exposure Frequent EF (day/year)	Exposure Duration ED (year)	Inhalation Reference Concentration RfC (mg/m^3)	Volatilization Factor for Construction Worker VF' (m^3/kg)	Volatilization Factor VF (m^3/kg)
0	0	**257.7813**	1	30	350	30	**0.003**	8239.584	82395.845

EQUATION FOR REMEDIATION OBJECTIVE - NONCARCINOGENICS
EQUATION S8 WORKSHEET - VOLATILIZATION FACTOR
Naphthalene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
RESIDENTIAL

$VF = Q/C * [(3.14*D_A*T)^{1/2}/(2*\rho_b*D_A)]*10^{-4}$

Site Setting Code		**1**	(residential=1; commercial=2; construction worker=3)	
Q/C	=	**68.810**	$(gm/m^2\text{-}s)/(kg/m^3)$	Inverse mean concentration @ center of square source
ρ_b	=	**1.7**	gm/cm^3 (site specific)	soil bulk density

Volatilization Factor VF (mg^3/kg)	Interim Calculated Value β_1 **$=(3.14*D_A*T)^{1/2}$**	Interim Calculated Value β_2 **$=(2*\rho_b*D_A)$**	Q/C (unitless)	Apparent Diffusivity D_A (cm^2/s)	Exposure Interval T (sec)	Exposure Duration ED (year)	Soil Bulk Density ρ_b (gm/cm^3)
82395.8449	**73.26905374**	**6.11881E-06**	**68.81**	**1.79965E-06**	950000000	30	**1.700**

EQUATION FOR REMEDIATION OBJECTIVE - NONCARCINOGENICS
EQUATION S10 WORKSHEET - APPARENT DIFFUSIVITY
Naphthalene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
RESIDENTIAL

$$D_A = [[(\theta_a^{3.33} * D_i * H') + (\theta_w^{3.33} * D_w)]/\eta^2] * [1/((\rho_b * K_d) + \theta_w + (\theta_a * H'))]$$

Henry's constant	H'	=	**0.0197**	unitless (default value)
Diffusivity in Air	D_i	=	**0.059**	cm^2/sec
Diffusivity in Water	D_w	=	**0.0000075**	cm^2/sec
soil bulk density	ρ_b	=	**1.7**	gm/cm^3 (site specific)
total soil porosity	η	=	**0.358**	unitless (calculated value based on site-specific bulk density and soil particle density)
water filled soil porosity	θ_w	=	**0.312**	unitless (calculated value based on calculated total soil porosity (equation S24))
air filled soil porosity	θ_a	=	**0.046**	unitless (calculated value based on calculated total soil porosity (equation S24))
default total soil porosity	$\eta_{(default)}$	=	**0.430**	unitless (default value from Appendix C; Table B)
default water filled soil porosity	θ_w	=	**0.300**	unitless (calculated value using default total soil porosity η)
default air filled soil porosity	θ_a	=	**0.130**	unitless (calculated value using default total soil porosity η)

Apparent Diffusivity D_A (cm^2/s)	Interim Calculated Value β_1 $= (\theta_a^{3.33} * D_i * H)$	Interim Calculated Value β_2 $= (\theta_w^{3.33} * D_w)$	Interim Calculated Value β_3 $= 1/[(\rho_b * K_d) + \theta_w + (\theta_a * H')]$	Air-Filled Soil Porosity θ_a (unitless)	Water-Filled Soil Porosity θ_w (unitless)	Soil-Water Partition K_d (cm^3/g)	Soil Porosity η (unitless)	Soil Bulk Density ρ_b (gm/cm^3)	Diffusivity in Air D_i (cm^2/sec)	Henry's Constant H' (unitless)	Diffusivity in Water D_w (cm^2/sec)
1.79965E-06	1.30242E-06	1.36105E-07	0.231317578	**0.130**	**0.300**	**2.365**	**0.430**	**1.700**	**0.059**	**0.0197**	**0.0000075**

EQUATION FOR AIR-FILLED POROSITY (θ_a), WATER-FILLED SOIL POROSITY (θ_w), PARTITION COEFFICIENT (K_d)
EQUATION S19, S20, S21, AND S24 WORKSHEET - SOIL PROPERTIES
Naphthalene
Champaign MGP
Champaign, Illinois
RESIDENTIAL

$\eta = 1-(\rho_b)/(\rho_s)$

$\theta_a = \eta - \theta_w$

$\theta_w = \eta * (I/K_s)^{(1/(2b+3))}$

$Kd = K_{oc} * f_{oc}$

K_s	=	**8**	m/yr (by soil type)	saturated hydraulic conductivity
$1/(2b+3)$	=	**0.042**	unitless (by soil type)	exponential parameter
ρ_s	=	**2.65**	gm/cm^3 (default value)	soil particle density
f_{oc}	=	**0.00473**	gm/gm (site specific)	fraction organic carbon content
ρ_b	=	**1.7**	gm/cm^3 (site specific)	soil bulk density
η	=	**0.43**	unitless (by soil type)	total soil porosity (default)
θ_a	=	**0.13**	unitless (by soil type)	air-filled soil porosity (default)
θ_w	=	**0.3**	unitless (by soil type)	water-filled soil porosity (default)
K_{oc}	=	**500**	cm^3/g	Organic Carbon Partition Coefficient
I	=	0.3	meters/year (default value)	infiltration rate

Use Equation	Calculated Water-Filled Soil Porosity	Calculated Air-Filled Soil Porosity	Default Water-Filled Soil Porosity	Default Air-Filled Soil Porosity	Constant Value	Saturated Hydraulic Conductivity	Infiltration Rate	Soil-Water Partition	Organic Carbon Partition Coefficient	Fraction Organic Carbon	Default Porosity Soil	Calculated Soil Porosity	ρ_b	ρ_s
S24 for total	θ_w	θ_a	θ_w	θ_a	1/(2b+3)	K_s	I	K_d	K_{oc}	f_{oc}	$\eta_{(default)}$	η	ρ_b	ρ_s
soil porosity (η)	unitless	unitless	unitless	unitless	(unitless)	(m/yr)	(m/yr)	(cm^3/g)	(cm^3/g)	(gm/gm)	(unitless)	(unitless)	(gm/cm^3)	(gm/cm^3)
YES	**0.312**	**0.046**			**0.042**	**8**	0.3	**2.365**	**500**	**0.00473**		**0.358**	**1.7**	**2.65**
NO			**0.300**	**0.130**							**0.43**			

DATA INPUT PARAMETERS		INPUT VALUES BELOW	UNITS	SOURCE
Constituent		Naphthalene		
Site Name		Champaign MGP		
Site Location		Champaign, Illinois		
Sample Location				
Sample Depth				
Constituent based parameters				
Organic-carbon partition coefficient	K_{oc}	500	cm^3/g	Default Value (TACO 742 Appendix C, Table E)
Henry's Constant	H'	0.0197	l/gm	Default Value (TACO 742 Appendix C, Table E)
Solubility	S	31	mg/l	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Air	D_i	0.059	cm2/sec	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Water	D_w	7.50E-06	cm2/sec	Default Value (TACO 742 Appendix C, Table E)
Inhalation Reference Concentration	RfC	3.00E-03	mg/m3	Integrated Risk Information System (IRIS) EPA Database
FOR SSL EQUATIONS - S4, S5, S8, S10, S19, S20, S21, and S24				
Site Specific Data				
Site Setting - Residential/Commercial/Construction Worker		**2**	**Enter 1 for residential, 2 for commercial, 3 for construction worker**	
Fraction organic carbon content	f_{oc}	0.00473	gm/gm	Site Specific (Average of foc from B-800, B-814, B-817)
Soil bulk density	ρ_b	1.7	gm/cm^3	Default Value (TACO 742 Appendix C, Table B)
Soil particle density	ρ_s	2.65	gm/cm^3	Default Value (TACO 742 Appendix C, Table B)
Air-filled soil porosity	θ_a	0.13	unitless	Site Specific Value from B845 (0.5 - 1.0 ft bgs)
Water-filled soil porosity	θ_w	0.3	unitless	Site Specific Value from B-845 (14.5 - 15.0, 19.5 - 20.0 ft bgs)
Total porosity (2)	η	0.43	unitless	Default Value (TACO 742 Appendix C, Table B)
Conditions (2) :	Use equation S24 for calculating total soil porosity?			**2** 1 = YES 2 = NO
Soil Type Specific				
Saturated hydraulic conductivity	K_s	8	m/yr	Default Value (TACO 742 Appendix C, Table K)
Exponential parameter	1/(2b+3)	0.042	unitless	Default Value (TACO 742 Appendix C, Table K)

EQUATION FOR REMEDIATION OBJECTIVE - NONCARCINOGENICS
EQUATION S4 AND S5 WORKSHEET - REMEDIATION OBJECTIVES
Naphthalene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
COMMERCIAL/INDUSTRIAL

RO = THQ * AT * 365 / [EF * ED * ((1/R*f*C) * (1/VF))]

Site Setting Code = **2** (residential=1; commercial=2; construction worker=3)

R*f*C = **0.003** mg/m^3 **Inhalation Reference Concentration**

Borehole Location	Depth Interval (feet)	**RO** Remediation Objective (mg/kg)	Target Hazard Quotient THQ (unitless)	Average Time AT (year)	Exposure Frequent EF (day/year)	Exposure Duration ED (year)	Inhalation Reference Concentration R*f*C (mg/m^3)	Volatilization Factor for Construction Worker VF' (m^3/kg)	Volatilization Factor VF (m^3/kg)
0	0	**410.4096**	1	25	250	25	**0.003**	9370.082	93700.822

EQUATION FOR REMEDIATION OBJECTIVE - NONCARCINOGENICS
EQUATION S8 WORKSHEET - VOLATILIZATION FACTOR
Naphthalene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
COMMERCIAL/INDUSTRIAL

$VF = Q/C * [(3.14*D_A*T)^{1/2}/(2*\rho_b*D_A)]*10^{-4}$

Site Setting Code		**2**	(residential=1; commercial=2; construction worker=3)	
Q/C	=	**85.810**	$(gm/m^2\text{-}s)/(kg/m^3)$	Inverse mean concentration @ center of square source
ρ_b	=	**1.7**	gm/cm^3 (site specific)	soil bulk density

Volatilization Factor VF (mg^3/kg)	Interim Calculated Value β_1 **$=(3.14*D_A*T)^{1/2}$**	Interim Calculated Value β_2 **$=(2*\rho_b*D_A)$**	Q/C (unitless)	Apparent Diffusivity D_A (cm^2/s)	Exposure Interval T (sec)	Exposure Duration ED (year)	Soil Bulk Density ρ_b (gm/cm^3)
93700.82151	**66.81474661**	**6.11881E-06**	**85.81**	**1.79965E-06**	790000000	25	**1.700**

EQUATION FOR REMEDIATION OBJECTIVE - NONCARCINOGENICS
EQUATION S10 WORKSHEET - APPARENT DIFFUSIVITY
Naphthalene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
COMMERCIAL/INDUSTRIAL

$$D_A = [[(\theta_a^{3.33} * D_i * H') + (\theta_w^{3.33} * D_w)]/\eta^2] * [1/((\rho_b * K_d) + \theta_w + (\theta_a * H'))]$$

Henry's constant	H'	=	**0.0197**	unitless (default value)
Diffusivity in Air	D_i	=	**0.059**	cm^2/sec
Diffusivity in Water	D_w	=	**0.0000075**	cm^2/sec
soil bulk density	ρ_b	=	**1.7**	gm/cm^3 (site specific)
total soil porosity	η	=	**0.358**	unitless (calculated value based on site-specific bulk density and soil particle density)
water filled soil porosity	θ_w	=	**0.312**	unitless (calculated value based on calculated total soil porosity (equation S24))
air filled soil porosity	θ_a	=	**0.046**	unitless (calculated value based on calculated total soil porosity (equation S24))
default total soil porosity	$\eta_{(default)}$	=	**0.430**	unitless (default value from Appendix C; Table B)
default water filled soil porosity	θ_w	=	**0.300**	unitless (calculated value using default total soil porosity η)
default air filled soil porosity	θ_a	=	**0.130**	unitless (calculated value using default total soil porosity η)

Apparent Diffusivity D_A (cm^2/s)	Interim Calculated Value $\beta_1 = (\theta_a^{3.33} * D_i * H)$	Interim Calculated Value $\beta_2 = (\theta_w^{3.33} * D_w)$	Interim Calculated Value $\beta_3 = 1/[(\rho_b * K_d) + \theta_w + (\theta_a * H')]$	Air-Filled Soil Porosity θ_a (unitless)	Water-Filled Soil Porosity θ_w (unitless)	Soil-Water Partition K_d (cm^3/g)	Soil Porosity η (unitless)	Soil Bulk Density ρ_b (gm/cm^3)	Diffusivity in Air D_i (cm^2/sec)	Henry's Constant H' (unitless)	Diffusivity in Water D_w (cm^2/sec)
1.79965E-06	1.30242E-06	1.36105E-07	0.231317578	**0.130**	**0.300**	**2.365**	**0.430**	**1.700**	**0.059**	**0.0197**	**0.0000075**

EQUATION FOR AIR-FILLED POROSITY (θ_a), WATER-FILLED SOIL POROSITY (θ_w), PARTITION COEFFICIENT (K_d)
EQUATION S19, S20, S21, AND S24 WORKSHEET - SOIL PROPERTIES
Naphthalene
Champaign MGP
Champaign, Illinois
COMMERCIAL/INDUSTRIAL

$\eta = 1-(\rho_b)/(\rho_s)$

$\theta_a = \eta - \theta_w$

$\theta_w = \eta * (I/K_s)^{(1/(2b+3))}$

$Kd = K_{oc} * f_{oc}$

K_s	=	**8**	m/yr (by soil type)	saturated hydraulic conductivity
$1/(2b+3)$	=	**0.042**	unitless (by soil type)	exponential parameter
ρ_s	=	**2.65**	gm/cm^3 (default value)	soil particle density
f_{oc}	=	**0.00473**	gm/gm (site specific)	fraction organic carbon content
ρ_b	=	**1.7**	gm/cm^3 (site specific)	soil bulk density
η	=	**0.43**	unitless (by soil type)	total soil porosity (default)
θ_a	=	**0.13**	unitless (by soil type)	air-filled soil porosity (default)
θ_w	=	**0.3**	unitless (by soil type)	water-filled soil porosity (default)
K_{oc}	=	**500**	cm^3/g	Organic Carbon Partition Coefficient
I	=	0.3	meters/year (default value)	infiltration rate

Use Equation	Calculated Water-Filled Soil Porosity	Calculated Air-Filled Soil Porosity	Default Water-Filled Soil Porosity	Default Air-Filled Soil Porosity	Constant Value	Saturated Hydraulic Conductivity	Infiltration Rate	Soil-Water Partition	Organic Carbon Partition Coefficient	Fraction Organic Carbon	Default Porosity Soil	Calculated Soil Porosity	ρ_b	ρ_s
S24 for total	θ_w	θ_a	θ_w	θ_a	1/(2b+3)	K_s	I	K_d	K_{oc}	f_{oc}	$\eta_{(default)}$	η	ρ_b	ρ_s
soil porosity (η)	unitless	unitless	unitless	unitless	(unitless)	(m/yr)	(m/yr)	(cm^3/g)	(cm^3/g)	(gm/gm)	(unitless)	(unitless)	(gm/cm^3)	(gm/cm^3)
YES	**0.312**	**0.046**			**0.042**	**8**	0.3	**2.365**	**500**	**0.00473**		**0.358**	**1.7**	**2.65**
NO			**0.300**	**0.130**							**0.43**			

DATA INPUT PARAMETERS		INPUT VALUES BELOW	UNITS	SOURCE
Constituent		**Naphthalene**		
Site Name		**Champaign MGP**		
Site Location		**Champaign, Illinois**		
Sample Location				
Sample Depth				
Constituent based parameters				
Organic-carbon partition coefficient	K_{oc}	500	cm^3/g	Default Value (TACO 742 Appendix C, Table E)
Henry's Constant	H'	0.0197	l/gm	Default Value (TACO 742 Appendix C, Table E)
Solubility	S	31	mg/l	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Air	D_i	0.059	cm2/sec	Default Value (TACO 742 Appendix C, Table E)
Diffusivity in Water	D_w	7.50E-06	cm2/sec	Default Value (TACO 742 Appendix C, Table E)
Inhalation Reference Concentration	RfC	3.00E-03	mg/m3	Integrated Risk Information System (IRIS) EPA Database
FOR SSL EQUATIONS - S4, S5, S8, S10, S19, S20, S21, and S24				
Site Specific Data				
Site Setting - Residential/Commercial/Construction Worker		**3**	**Enter 1 for residential, 2 for commercial, 3 for construction worker**	
Fraction organic carbon content	f_{oc}	0.00473	gm/gm	Site Specific (Average of foc from B-800, B-814, B-817)
Soil bulk density	ρ_b	1.7	gm/cm^3	Default Value (TACO 742 Appendix C, Table B)
Soil particle density	ρ_s	2.65	gm/cm^3	Default Value (TACO 742 Appendix C, Table B)
Air-filled soil porosity	θ_a	0.13	unitless	Default Value (TACO 742 Appendix C, Table B)
Water-filled soil porosity	θ_w	0.3	unitless	Default Value (TACO 742 Appendix C, Table B)
Total porosity (2)	η	0.43	unitless	Default Value (TACO 742 Appendix C, Table B)
Conditions (2) :	Use equation S24 for calculating total soil porosity?			**2** 1 = YES 2 = NO
Soil Type Specific				
Saturated hydraulic conductivity	K_s	8	m/yr	Default Value (TACO 742 Appendix C, Table K)
Exponential parameter	1/(2b+3)	0.042	unitless	Default Value (TACO 742 Appendix C, Table K)

EQUATION FOR REMEDIATION OBJECTIVE - NONCARCINOGENICS
EQUATION S4 AND S5 WORKSHEET - REMEDIATION OBJECTIVES
Naphthalene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
CONSTRUCTION WORKER

RO = THQ * AT * 365 / [EF * ED * ((1/R*f*C) * (1/VF))]

Site Setting Code = **3** (residential=1; commercial=2; construction worker=3)

R*f*C = **0.003** mg/m^3 **Inhalation Reference Concentration**

Borehole Location	Depth Interval (feet)	**RO** Remediation Objective (mg/kg)	Target Hazard Quotient THQ (unitless)	Average Time AT (year)	Exposure Frequent EF (day/year)	Exposure Duration ED (year)	Inhalation Reference Concentration R*f*C (mg/m^3)	Volatilization Factor for Construction Worker VF' (m^3/kg)	Volatilization Factor VF (m^3/kg)
0	0	**2.6550**	1	0.115	30	1	**0.003**	632.530	6325.300

EQUATION FOR REMEDIATION OBJECTIVE - NONCARCINOGENICS
EQUATION S8 WORKSHEET - VOLATILIZATION FACTOR
Naphthalene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
CONSTRUCTION WORKER

$VF = Q/C * [(3.14*D_A*T)^{1/2}/(2*\rho_b*D_A)]*10^{-4}$

Site Setting Code **3** (residential=1; commercial=2; construction worker=3)

Q/C = **85.810** $(gm/m^2\text{-}s)/(kg/m^3)$ Inverse mean concentration @ center of square source

ρ_b = **1.7** gm/cm^3 (site specific) soil bulk density

Volatilization Factor VF **(mg^3/kg)**	Interim Calculated Value β_1 **$=(3.14*D_A*T)^{1/2}$**	Interim Calculated Value β_2 **$=(2*\rho_b*D_A)$**	Q/C (unitless)	Apparent Diffusivity D_A (cm^2/s)	Exposure Interval T (sec)	Exposure Duration ED (year)	Soil Bulk Density ρ_b (gm/cm^3)
6325.299636	**4.510347781**	**6.11881E-06**	**85.81**	**1.79965E-06**	3600000	1	**1.700**

EQUATION FOR REMEDIATION OBJECTIVE - NONCARCINOGENICS
EQUATION S10 WORKSHEET - APPARENT DIFFUSIVITY
Naphthalene
SOIL INHALATION EXPOSURE ROUTE - ORGANIC CONSTITUENTS
Champaign MGP
Champaign, Illinois
CONSTRUCTION WORKER

$$D_A = [[(\theta_a^{3.33} * D_i * H') + (\theta_w^{3.33} * D_w)]/\eta^2] * [1/((\rho_b * K_d) + \theta_w + (\theta_a * H'))]$$

Henry's constant	H'	=	**0.0197**	unitless (default value)
Diffusivity in Air	D_i	=	**0.059**	cm^2/sec
Diffusivity in Water	D_w	=	**0.0000075**	cm^2/sec
soil bulk density	ρ_b	=	**1.7**	gm/cm^3 (site specific)
total soil porosity	η	=	**0.358**	unitless (calculated value based on site-specific bulk density and soil particle density)
water filled soil porosity	θ_w	=	**0.312**	unitless (calculated value based on calculated total soil porosity (equation S24))
air filled soil porosity	θ_a	=	**0.046**	unitless (calculated value based on calculated total soil porosity (equation S24))
default total soil porosity	$\eta_{(default)}$	=	**0.430**	unitless (default value from Appendix C; Table B)
default water filled soil porosity	θ_w	=	**0.300**	unitless (calculated value using default total soil porosity η)
default air filled soil porosity	θ_a	=	**0.130**	unitless (calculated value using default total soil porosity η)

Apparent Diffusivity D_A (cm^2/s)	Interim Calculated Value $\beta_1 = (\theta_a^{3.33} * D_i * H)$	Interim Calculated Value $\beta_2 = (\theta_w^{3.33} * D_w)$	Interim Calculated Value $\beta_3 = 1/[(\rho_b * K_d) + \theta_w + (\theta_a * H')]$	Air-Filled Soil Porosity θ_a (unitless)	Water-Filled Soil Porosity θ_w (unitless)	Soil-Water Partition K_d (cm^3/g)	Soil Porosity η (unitless)	Soil Bulk Density ρ_b (gm/cm^3)	Diffusivity in Air D_i (cm^2/sec)	Henry's Constant H' (unitless)	Diffusivity in Water D_w (cm^2/sec)
1.79965E-06	1.30242E-06	1.36105E-07	0.231317578	**0.130**	**0.300**	**2.365**	**0.430**	**1.700**	**0.059**	**0.0197**	**0.0000075**

EQUATION FOR AIR-FILLED POROSITY (θ_a), WATER-FILLED SOIL POROSITY (θ_w), PARTITION COEFFICIENT (K_d)
EQUATION S19, S20, S21, AND S24 WORKSHEET - SOIL PROPERTIES
Naphthalene
Champaign MGP
Champaign, Illinois
CONSTRUCTION WORKER

$\eta = 1-(\rho_b)/(\rho_s)$

$\theta_a = \eta - \theta_w$

$\theta_w = \eta * (I/K_s)^{(1/(2b+3))}$

$Kd = K_{oc} * f_{oc}$

K_s	=	**8**	m/yr (by soil type)	saturated hydraulic conductivity
$1/(2b+3)$	=	**0.042**	unitless (by soil type)	exponential parameter
ρ_s	=	**2.65**	gm/cm^3 (default value)	soil particle density
f_{oc}	=	**0.00473**	gm/gm (site specific)	fraction organic carbon content
ρ_b	=	**1.7**	gm/cm^3 (site specific)	soil bulk density
η	=	**0.43**	unitless (by soil type)	total soil porosity (default)
θ_a	=	**0.13**	unitless (by soil type)	air-filled soil porosity (default)
θ_w	=	**0.3**	unitless (by soil type)	water-filled soil porosity (default)
K_{oc}	=	**500**	cm^3/g	Organic Carbon Partition Coefficient
I	=	0.3	meters/year (default value)	infiltration rate

Use Equation	Calculated Water-Filled Soil Porosity	Calculated Air-Filled Soil Porosity	Default Water-Filled Soil Porosity	Default Air-Filled Soil Porosity	Constant Value	Saturated Hydraulic Conductivity	Infiltration Rate	Soil-Water Partition	Organic Carbon Partition Coefficient	Fraction Organic Carbon	Default Porosity Soil	Calculated Soil Porosity	ρ_b	ρ_s
S24 for total	θ_w	θ_a	θ_w	θ_a	1/(2b+3)	K_s	I	K_d	K_{oc}	f_{oc}	$\eta_{(default)}$	η	ρ_b	ρ_s
soil porosity (η)	unitless	unitless	unitless	unitless	(unitless)	(m/yr)	(m/yr)	(cm^3/g)	(cm^3/g)	(gm/gm)	(unitless)	(unitless)	(gm/cm^3)	(gm/cm^3)
YES	**0.312**	**0.046**			**0.042**	**8**	0.3	**2.365**	**500**	**0.00473**		**0.358**	**1.7**	**2.65**
NO			**0.300**	**0.130**							**0.43**			

Appendix C
City Ordinance

Run Date :11/20/2008

DLC Assignment Form

Assignment ID :6513
Subject :Champaign/Former BP Service Staiton #5297
Subject Type :Ordinance Review
DLC In Date :11/20/2008
DLC File No. :
Correspondence No. :R08112001

DLC Completed Date. :

Assigned Staff:

Geving, Kim	Attorney
Barrett, John	Bureau Requestor

Project Details:
Status Issued Date: 11/20/2008 Due Date: 12/19/2008
Please review ordinance #2007-138 for Champaign

Comments:

CERTIFICATE

I, Glenda F. Robertson, duly Appointed, fully Qualified, and Deputy City Clerk of the City of Champaign, County of Champaign, State of Illinois, do hereby certify that the attached is a true and correct copy of Council Bill No. 2007-138 "An Ordinance Amending Chapter 16 of the Municipal Code, 1985, As Amended, by Adding Article III Entitled "Groundwater Restrictions" and Approving a Memorandum of Understanding with the Illinois Environmental Protection Agency (Health and Sanitation - Groundwater Restrictions)", approved on June 5, 2007 and covers the entire City of Champaign.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the City of Champaign, County of Champaign, State of Illinois this 23rd day of October, 2008.

Glenda F. Robertson

Glenda F. Robertson
Deputy City Clerk

SEAL

CITY OF CHAMPAIGN, ILLINOIS
A HOME RULE MUNICIPAL CORPORATION

COUNCIL BILL NO. 2007-138

An Ordinance Amending Chapter 16 of the Municipal Code, 1985, As Amended, by Adding Article III Entitled "Groundwater Restrictions" and Approving a Memorandum of Understanding with the Illinois Environmental Protection Agency (Health and Sanitation - Groundwater Restrictions)

ADOPTED BY THE
CITY COUNCIL
OF THE
CITY OF CHAMPAIGN

THIS 5th DAY OF JUNE, 2007
Published in pamphlet form THIS 6TH DAY OF JUNE, 2007

COUNCIL BILL NO. 2007-138

AN ORDINANCE

AMENDING CHAPTER 16 OF THE MUNICIPAL CODE, 1985, AS AMENDED, BY ADDING ARTICLE III ENTITLED "GROUNDWATER RESTRICTIONS" AND APPROVING A MEMORANDUM OF UNDERSTANDING WITH THE ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
(Health and Sanitation - Groundwater Restrictions)

WHEREAS, certain properties in the City of Champaign, Illinois have been used over a period of time for commercial/industrial purposes; and

WHEREAS, because of said use, concentrations of certain chemical constituents in the groundwater beneath the City may exceed Class 1 groundwater quality standards for potable resource groundwater as set forth in 35 Illinois Administrative Code 620 or Tier 1 remediation objectives as set forth in 35 Illinois Administrative Code 742; and

WHEREAS, the City of Champaign desires to limit potential threats to human health from groundwater contamination while facilitating the redevelopment and productive use of properties that are the source of said chemical constituents;

NOW, THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF CHAMPAIGN, ILLINOIS, as follows:

Section 1. That Chapter 16 of the Champaign Municipal Code, 1985, as amended, entitled "Health and Sanitation," is hereby amended to add Article III, entitled "Groundwater Restriction Ordinance," which shall read as follows:

"ARTICLE III. GROUNDWATER RESTRICTION ORDINANCE

Sec. 16-20. Use of groundwater as a potable water supply prohibited.

(a) *Potable water* is any water used for human or domestic consumption, including, but not limited to, water used for drinking, bathing, swimming, washing dishes, or preparing foods.

(b) Except for such uses or methods in existence before the effective date of this ordinance, the use of, or attempt to use as a potable water supply groundwater from within the corporate limits of the City of Champaign by the installation or drilling of wells or by any other method is hereby prohibited, except at points of withdrawal by the City of Champaign.

(c) The City Engineer will notify the IEPA Bureau of Land of any proposed ordinance changes or requests for variance at least 30 days prior to the date the City is scheduled to take action on the proposed change or request.

(d) The City Engineer will maintain a registry of all sites within its corporate limits that have received "No Further Remediation" determinations from the IEPA.

(e) The City Engineer will review the registry of sites established under this section prior to siting public potable water supply wells within the area covered by this section.

(f) The City Engineer will determine whether the potential source of potable water has been or may be affected by contamination left in place at the sites tracked and reviewed under this section.

(g) The City Engineer will take action as necessary to ensure that the potential source of potable water is protected from contamination or treated before it is used as a potable water supply."

Section 2. That this ordinance shall be effective immediately, it being determined by the Council that it is urgent that this ordinance take effect at the earliest possible date.

Section 3. That the City Clerk is hereby directed to publish this Ordinance immediately after passage.

Section 4. That the Memorandum of Understanding with the Illinois Environmental Protection Agency (IEPA), in substantially the form as attached hereto and incorporated by reference herein as Exhibit "A", is hereby approved, and the City Manager is hereby authorized to sign said Memorandum of Understanding.

Section 5. Any person violating the provisions of this ordinance shall be fined an amount not to exceed $750.00 and in accordance with the general penalty provisions of the Code set forth in Section 1-21, 1-22, 1-23, and 1-24.

Section 6. All ordinances or parts of ordinances in conflict with this ordinance are hereby repealed insofar as they are in conflict with this ordinance.

Section 7. If any provision of this ordinance or this application to any person or under any circumstances is adjudged invalid, such adjudication shall not affect the validity of the ordinance as a whole or of any portion not adjudged invalid.

Section 8. This ordinance shall be in full force and effect from and after its passage, approval and publication as required by law.

COUNCIL BILL NO. 2007- 138

PASSED: June 5, 2007

APPROVED: _____
Mayor

ATTEST: _____
Deputy City Clerk

APPROVED AS TO FORM:

_____
City Attorney

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MEMORANDUM OF UNDERSTANDING BETWEEN THE CITY OF CHAMPAIGN AND THE ILLINOIS ENVIRONMENTAL PROTECTION AGENCY REGARDING THE USE OF A LOCAL GROUNDWATER OR WATER WELL ORDINANCE AS AN ENVIRONMENTAL INSTITUTIONAL CONTROL

I. PURPOSE AND INTENT

A. This Memorandum of Understanding ("MOU") between the City of Champaign and the Illinois Environmental Protection Agency ("Illinois EPA") is entered into for the purpose of satisfying the requirements of 35 Ill. Adm. Code 742.1015 for the use of groundwater or water well ordinances as environmental institutional controls. The Illinois EPA has reviewed the groundwater or water well ordinance of June 5, 2007 (Attachment A) and determined that the ordinance prohibits the use of groundwater for potable purposes and/or the installation and use of new potable water supply wells by private entities but does not expressly prohibit those activities by the unit of local government itself. In such cases, 35 Ill. Adm. Code 742.1015(a) provides that the unit of local government may enter into an MOU with the Illinois EPA to allow the use of the ordinance as an institutional control.

B. The intent of this Memorandum of Understanding is to specify the responsibilities that must be assumed by the unit of local government to satisfy the requirements for MOUs as set forth at 35 Ill. Adm. Code 742.1015(i).

II. DECLARATIONS AND ASSUMPTION OF RESPONSIBILITY

In order to ensure the long-term integrity of the groundwater or water well ordinance as an environmental institutional control and that risk to human health and the environment from contamination left in place in reliance on the groundwater or water well ordinance is effectively managed, the City of Champaign hereby assumes the following responsibilities pursuant to 35 Ill. Adm. Code 742.1015(d)(2) and (i):

A. The City of Champaign will notify the Illinois EPA Bureau of Land of any proposed ordinance changes or requests for variance at least 30 days prior to the date the local government is scheduled to take action on the proposed change or request (35 Ill. Adm. Code 742.1015(i)(4));

B. The City of Champaign will maintain a registry of all sites within its corporate limits that have received "No Further Remediation" determinations in reliance on the ordinance from the Illinois EPA (35 Ill. Adm. Code 742.1015(i)(5));

C. The City of Champaign will review the registry of sites established under paragraph II. B. prior to siting public potable water supply wells within the area covered by the ordinance (35 Ill. Adm. Code 742.1015(i)(6)(A));

D. The City of Champaign will determine whether the potential source of potable water has been or may be affected by contamination left in place at the sites tracked and reviewed under paragraphs II. B. and C. (35 Ill. Adm. Code 742.1015(i)(6)(B)); and

E. The City of Champaign will take action as necessary to ensure that the potential source of potable water is protected from contamination or treated before it is used as a potable water supply (35 Ill. Adm. Code 742.1015(i)(6)(C)).

NOTE: Notification under paragraph II. A. above or other communications concerning this MOU should be directed to:

Manager, Division of Remediation Management
Bureau of Land
Illinois Environmental Protection Agency
P.O. Box 19276
Springfield, IL 62794-9276

III. SUPPORTING DOCUMENTATION

The following documentation is required by 35 Ill. Adm. Code 742.1015(i) and is attached to this MOU:

A. Attachment A: A copy of the groundwater or water well ordinance certified by the City Clerk or other official as the current, controlling law (35 Ill. Adm. Code 742.1015(i)(3));

B. Attachment B: Identification of the legal boundaries within which the ordinance is applicable (certification by city clerk or other official that the ordinance is applicable everywhere within the corporate limits; if ordinance is not applicable throughout the entire city or village, legal description and map of area showing sufficient detail to determine where ordinance is applicable) (35 Ill. Adm. Code 742.1015(i)(2));

C. Attachment C: A statement of the authority of the unit of local government to enter into the MOU (Council Resolution, code of ordinances, inherent powers of Mayor or other official signing MOU -- attach copies) (35 Ill. Adm. Code 742.1015(i)(1)).

IN WITNESS WHEREOF, the lawful representatives of the parties have caused this MOU to be signed as follows:

FOR: THE CITY OF CHAMPAIGN

BY: _____ DATE: 10-17-08
STEVEN C. CARTER, Its City Manager

APPROVED AS TO FORM:

_____
Assistant City Attorney

FOR: ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

BY: _____ DATE: _____
Manager, Division of Remediation Management
Bureau of Land