DES Waste Management Division
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Project Number: 0000346

OW-5/55R Area In-Situ Geochemical Stabilization Remediation Pilot Test Consent Decree, Docket No. 04-E-0151 Former Koppers Wood Treating Plant Hills Ferry Road, PO Box 3485 Nashua, New Hampshire

NHDES Site #:198708017
Project Type: HAZWASTE

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Report Date:
December 30, 2014

KEY ENVIRONMENTAL INCORPORATED

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December 30, 2014

Mr. Michael McCluskey, P.E.
Department of Environmental Services
Waste Management Division
29 Hazen Drive
Concord, NH 03301-6509

Re: **Consent Decree, Docket No. 04-E-0151**
Beazer East, Inc. Nashua, NH Site DES#198708017

Subject: **OW-5/55R Area In-Situ Geochemical Stabilization Remediation Pilot Test Prepared by Tetra Tech**

Dear Mr. McCluskey:

On behalf of Beazer East, Inc. (Beazer), Key Environmental, Inc. (KEY) hereby provides this report on the OW-5/55R Area In-Situ Geochemical Stabilization Remediation Pilot Test (ISGS Pilot Report) for submittal to the New Hampshire Department of Environmental Services (Department) regarding the Former Koppers Company Inc. Site (Site) (DES# 198708017) located in Nashua, New Hampshire. The ISGS Pilot Report has been prepared by Tetra Tech to provide a summary of the activities and initial results of the ISGS pilot test carried out in November 2014.

If you have any questions, or need additional information regarding this submittal, please call the undersigned at (207) 772-8100.

Sincerely,
Key Environmental, Inc.

Pete Sawchuck, P.E
Project Manager

cc: \ Mr. Michael Bollinger – Beazer
Mr. Mark Lahr – KEY
Mr. James Erickson – Tetra Tech

120 Exchange Street ⬩ Portland, Maine ⬩ 04101 ⬩ (207) 772-8100 ⬩ Fax: (207) 772-8101

OW-5/55R Area In-Situ Geochemical Stabilization Remediation Pilot Test, Former Koppers Company Inc. Site, Nashua, New Hampshire

Version 1
Nashua, New Hampshire

[Status]
December 24, 2014

Prepared on behalf of Beazer East, Inc.

TETRA TECH

APPROVAL

James R. Erickson

12/24/14

________________________________ Date:_________

James R. Erickson
Project Manager for Beazer East, Inc.
Tetra Tech, Inc.

REVISION HISTORY

Version	Date	Description
1	December 24, 2014	Initial Release

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ABBREVIATIONS AND ACRONYMS

bgs	Below Ground Surface
COI	Constituent of Interest
DER	Data Evaluation Report
EPA	Environmental Protection Agency
EVS©	Environmental Visualization System (CTech, 2014)
g $KMnO_4$/kg	Grams of Potassium Permanganate per Kilogram of Dry Soil
gpm	Gallons per Minute
ISGS	*In-Situ* Geochemical Stabilization
msl	Mean Sea Level
NAPL	Non-Aqueous Phase Liquid
pSOD	Permanganate Soil Oxidant Demand
REMOX EC	Sodium Permanganate-Based Reagent
ROI	Radius of Influence
SVOCs	Semi-Volatile Organic Compounds
Site	Former Koppers Site
SBS	Sheetpile Barrier System
TIP	Temporary Injection Point
UIC	Underground Injection Control
VOCs	Volatile Organic Compounds
Workplan	OW-5/55R Area In-Situ Geochemical Stabilization Remediation Pilot Test Workplan, Former Koppers Site, Nashua New Hampshire, Tetra Tech, June 6, 2014

1.0 INTRODUCTION

This report documents the implementation of a pilot test to remediate subsurface non-aqueous phase liquids (NAPLs) at the former Koppers Site (the Site) in Nashua, New Hampshire (Figure 1-1).

The *in-situ* geochemical stabilization (ISGS) demonstration project is partitioned into three phases consisting of the following: 1) Phase I – refine OW-5/55R Characterization; 2) Phase II - ISGS Reagent Injection; and 3) Phase III - Performance Evaluation. Phase I of the ISGS field demonstration project focused on characterization NAPL impacts in the OW-5/55R Area, and consisted of drilling investigative borings with corresponding temporary injection point (TIP) installation. The results of the investigation, boring logs and as-built NAPL recovery well and TIP diagrams were presented in the OW-55/55R area ISGS pilot test workplan (Workplan) (Tetra Tech, 2014).

The approach to the Pilot Test was described in the Workplan and the Key response to New Hampshire Department of Environmental Services (NHDES) comments letter dated October 21, 2014. The Workplan was approved by the NHDES in a letter addressed to Beazer East, dated November 6, 2014. The NHDES temporary groundwater discharge permit, dated November 4, 2014, and the NHDES Workplan approval letter are provided in Appendix D.

1.1 OVERVIEW OF ISGS TECHNOLOGY

The ISGS remediation technology consists of an enhanced permanganate-based reagent (RemOx® EC) that is injected into NAPL impacted zones for the purposes of NAPL treatment, containment/stabilization and solute flux reduction. Silica-based precipitates are deposited around NAPL ganglia and droplets following reagent injection. The precipitate that forms around the NAPL effectively isolates the free-phase NAPL from future migration and groundwater dissolution reactions. In addition to containing the free-phase NAPL, oxidation of dissolved-phase constituents results in a “hardening” or "chemical weathering” of the NAPL as it loses its more labile semi-volatile organic compounds (SVOCs). The deposition of the mineral shell also reduces the overall formation permeability in the treated area, thereby reducing the volumetric flux of upgradient groundwater into and through the impacted area. The ISGS processes reduce organic constituent loading to the groundwater and allow natural-attenuation mechanisms to more effectively degrade dissolved-phase organic constituents downgradient of the treated area. Thus, the remedy will reduce contaminant toxicity, mobility and volume through *in-situ* treatment.

1.2 OBJECTIVES AND APPROACH

1.2.1 OBJECTIVES

The primary objectives of the ISGS injection testing (i.e. pilot test) were to demonstrate and measure the effectiveness of ISGS remedy implementation in the OW-5/55R Area.

The short-term (< 6 months) goal consists of reducing the NAPL recovery volumes in the nearby wells and TIPS, and the long-term goal is the elimination of NAPL seeps along the bank of the Merrimack River.

1.2.2 APPROACH

The approach to the Pilot Test was described in the Workplan (Tetra Tech, 2014). The pilot test was performed in the OW-5/55R area, approximately 250 feet south of the Sheetpile Barrier Wall. The pilot-test area is approximately 45 feet by 75 feet and locations for injection were arranged in a grid-like pattern throughout the pilot-test area.

The pilot test targeted the most highly impacted NAPL areas as identified by lithologic logs from Phase I characterization borings and temporary injection point installations (Key, 2013). The spatial distribution of NAPL was established using the NAPL data collected from the characterization boreholes to create a spatial data set for the relative NAPL saturation. EVS© software (C Tech, 2014) was used to project the relative NAPL saturation in three-dimensions. Targeted injection depths were then based on the resulting projection. Borehole lithology data were entered into the EVS© model to assist with identifying potential lithologic controls on the reagent injections.

A direct-push Geoprobe® rig was used to deliver reagent to the targeted depth intervals using an injection tool specifically designed to perform reagent injection over 2-foot intervals. The injection approach at each of the injection point locations was to start with the deepest target interval, then proceeding to shallower intervals in turn. Most injection locations were advanced to depths between 25 and 32 feet bgs. The previously-installed TIPs were not used for reagent injection.

1.3 SITE DESCRIPTION AND HYDROGEOLOGY

The Site is located in the town of Nashua, on the western shore of the Merrimack River. On either side of the river valley, low hills consist of a mix of outwash-derived gravels, sands, silts and clays overlying a 10 to 15 foot layer of glacial till, which in turn is deposited directly on the crystalline, meta-sedimentary bedrock. The hydrogeology of the Site has been thoroughly characterized over the past 25 years by numerous investigations with the most recent comprehensive investigation described in the DER developed by Key (2011).

1.3.1 TERRACE DEPOSITS

The banks of the Merrimack River at the Site consist of interlayered alluvial silts and sands, collectively termed the terrace deposits. Under saturated conditions, the loosely-packed nature, and lack of clay content of these silts/sands may lead to their hydraulic mobilization, a term referred to as "flowing sands." Flowing sands complicates the installation of wells and TIPSs, as the flowing sands may pass through filter pack material and enter screen/well casings under induced hydraulic gradients or agitation. The terrace deposits have an aggregate thickness ranging from 0 to 40 feet.

Beneath the Site itself, the upper-most layer of material is commonly described as the Fill, and is present with a thickness ranging from approximately 0 to 30 feet. The fill material consists of silts and sands used to level the land surface for wood-treating operations.

1.3.2 GLACIAL TILL AND BEDROCK

A thin layer of glacial till has been found to be present between the terrace deposits and the bedrock at most locations at the Site between 0 to10 feet thick.

The bedrock beneath the glacial deposits consists of meta-sedimentary rocks of Pre-Silurian to early Devonian age. The formation trends southwest-northeast and consists of near-vertically oriented phyllites, granulites, gneisses and schists that are intruded by granodiorite and binary granite (Toppin, 1987).

2.0 PILOT TEST ISGS REMEDY IMPLEMENTATION

The pilot-test was used to determine the effectiveness of ISGS reagent and delivery in order to more effectively implement the full-scale ISGS remedy. The pilot-test location was selected based on the presence of elevated NAPL impacts in this area. The pilot test involved several steps including installation of a set of sentinel piezometers, an initial round of pre-testing observations, reagent injection, and monitoring of the results of the injection.

2.1 SENTINEL PIEZOMETERS

To supplement the existing piezometers (OSPZ-01 and OSPZ-01BR), four additional piezometers were installed for the purposes of monitoring the downgradient lateral extent of injected reagent during the pilot test. Two of the piezometers (PZ-33 and PZ-34) were installed between the intended injection area and the bank of the Merrimack River, and two (OSPZ-02 and OSPZ-03) were installed on the riverbank bench midway between the pilot-test area and the Merrimack River. The locations of these piezometers are shown in Figure 1-1. Installation details and associated lithologic logs for PZ-33 and PZ-34 are included in Appendix A, and construction details for all four piezometers are presented in Table 2-1.

2.2 PRE-TESTING OBSERVATIONS

One of the primary concerns of the NHDES was the potential for reagent to discharge into the Merrimack River. In order to evaluate and mitigate this potential, a number of monitoring wells and piezometers, located between the pilot-test area and river, were monitored for the presence of reagent during and after reagent injections. Prior to implementation of the pilot test, each of the monitoring wells, piezometers and TIPs located between the pilot-test area and the river was “instrumented” with a 1/8-inch diameter cotton rope, weighted to hang at the bottom of the casing. The cotton rope adsorbed the reagent and turned a bright purple color when in contact with reagent. The presence of purple stained rope in wells, piezometers and TIPs were used to determine if reagent was present immediately upgradient of the river, prior to discharging.

The bank of the Merrimack River was inspected several times daily before and during the pilot test for the presence of reagent and/or new NAPL sheens. Prior to the test, two patches of hydrocarbon sheen at the river bank were observed. One was adjacent to the shallow piezometer OSPZ-01, and the second approximately 15 feet north of OSPZ-03. Both sheens were in an area already surrounded by hydrocarbon containment barrier booms.

2.3 PILOT-TEST DESIGN

The initial pilot-test injection point locations presented in the Workplan were based on a triangular grid with approximately 15-foot spacing between injection points (Figure 1-1). The locations of three injection points were changed during the field implementation because the screened intervals for the TIPs intended for injection were blocked. To compensate, additional direct-push injection were performed at locations immediately adjacent to each of the TIPs. The 15-foot grid spacing was based on an anticipated injection radius of approximately 10 feet. The more conservative 15-foot grid spacing was chosen in order to treat areas that lie between the hypothesized cylindrical treatment areas. The 15-foot grid spacing results in circular areas that overlap by approximately 5 feet and helps to ensure that sufficient volumes of reagent are injected to treat both the cylindrical areas and the intervening areas.

The reagent injection volume was based on an assumed average porosity of 15 percent, an estimated average NAPL saturation of 7 percent, and a ROI of 10 feet. The smallest vertical interval treated was limited to 2 feet, the length of the injection tool. Based on the assumptions above, a total of 49.3 gallons of reagent was planned for injection into each 2-foot zone.

The injection tool was advanced to the deepest injection interval with the Geoprobe® rig to start injections at each location; the tool was sequentially raised to inject into shallower zones (i.e. Bottom-to-top injections) until all targeted zones at a specific location were treated. Reagent was injected through the center of the 2-inch ID (2.25-inch OD) drill casing and into the 2-foot long injection tool. Targeted injection intervals are provided in Table 2-2.

The RemOx® EC was mixed in two 200-gallon tanks, based on the volume needed for each successive borehole, immediately prior to injections. One of the challenges with the reagent is ensuring that solids added to the mixture stay in solution. Therefore, the reagent needs to be prepared immediately prior to injection at a particular location to prevent precipitation of the solids prior to injection.

One issue that was anticipated for the pilot-test injections was daylighting (i.e., short circuiting) of the reagent at surrounding TIPs and previously completed injection points. If daylighting was observed via the casing of adjacent TIPs, injection for that interval ceased and the threaded cap on the top of the impacted TIPs were tightened. To minimize the likelihood of daylighting up the casing of monitoring wells, the j-plug well seal used at the top of each well was tightened, or in some cases entirely replaced with a new j-plug prior to injection activities. Any reagent that daylighted at the injection location or nearby TIPs during injection was neutralized with organic-rich content manure. Residual amounts of remaining reagent were neutralized by spraying with a solution consisting of water, vinegar and peroxide.

To prevent potential ISGS reagent daylighting (i.e. flowing vertically upward through the formation and/or injection borehole, and discharging at land surface) the borings were abandoned by backfilling with a cement-bentonite grout. The grout consisted of ASTM Type I Portland cement, powdered bentonite, and potable city water. The grout was placed by retracting the Geoprobe® drill casing and pouring the grout into the open borehole.

2.4 ISGS REAGENT INJECTIONS

ISGS reagent injections were performed in accordance with the Workplan. The pilot test consisted of injecting reagent via 22 direct-push borings (Figure 2-2). The Workplan stated that 18 direct-push borings and 4 TIPs would be used to inject the reagent. Due to a portion of the TIPs being blocked, four injection points were substituted for the TIPs, increasing the total number of direct-push injection borings to 22 (Figure 2-2). The four TIP locations planned for injection (IP13-01, IP13-04, IP13-06 and IP13-07) were not used during the pilot test because the screened interval of the TIPs was obstructed by flowing sands. Additional direct-push injection points (DP-19, DP-20, DP-21 and DP-22) were added in the field to address NAPL impacts in the area of the TIPs. Injections were performed over a 3-day period (November 11 to 13, 2014). Proposed versus actual injection zones and reagent volumes are provided in Table 2-2. A summary report prepared by the injection contractor is provided in Appendix B. Appendix C shows individual injection point injection intervals, volumes, and reagent flow rates.

With one exception, the reagent volume was successfully injected into all of the targeted injection intervals. In DP-7, the depth interval from 29-31 feet would not accept reagent. The tool was raised 2 feet (27-29 feet), and the injection volume for this interval was doubled (100 gallons) to provide sufficient reagent to treat the 4-foot zone (27-31 feet). A total of 2,985 gallons of reagent was injected into the pilot test area.

Direct-Push Injections

The direct-push method successfully delivered reagent at all of the 22 direct-push injection locations. An adjustment was made in the field to increase the injection interval for some zone by 1 foot to allow for equal 2-foot injection intervals. As a result, the targeted depth intervals for ten of the locations (DP-1, DP-5, and DP-12 through DP-18) were increased by 1 foot.

The injection methodology used by the contractor involved an initial burst of air under pressure designed to develop injection pathways. This pressure was typically between 130 and 150 psi until a significant line-pressure drop was observed, followed by reagent injection. The objective of this step is to open pathways for the reagent to follow. The injection pressures required to maintain reagent flow was typically 35 to 40 psi; however, in a few cases injection pressures of approximately 50 psi were required.

Flow rates are directly related to injection pressures. Increasing the injection pressure, typically results in increased reagent flow rates for a specific zone. An attempt was made to keep flow rates under 10 gal/min. Initially flow rates were over 10 gal/min, but reducing injection pressures from 40 to 35 psi generally reduced the rates to below this threshold. Flow rates varied from 6 to 15 gal/min. Following reagent injection, water was flushed through the injection hose and casing to clear them of reagent. A short burst of high-pressure air was then injected into the hose and casing to remove the water and residual reagent from the injection string. Further details on the injection technique are provided in Appendix B.

The following is a description of the injection activities performed in each of the direct-push borings. A summary of the planned and performed injection volumes, depth intervals and rates is provided in Table 2-2. Additional detailed information for each of the injection points is provided in the field logs of Appendix C.

Direct-Push Location DP-1

This direct-push injection point was designated to receive 123 gallons of reagent in 5 linear feet of borehole (Table 2-2). A total of 148.5 gallons of reagent was injected into 6 linear feet in three depth intervals (25-27 ft; 27-29 ft; and 30-32 ft bgs) each at a liquid injection pressure of 40 psi. Injection rates ranged from 10 to 17 gal/min.

Direct-Push Location DP-2

This direct-push injection point was designated to receive 99 gallons of reagent in 4 linear feet of borehole (Table 2-2). A total of 99 gallons of reagent was injected into two depth intervals (29-31 ft; and 31-33 ft bgs) each at a liquid injection pressure of 40 psi. Injection rates ranged from 5 to 12.5 gal/min.

Direct-Push Location DP-3

This direct-push injection point was designated to receive 99 gallons of reagent in 4 linear feet of borehole (Table 2-2). A total of 99 gallons of reagent was injected into two depth intervals (29-31 ft; and 31-33 ft bgs) at a liquid injection pressures of 40 and 35 psi, respectively. Injection rates ranged from 6.5 to 16.5 gal/min.

Direct-Push Location DP-4

This direct-push injection point was designated to receive 49.5 gallons of reagent in 2 linear feet of borehole (Table 2-2). Due to miscommunication in the field, a total of 99 gallons rather than 49.5 gallons of reagent were injected into the depth interval from 29-31 ft bgs. Injection was performed using a pressure of 40 psi, resulting in an injection rate of 12.5 gal/min.

Direct-Push Location DP-5

This direct-push injection point was designated to receive 123 gallons of reagent in 5 linear feet of borehole (Table 2-2). A total of 148.5 gallons of reagent was injected into 6 linear feet in three depth intervals (25-27 ft; 27-29 ft; and 30-32 ft bgs) each at a liquid injection pressure of 40 psi, receiving approximately 49.5 gallons. Injection rates ranged from 10 to 12.5 gal/min.

Direct-Push Location DP-6

This direct-push injection point was designated to receive 148.5 gallons of reagent in 6 linear feet of borehole (Table 2-2). A total of 187.5 gallons of reagent was injected into 6 linear feet in three depth intervals (24-26 ft; 26-28 ft; and 30-32 ft bgs) each at a liquid injection pressure of 35 psi, receiving approximately 62.5 gallons. Injection rates ranged from 5 to 15.6 gal/min.

Direct-Push Location DP-7

This direct-push injection point was designated to receive 247 gallons of reagent in 8 linear feet of borehole (Table 2-2). A total of 250 gallons of reagent was injected into 6 linear feet in three depth intervals (25-27 ft; 27-29 ft; and 31-33 ft bgs) each at a liquid injection pressure of 35 psi. Originally the depth interval from 29-31 ft bgs had been targeted for injection, but flow could not be established. When greater than 180 psi pressure was determined to be insufficient to clear the blockage, the tool was retracted 2 feet, and injection resumed. The volume for the interval was doubled to include that intended for the lower, blocked interval. The injection rate was approximately 10 gal/min in each interval.

Direct-Push Location DP-8

This direct-push injection point was designated to receive 148.5 gallons of reagent in 6 linear feet of borehole (Table 2-2). A total of 187.5 gallons of reagent was injected into 6 linear feet in three depth intervals (25-27 ft; 29-31 ft; and 31-33 ft bgs) each at a liquid injection pressure of 35 psi. Injection rates ranged from 8 to 10 gal/min.

Direct-Push Location DP-9

This direct-push injection point was designated to receive 99 gallons of reagent in 4 linear feet of borehole (Table 2-2). A total of 125 gallons of reagent was injected into two depth intervals (29-31 ft; and 31-33 ft bgs) each at a liquid injection pressure of 40 psi. Injection rates ranged from 9 to 10.5 gal/min.

Direct-Push Location DP-10

This direct-push injection point was designated to receive 99 gallons of reagent in 6 linear feet of borehole (Table 2-2). A total of 99 gallons of reagent was injected into two depth intervals (29-31 ft; and 31-33 ft bgs) each at a liquid injection pressure of 40 psi. Injection rates ranged from 5 to 16 gal/min.

Direct-Push Location DP-11

This direct-push injection point was designated to receive 148.5 gallons of reagent in 6 linear feet of borehole (Table 2-2). Originally planned for two 3-foot intervals (25-27 ft; 27-28 ft; 30-32 ft; and 32-33 ft bgs), the injection pattern was adjusted in the field due to the 2-foot length of the injection tool. A total of 148.5 gallons of reagent was injected into 6 linear feet in three depth intervals (26-28 ft; 28-30 ft; and 30-32 ft bgs) each at a liquid injection pressure of 30 psi. Injection rates ranged from 7 to 10 gal/min.

Direct-Push Location DP-12

This direct-push injection point was designated to receive 148.5 gallons of reagent in 6 linear feet of borehole (Table 2-2). Originally planned for a two 3-foot intervals (25-27 ft; 27-28 ft; 30-32 ft; and 32-33 ft bgs), the injection pattern was adjusted in the field due to the 2-foot length of the injection tool. A total of 148.5 gallons of reagent was injected into 6 linear feet in three 2-foot depth intervals (25-27 ft; 29-31 ft; and 31-33 ft bgs) each at a liquid injection pressure of 35 psi. Injection rates ranged from 6 to 8 gal/min.

Direct-Push Location DP-13

This direct-push injection point was designated to receive 148.5 gallons of reagent in 6 linear feet of borehole (Table 2-2). Originally planned for a two 3-foot intervals (25-27; 27-28; 30-32; and 32-33 ft bgs), the injection pattern was adjusted in the field due to the 2-foot length of the injection tool. A total of 125 gallons of reagent was injected into two depth intervals (26-28 ft; and 31-33 ft bgs) each at a liquid injection pressure of 35 psi. Injection rates ranged from 8 to 9 gal/min.

Direct-Push Location DP-14

This direct-push injection point was designated to receive 74 gallons of reagent in 3 linear feet of borehole (Table 2-2). Originally planned for a 3-foot interval from 25-28 ft bgs, the injection pattern was adjusted in the field due to the 2-foot length of the injection tool. A total of 99 gallons of reagent was injected into two depth intervals (26-28 ft; and 31-33 ft bgs), the upper interval at a liquid pressure of 40 psi, and the lower interval at a liquid injection pressure of 25 psi. Injection rates ranged from 5 to 7 gal/min.

Direct-Push Location DP-15

This direct-push injection point was designated to receive 123 gallons of reagent in 5 linear feet of borehole (Table 2-2). Originally planned for a 5-foot interval from 27-32 ft bgs, the injection pattern was adjusted in the field due to the 2-foot length of the injection tool. A total of 148.5 gallons of reagent was injected into three depth intervals (26-28 ft; 28-30ft; and 30-32 ft bgs), the upper interval at a liquid pressure of 25 psi, and the lower two intervals at a liquid injection pressure of 40 psi. Injection rates ranged from 6 to 12 gal/min.

Direct-Push Location DP-16

This direct-push injection point was designated to receive 49.5 gallons of reagent in 2 linear feet of borehole (Table 2-2). A total of 49.5 gallons of reagent was injected into the depth interval from 29-31 ft bgs. Injection was performed using a pressure of 40 psi, resulting in an injection rate of 12.5 gal/min.

Direct-Push Location DP-17

This direct-push injection point was designated to receive 74 gallons of reagent in 3 linear feet of borehole (Table 2-2). Originally planned for a 3-foot interval from 25-28 ft bgs, the injection pattern was adjusted in the field. A total of 99 gallons of reagent was injected into two depth intervals (26-28 ft; and 30-32 ft bgs), at a liquid injection pressure of 35 psi and an injection rate of 8 gal/min. The lower interval had not been originally planned, but was added based on proximity to IP13-06 where NAPL had been previously identified in that depth range.

Direct-Push Location DP-18

This direct-push injection point was designated to receive 74 gallons of reagent in 3 linear feet of borehole (Table 2-2). Originally planned for a 3-foot interval from 25-28 ft bgs, the injection pattern was adjusted in the field. A total of 99 gallons of reagent was injected into two depth intervals (24-26 and 26-28 ft bgs). Injection rates ranged from 6 to 7 gal/min.

Direct-Push Location DP-19

This direct-push injection point was conducted as a replacement for TIP IP13-06, whose screened interval in the depth range associated with NAPL impacts was blocked by sand. The injection intervals were selected in the field to correspond to the impacted intervals of IP13-06 (26-28 ft and 30-32 ft bgs). A total of 125 gallons of reagent was injected into the two depth intervals at a liquid pressure of 35 psi resulting in an injection rate of approximately 10 gal/min.

Direct-Push Location DP-20

This direct-push injection point was conducted as a replacement for TIP IP13-01, whose screened interval in the depth range associated with NAPL impacts was blocked by sand. The injection intervals were selected in the field to correspond to the impacted intervals of IP13-01 (25-27 ft, 30-32 ft, 32-24 ft, and 36-38 ft bgs). A total of 250 gallons of reagent was injected into these four depth intervals at a liquid pressure of 35 psi resulting in an injection rate of approximately 9 - 10 gal/min.

Direct-Push Location DP-21

This direct-push injection point was conducted as a replacement for TIP IP13-04, whose screened interval in the depth range associated with NAPL impacts was blocked by sand. The injection intervals were selected in the field to correspond to the impacted intervals of IP13-04 (25-27 ft and 31-33 ft bgs). A total of 125 gallons of reagent was injected into the two depth intervals at a liquid pressure of 35 psi resulting in an injection rate of approximately 9 gal/min.

Direct-Push Location DP-22

This direct-push injection point was conducted as a replacement for TIP IP13-07, whose screened interval in the depth range associated with NAPL impacts was blocked by sand. The injection intervals were selected in the field to correspond to the impacted intervals of IP13-07 (26-28 ft and 28-30 ft bgs). A total of 125 gallons of reagent was injected into the two depth intervals at a liquid pressure of 35 psi resulting in an injection rate of approximately 8 to 9 gal/min. During injection, leakage reagent was observed to daylight from the under the cap on IP13-07, which was tightened to stop the flow.

2.5 FORMATION PRESSURIZATION FROM REAGENT INJECTION

Periodic water-level monitoring was performed during reagent injections to provide qualitative information on formation pressures. Water-level measurements were conducted at all sentinel piezometers prior to and during injections.

The water-level monitoring during the pilot test demonstrated that reagent injections temporarily pressurize the targeted treatment zones enough to raise water levels 2 to 3 feet at a distance of 15 to 20 feet from a direct-push injection location. This monitoring demonstrated that increased formation pressures will necessitate the use of tight fitting caps for all TIPs and well casings prior to full-scale injections.

2.6 PILOT-TEST REAGENT MIGRATION OBSERVATIONS

A cotton rope was suspended in each of the piezometers, and two of the TIPs located between the pilot-test area and the Merrimack River to monitor for reagent intrusion. During the pilot test, observations were recorded multiple times per day to provide an indication of lateral movement of reagent toward the river.

Reagent was not detected in any of the sentinel piezometers during the pilot test, indicating that the reagent did not migrate to within approximately 30 feet of the river. During the pilot test, it was observed that the TIP IP13-02 became blocked with a sand plug to a depth of approximately 4 feet bgs. This prevented monitoring during injections at this observation point.

2.7 RIVERBANK MONITORING

The Merrimack River bank was monitored throughout the pilot test to ensure that reagent was not reaching the river. At no time was reagent seen along the riverbank or in the water or sediment immediately adjacent to the riverbank.

3.0 POST-INJECTION EVALUATION

Following the performance of reagent injection activities, an evaluation of the status of the pilot-test area TIPs and monitoring wells was performed. A summary of this evaluation is provided below.

3.1 POST-TESTING OBSERVATIONS

Immediately following injection activities, each TIP and piezometer between the pilot-test area and the river was evaluated to document the presence of reagent. Reagent was observed in a number TIPs in close proximity to the injection locations (Figure 2-2). Sand plugs displaced up the casing during the pre-treatment air injections prevented the observation of reagent in IP13-02 and IP13-06. Although OW-5, OW-55R and OW-56 were not included in this initial evaluation round, reagent was observed to briefly daylight and flow from the top of casing in OW-55R prior to tightening of the well seal.

On November 14, 2014 (one day after completion of pilot-testing activities) a round of NAPL and reagent monitoring was performed at each of the TIPs and monitoring wells. During this monitoring event, the depth to water and total well/TIP depths were also measured. NAPL was observed in IP13-04, however flowing sands appear to have partially blocked the injection point to a depth of 13.4 ft bgs. NAPL was also observed in IP13-05 and OSPZ-01. Reagent was observed in monitoring well OW-56; however, NAPL was not detected. NAPL was not observed in monitoring well OW-55R; however, the well was obstructed by sludge-like material (reacted reagent) above the well screen. Reagent was not observed in any of the sentinel piezometers during this monitoring event.

In several cases, a sand plug was observed in TIPs at or near land surface immediately following the injection. During the November 14, 2014 monitoring event, the depth to the sand plug in two TIPs (IP13-10 and -11) was observed to have fallen to 13.58 and 16.19 feet, respectively. This apparent post-injection blockage is believed to be due to a sand plug in the screened interval being pushed up the casing during pre-treatment of the formation with a burst of high-air pressure.

3.2 NAPL MONITORING AND RECOVERY

On December 16, 2014 KEY Environmental performed well re-development on monitoring wells OW-55R and OW-56. In each well, water was injected to break up the sludge, then a mixture of water and sludge was pumped from the well in a volume greater than that injected. Approximately 8 gallons of water were injected into OW-55R, followed by the removal of 12 gallons of water/reagent mix. In OW-56, 24 gallons of water were added, and 32 gallons were removed. Each of the wells was cleared of the blockage to its originally installed depth. In the process, reacted and non-reacted reagent present in each of the casings was also cleared. Liquid from each of the wells was described as pinkish-black in color post-development (written communication, Key Environmental, December 12, 2014).

Prior to pilot-test activities, NAPL monitoring and recovery had been performed on a regular schedule for the TIPs and monitoring wells. These data have previously been presented in the Workplan and are not presented again here. NAPL monitoring and recovery events are scheduled to be resumed on a monthly basis following planned redevelopment activities for the TIPs.

In addition to NAPL thickness monitoring and recovery, as part of the evaluation of the effectiveness of the pilot test, confirmatory soil cores are planned. As documented in the Workplan, a minimum of six geologic cores will be collected to qualitatively evaluate reagent distribution and contact with NAPL zones. These cores will be collected approximately 3 months following ISGS reagent injection activities, in accordance with the Workplan.

4.0 PRE-FINAL FULL-SCALE REMEDIATION DESIGN

The primary objective of the ISGS pilot-test injections was to determine the effectiveness of ISGS reagent performance and injection methods in order to more effectively implement the full-scale ISGS remedy. The results and lessons learned will be used to design the full-scale remediation and streamline field implementation.

The following is a summary of lessons learned during the pilot test:

- An assumed 10-foot radius for reagent injection appears reasonable;
- Reagent did not extend beyond the projected treatment zone; and was not observed in TIPs or piezometers between the treatment zone and river. The radius of influence resulting from this pilot test can be used in developing plans to monitor and prevent or control potential reactant flow into the river;
- Injection pressures of 35 to 40 psi, with flow rates of 6 to 10 gal/min appears reasonable for the alluvial deposits at the Site;
- Approximately 5 to 6 injection points can be performed daily with one rig; a higher production rate can be achieved with multiple rigs;
- The method of manually recording tank volumes proved effective for monitoring injected reagent volumes;
- The reagent mixing process was effective. A temporary structure will be erected on-Site to accommodate mixing for full-scale implementation;
- A cement/bentonite grout is effective at sealing the borehole after injection.
- The potential for short circuiting (i.e., daylighting) of ISGS reagent exists for wells, TIPs, and infrastructure foundations and pathways. All TIPs and monitoring wells will be capped prior to full-scale injections to prevent short-circuiting of groundwater and reagent via these pathways. Tight seals on all wells within 15 to 20-ft radius of injection location should be confirmed, and ensure that well vaults with locking lids are closed tightly to prevent risk of j-plug being expelled under formation pressure. In addition, containment and neutralization solution will be use in the event of reagent daylighting during injections.

5.0 REFERENCES

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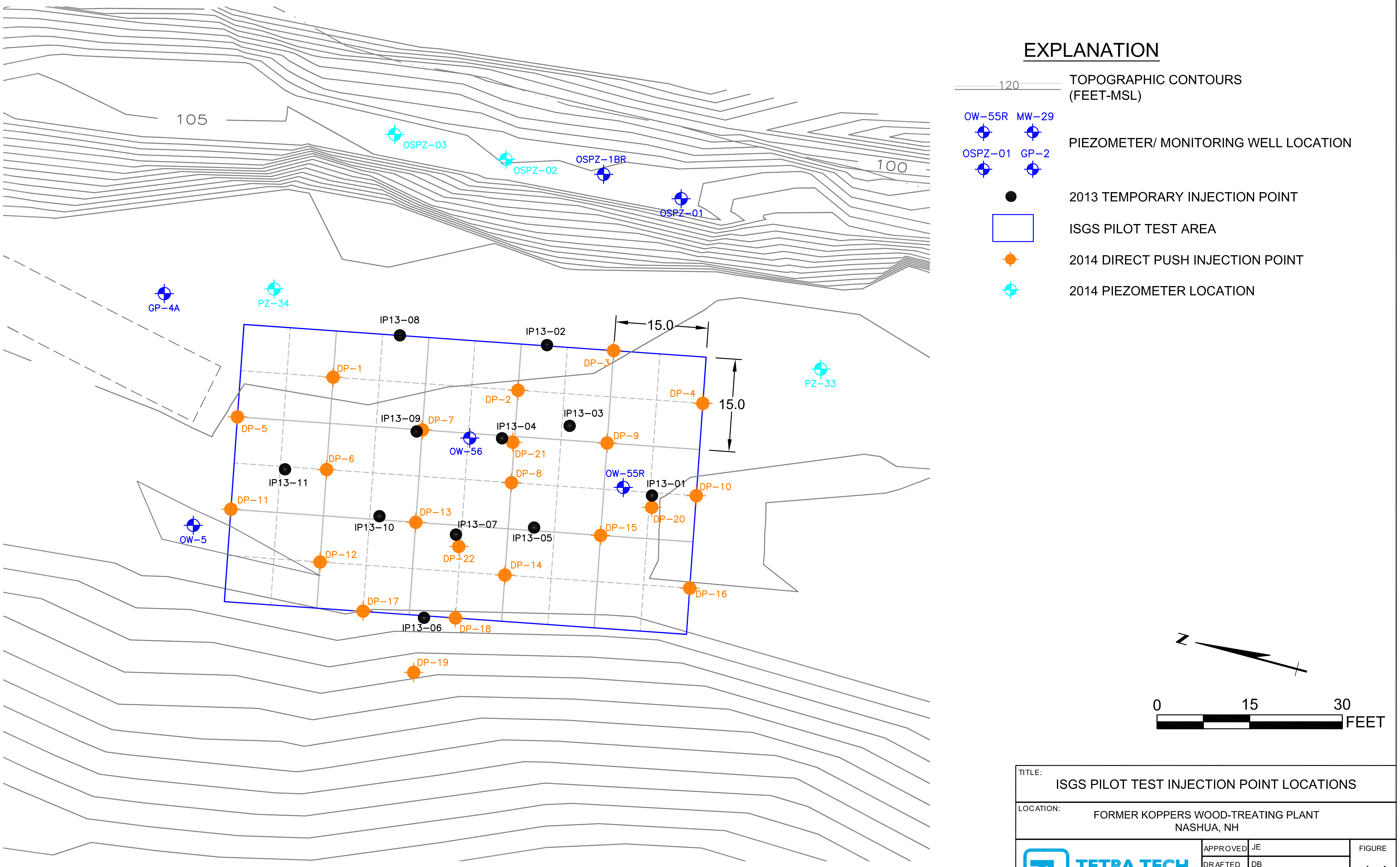
Koteff, Carl, 1976, Surficial geologic map of the Nashua North quadrangle, Hillsborough and Rockingham Counties, New Hampshire. U.S. Geological Survey Geologic Quadrangle Map GQ-1290, http://ngmdb.usgs.gov/Prodesc/proddesc_10825.htm

Toppin, K.W., 1987, *Hydrogeology of stratified-drift aquifers and water quality in the Nashua Regional Planning Commission area, south-central New Hampshire*: U.S. Geological Survey Water-Resources Investigations Report 86-4358, 45 p., 6 pls.

Tetra Tech, 2014 "*OW-5/55R Area In-Situ Geochemical Stabilization Remediation Pilot Test Workplan, Former Koppers Site, Nashua New Hampshire*", June 25, 2014; revised October 20, 2014.

FIGURES



TITLE:

ISGS PILOT TEST INJECTION POINT LOCATIONS

LOCATION:

FORMER KOPPERS WOOD-TREATING PLANT
NASHUA, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	DB	1-1
PROJECT#	117-2201294	
DATE	10/17/14	

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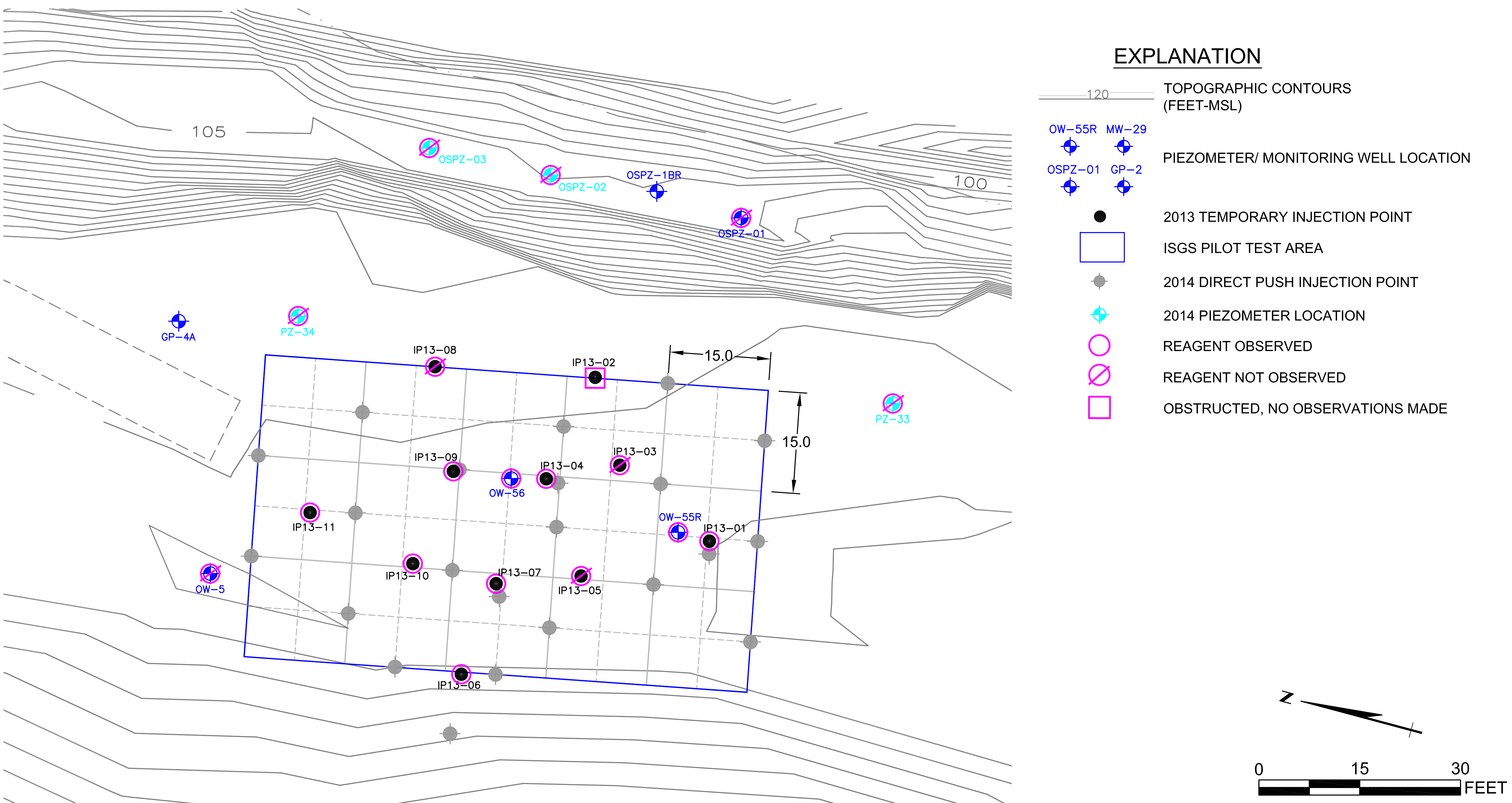

TITLE:
POST-PILOT TEST REAGENT OBSERVATIONS

LOCATION:
FORMER KOPPERS WOOD-TREATING PLANT
NASHUA, NH

TETRA TECH

APPROVED JE
DRAFTED DB
PROJECT# 117-2201294
DATE 10/17/14

FIGURE
2-1

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TABLES

Table 2-1. Sentinel Piezometer Construction Details

Piezometer	Northing	Easting	Diameter	TOC (ft amsl)	Stick-up Length (ft)	Screened Interval (ft bgs)	Screen Construction	Piezometer bottom (ft bgs)
PZ-33	104474.56	1040370.85	1-inch	121.02	0.54	23 - 33	Pre-packed 20-slot PVC	33
PZ-34	104562.24	1040362.95	1-inch	120.42	0.57	23 - 33	Pre-packed 20-slot PVC	33
OSPZ-02	104529.85	1040386.44	1-inch	106.35	2.17	7.0 -17.0	SS; 15-slot	17.5
OSPZ-03	104547.65	1040388.12	1-inch	106.04	2.16	7.2 - 17.2	SS; 15-slot	17.7

Notes:

Survey coordinates are reported as New Hampshire State Plane (NAD 83)

TOC = Top of casing

ft = feet

amsl = above mean sea level (NAVD 88)

bgs = below ground surface

N/A = Not Available

Table 2-2. Comparison of Targeted and Actual Injection Volumes For Pilot Test

Direct-Push Injection Point	Target Volume Injected (gal)	Actual Volume Injected (gal)	Difference (gal)
DP-1	123	149	25
DP-2	99	99	0
DP-3	99	99	0
DP-4	49	99	50
DP-5	123	149	25
DP-6	148	188	39
DP-7	197	250	53
DP-8	148	188	39
DP-9	99	125	26
DP-10	99	99	0
DP-11	148	149	0
DP-12	148	149	0
DP-13	148	125	-23
DP-14	74	99	25
DP-15	123	149	25
DP-16	49	49	0
DP-17	74	99	25
DP-18	74	99	25
Totals	**2,023**	**2,360**	**337**

Temporary Injection Points	Target Volume Injected (gal)	Actual Volume Injected (gal)	Difference (gal)
IP13-01[2]	247	0	-247
DP-20[1]	0	250	250
IP13-04[2]	247	0	-247
DP-21[1]	0	125	125
IP13-06[2]	247	0	-247
DP-19[1]	0	125	125
IP13-07[2]	247	0	-247
DP-22[1]	0	125	125
Totals	**987**	**625**	**-362**

Overall	**3,010**	**2,985**	**-25**

[1] New Injection Points added in field

[2] Injection Point not used

APPENDIX A

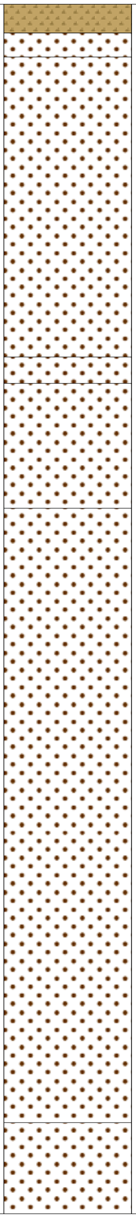
LITHOLOGIC LOGS AND AS-BUILT DIAGRAMS FOR PZ-33 AND PZ-34

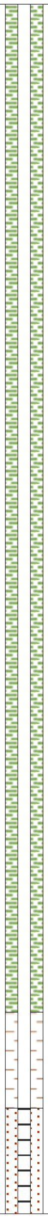
KEY ENVIRONMENTAL INCORPORATED

BOREHOLE LOG: PZ-33

DATE DRILLED: 10/17/2014

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: NASHUA	DRILLING CO: NE BORING
SITE LOCATION: NASHUA, NH	DRILLER: Carl Downing
PROJECT NO: 13694-01	DRILLING RIG: 6610 GEOPROBE
FIELD GEOLOGIST: K BROSSEAU	DRILLING METHOD: GEOPROBE
PROJECT MANAGER: P. SAWCHUCK	SAMPLING METHOD: DIRECT PUSH
	TOTAL DEPTH: 33





Depth (ft-bgs)	Lithol Log	Sample Description		Recov	PID	Graphical Completion Log	Completion Description
0		Dark brown topsoil, dry					
1		2.5Y 5/4 lt olive brown f to m SAND, dry					
2				3.7	0		
3							
4		10 YR 6/6 yellowish brown vf SAND, some silt, dry					
5							
6							
7				3.6	0		
8		10 YR 6/4 light yellowish brown, f to m SAND, some silt, dry.					
9		10 YR 4/6 dk yellowish brown poorly sorted SAND with some semi rounded gravel, dry					
10							
11							
12				4.2	0		
13							
14							1" PVC Riser
15							
16		2.5Y 7/4 pale yellow, f SAND, some silt, silty seams 12.63'-13.85', clayey seams 18.65', moist at 18.3'. Oxidized banding.					
17				4.2	0		Cement Grout
18							
19							
20							
21							Bentonite
22				4.4	0		
23							
24							
25							

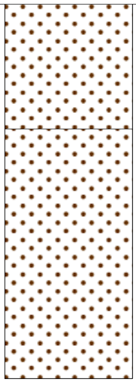
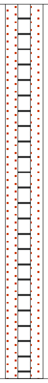
NOTES: DRAFT

KEY ENVIRONMENTAL INCORPORATED

BOREHOLE LOG: PZ-33

DATE DRILLED: 10/17/2014

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: NASHUA	DRILLING CO: NE BORING
SITE LOCATION: NASHUA, NH	DRILLER: Carl Downing
PROJECT NO: 13694-01	DRILLING RIG: 6610 GEOPROBE
FIELD GEOLOGIST: K BROSSEAU	DRILLING METHOD: GEOPROBE
PROJECT MANAGER: P. SAWCHUCK	SAMPLING METHOD: DIRECT PUSH
	TOTAL DEPTH: 33

Depth (ft-bgs)	Lithol Log	Sample Description		Recov	PID	Graphical Completion Log	Completion Description
26 27		2.5Y 5/4 lt olv brown to 5Y4/2 olv grey, vf SAND some silt, slight odor, sheen 27.65'-27.8'		3.7	0		Pre-Packed 10' 20-slot 1" PVC screen
28 29 30 31 32 33		5Y 4/3 olive, vf SAND tr silt, odor, 1/8" NAPL seam at 27.8, sheen to 28.2', no odor 31.3', bottom 5Y 5/1 olv gry		2.4	0		

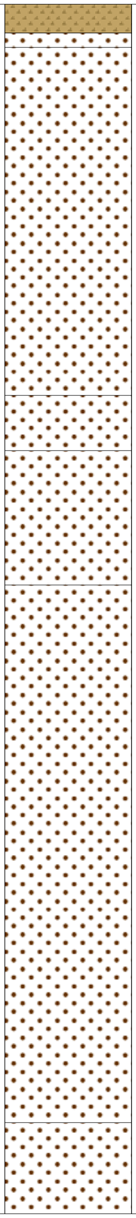
NOTES: DRAFT

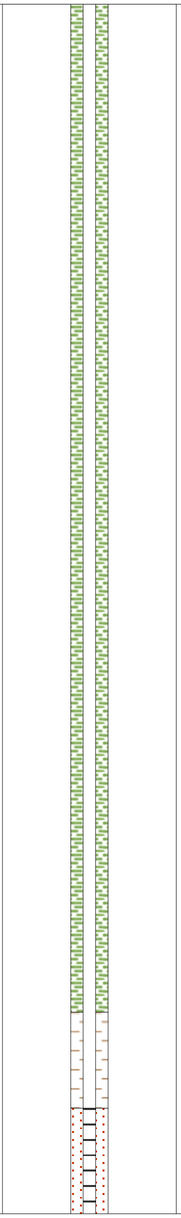
KEY ENVIRONMENTAL INCORPORATED

BOREHOLE LOG: PZ-34

DATE DRILLED: 10/17/2014

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: NASHUA	DRILLING CO: NE BORING
SITE LOCATION: NASHUA, NH	DRILLER: Carl Downing
PROJECT NO: 13694-01	DRILLING RIG: 6610 GEOPROBE
FIELD GEOLOGIST: K BROSSEAU	DRILLING METHOD: GEOPROBE
PROJECT MANAGER: P. SAWCHUCK	SAMPLING METHOD: DIRECT PUSH
	TOTAL DEPTH: 33





Depth (ft-bgs)	Sample Description	Recov	PID	Completion Description
0	2.5Y 4/3 olv brown vf SAND, some silt, topsoil upper 0.3', dry			
1	2.5Y 6/3 lt yellowish brown vf SAND tr silt, dry			
2		3.45	0	
3				
4	10YR 6/6 yellowish brown vf SAND some silt, dry			
5				
6				
7		3.6	0	
8	2.5Y 5/6 ly olv brown poorly srtd SAND some gravel, dry			
9				
10	2.5Y 4/2 lt grey vf SAND, little silt dry			
11				
12		4.2	0	
13				
14				1" PVC Riser
15				
16				
17	2.5Y 4/2 lt grey, orange oxidation banding throughout, f SAND little silt, thin silty seams 22.85'-22.9'	3.1	0	Cement Grout
18				
19				
20				
21				Bentonite
22		4.15	0	
23				
24				
25	5Y 5/2 olv grey vf SAND little silt,			

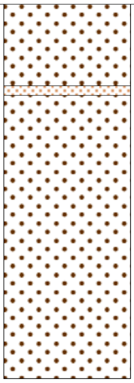
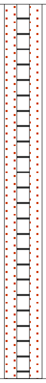
NOTES: DRAFT

ENVIRONMENTAL INCORPORATED

BOREHOLE LOG: PZ-34

DATE DRILLED: 10/17/2014

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: NASHUA	DRILLING CO: NE BORING
SITE LOCATION: NASHUA, NH	DRILLER: Carl Downing
PROJECT NO: 13694-01	DRILLING RIG: 6610 GEOPROBE
FIELD GEOLOGIST: K BROSSEAU	DRILLING METHOD: GEOPROBE
PROJECT MANAGER: P. SAWCHUCK	SAMPLING METHOD: DIRECT PUSH
	TOTAL DEPTH: 33

Depth (ft-bgs)	Lithol Log	Sample Description		Recov	PID	Graphical Completion Log	Completion Description
		running sands					
26							Pre-Packed 10'
27		5Y 4/2 olv grey SILT some clay, NAPL odor					
28				3.85	0		20-slot 1" PVC screen
29							
30		5Y 5/2 olv grey to 5Y 5/1 grey, f to m SAND, some silt					
31				2.3	0		
32							
33							

NOTES: DRAFT

APPENDIX B

IET TECHNOLOGY DISCUSSION AND FIELD REPORT

IET

Innovative Environmental Technologies, Inc.

Technology discussion and Field Report

to

Tetra Tech

For

The Application of
In-Situ Geochemical Stabilization (ISGS)

At

Former Beazer Facility
2 Hills Ferry Road
Nashua, NH 03064

November 2014

Innovative Environmental Technologies, Inc.
6151 Kellers Church Road
Pipersville, PA 18947
(888) 721-8283

EXECUTIVE SUMMARY

On behalf of Tetra Tech, Innovative Environmental Technologies, Inc. (IET) has prepared the following injection report. This report has been prepared to document injection activities conducted at the former Koppers Company Inc. site located in Nashua, NH. The remediation field test pilot program was implemented between November 11th, 2014 and November 13th, 2014. IET implemented a geochemical stabilization technology in order to decrease and immobilize non-aqueous phase liquid (NAPL) that has been historically present from approximately 24-38' below ground surface (bgs) and to obtain information for the full scale design of the geochemical stabilization remedy.

IET completed 22 direct push injection locations in the area proposed and injected 2,985 gallons of a 4.5% In-Situ Geochemical Stabilization (ISGS) solution. Consisting of the following materials: of 40% $NaMnO_4$, 37.5% Na_2SiO_3, Ferrous Carbonate, and Calcium Chloride across the site. These components were systematically mixed into a low viscosity, injectable fluid. In the subsurface, the injected fluid will dehydrate and encapsulate partially oxidized NAPL and contaminated soil particles within silica beads. Slight field modifications were made to the proposed pilot design during the implementation period. These changes included the addition of injection intervals, volume augmentation and direct push injection relocation. Additionally the temporary injection points: IP13-01, IP13-04, IP13-06, and IP13-07 were replaced with direct push injections. No instances of surfacing were encountered in the injection area or along the Merrimack River.

A detailed description of each injection can be viewed in the attached field logs in Appendix 2. Liquid pressures ranging from 35-40 psi, with a maximum of 50 psi were utilized to deliver the ISGS solution into the targeted soils.

INTRODUCTION

The former Koppers Company Inc. site, located in Nashua, NH, was identified by Tetra Tech, the consulting engineer, as having soils and groundwater impacted by the historical release of Cresote derived NAPL. An injection program was proposed by IET for the immobilization of NAPL at the site utilizing ISGS technologies.

INJECTION PROCEDURES

IET completed a total of 51 injections at the Beazer site. Injection logs are provided in Appendix 2.

Direct-Push-Driven Perforated Rod Placement

A GeoProbe 6610 (pictured below), was utilized to drive a retractable screen to depths ranging from 24 to 38' bgs.

Figure 1: GeoProbe 6610

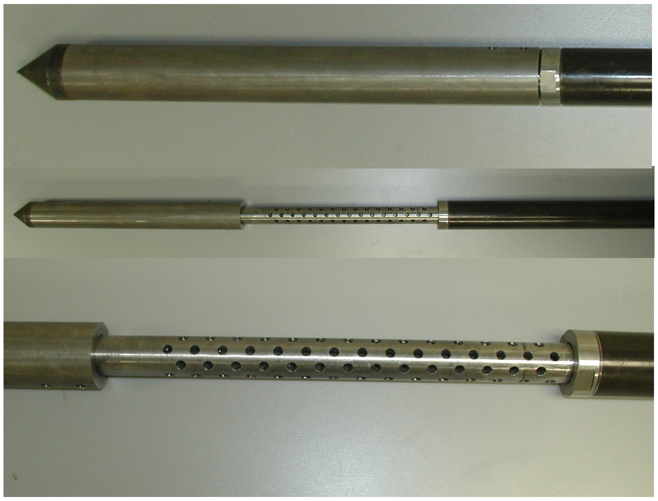


Figure 2: IET Retractable Injection Screen

Injection Technique

Subsurface Pathway Development

Compressed air was used to propel all injectants into the subsurface. Compressed air was first injected into the subsurface at approximately 150 pounds per square inch (psi) until a significant pressure drop was observed at the injection pressure vessel. This process is referred to as pre-injection pathway development. The intent of this step is to open pathways in the subsurface for the injectants to follow. These pathways are believed to be those more permeable pathways along which NAPL residues are more likely to be present. Liquid and liquid-entrained injectants are then delivered into the pathways that were produced during this step.

ISGS Injection

A 4.5% ISGS solution is injected at approximately 35 psi over two foot intervals, within the targeted zone 24-38' bgs. ISGS utilizes modified sodium permanganate ($NaMnO_4$) for in-situ management of NAPL. The ISGS reagents react with organic (and certain inorganic) constituents of interest (COIs) present as soil residuals (e.g., NAPL or ganglia). Various reactions associated with ISGS processes serve to physically encrust NAPL and rapidly reduce aquifer permeability, thereby stabilizing NAPL residuals and accelerating remediation by natural attenuation of dissolved phase COI/plume constituents.

Rinse

Approximately ten gallons of water was injected to clear the injection lines of any residual liquids.

Post Injection Line Purge

Compressed air was injected to clear the lines of remedial liquids at approximately 50 psi before moving to the next injection.

PILOT AREA

Various intervals were targeted across the 4,900 sq.ft. injection area. This area was completed using 22 direct push injection points. No issues of surfacing were encountered during the implementation of the design. Slight pressure build up was noted from several of the one inch PVC temporary wells within the injection area but these pressures dissipated as the pressure of the subsurface dissipated. Originally four of the temporary points were proposed injection points but after applying slight air pressure it was discovered that the screens of these points were clogged with native soils prior to the start of injection activities. Overall, the proposed amount of 4.5% ISGS solution was injected at the appropriate depths across the area without issue. The injection locations are pictured below in Figure 3. A description of each injection point can be viewed in the field logs attached in Appendix 2. This description includes start and end times for each injection, injection pressures, volumes, and targeted vertical.

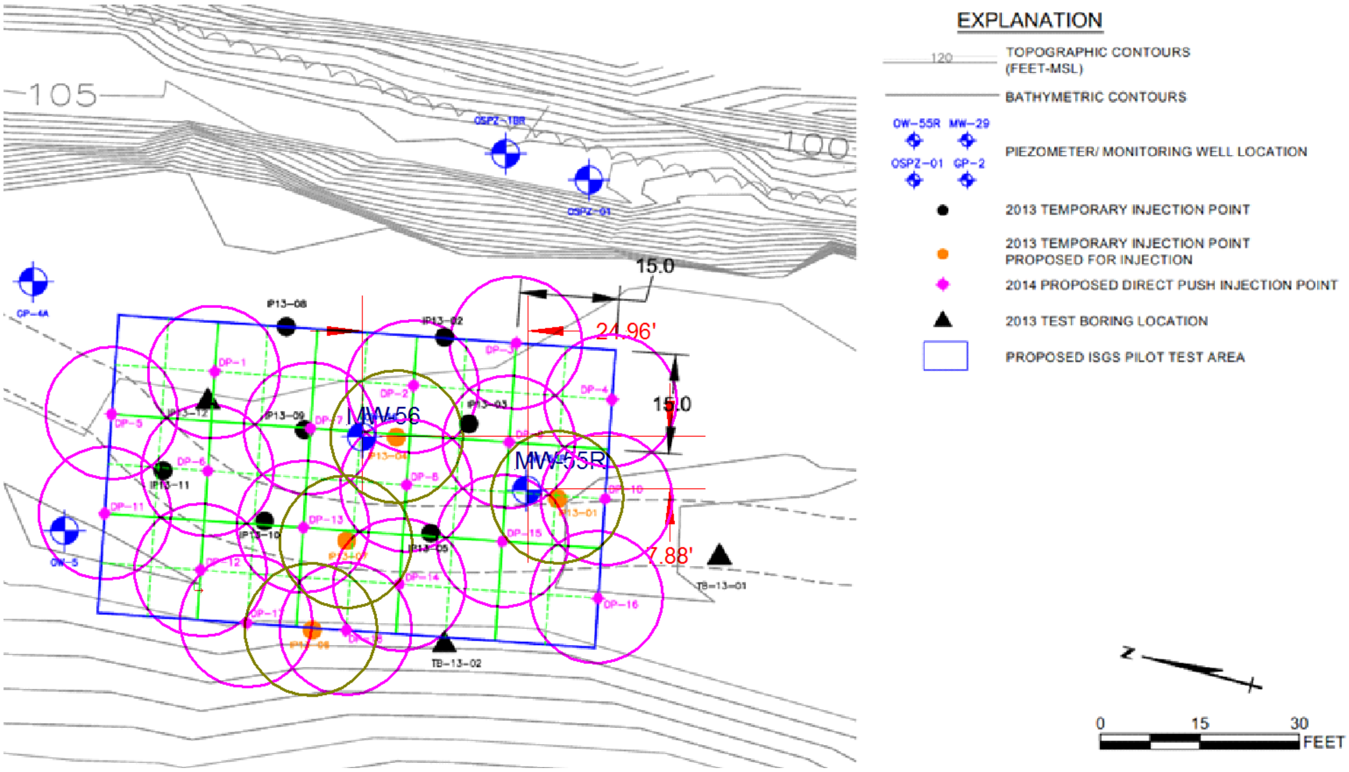
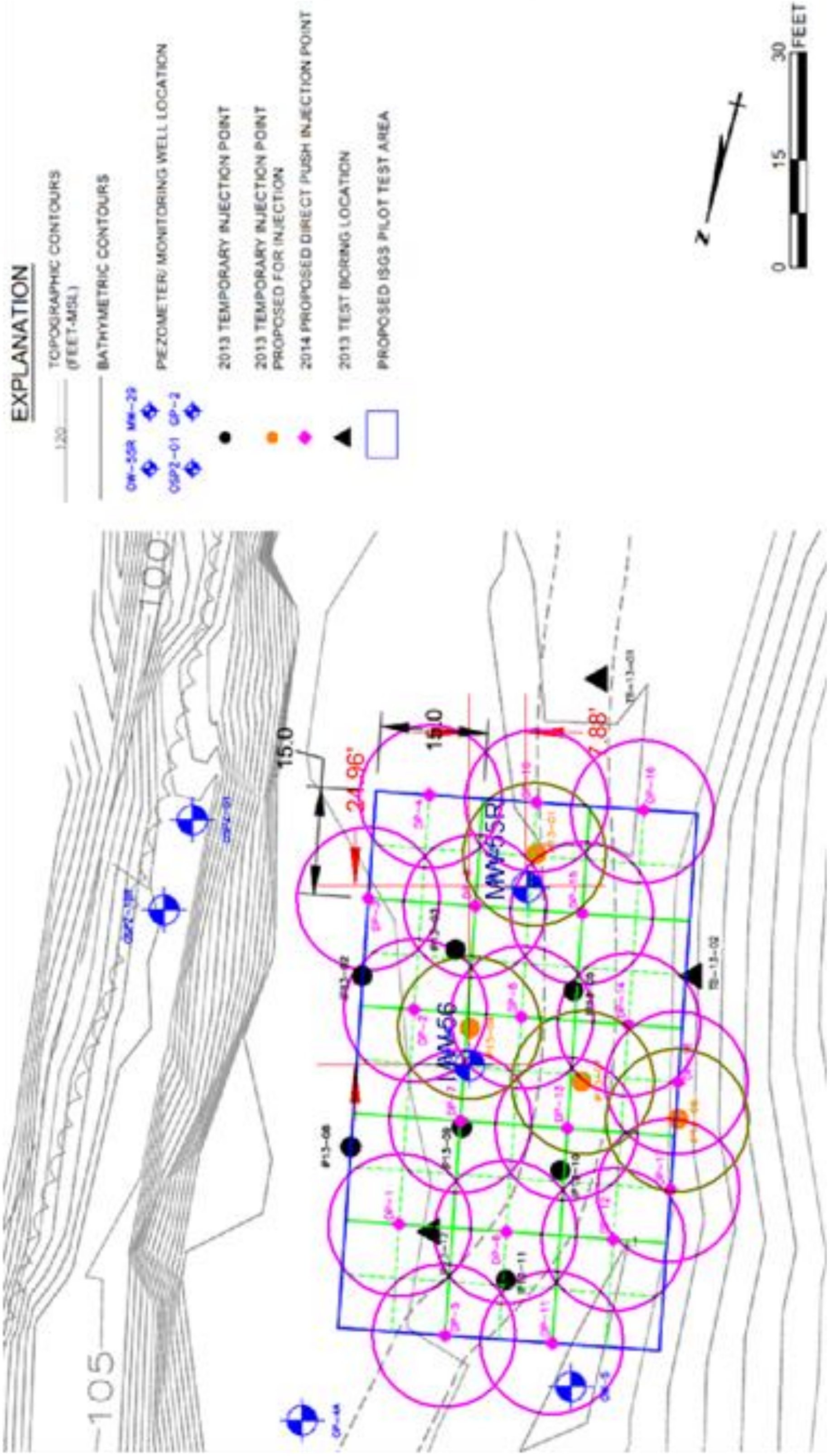


Figure 3: As-Built Injection Grid

CONCLUSION

IET was successful in introducing all ISGS solution into the proposed subsurface intervals in the pilot area. No significant issues were encountered during the field implementation of the injection program. IET did not observe any surfacing throughout the implementation of the pilot design. IET looks forward to partnering with Tetra Tech in analyzing the data from the pilot study.

Appendix 1: Site Map



Appendix 2: Field Logs

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

Date of Injection:	11/11/14	13:40 To 13:45	13:32 To 13:35	13:26 To 13:30	13:26 To 13:45
Grid Point:	DP-1				

							SUMMARY	
DP-1	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**25-27' bgs**	**25-27' bgs**	**27-29' bgs**	**27-29' bgs**	**30-32' bgs**	**30-32' bgs**	**26-32' bgs**	**26-32' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**	**5**	**5**		
Pressure of Pre-injection pathway development	**130**	**150**	**130**	**150**	**130**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**5.4**	**5.4**
Gallons of 40% Sodium Permanganate Soln	**4.5**	**4.5**	**4.5**	**4.5**	**4.5**	**4.5**	**13.5**	**13.5**
Pounds of $FeCO_3$	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**30.6**	**30.6**
Pounds of $CaCl_2$	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**30.6**	**30.6**
Gallons of Water	**43**	**43**	**43**	**43**	**43**	**43**	**129**	**129**
Gallons of 4.5% ISGS Solution	**49.5**	**49.5**	**49.5**	**49.5**	**49.5**	**49.5**	**148.5**	**148.5**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up. Added Additive/ interval 27-29' , 28-30', 30-32'

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

Date of Injection: 11/11/14

13:04 To 13:08

12:39 To 12:49

12:39 To 13:08

Grid Point: DP-2

					SUMMARY	
DP-2	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**29-31' bgs**	**29-31' bgs**	**31-33' bgs**	**31-33' bgs**	**29-33' bgs**	**29-33' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**		
Pressure of Pre-injection pathway development	**140**	**150**	**140**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**1.8**	**1.8**	**1.8**	**1.8**	**3.6**	**3.6**
Gallons of 40% Sodium Permanganate Soln	**4.5**	**4.5**	**4.5**	**4.5**	**9**	**9**
Pounds of $FeCO_3$	**10.2**	**10.2**	**10.2**	**10.2**	**20.4**	**20.4**
Pounds of $CaCl_2$	**10.2**	**10.2**	**10.2**	**10.2**	**20.4**	**20.4**
Gallons of Water	**43**	**43**	**43**	**43**	**86**	**86**
Gallons of 4.5% ISGS Solution	**49.5**	**49.5**	**49.5**	**49.5**	**99**	**99**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up.

Pump Pressure 40 psi 31-33' and 40 psi 29-31'

IET

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

Date of Injection: 11/11/14

11:51 To 11:59

11:47 To 11:50

11:47 To 11:59

Grid Point: DP-3

					SUMMARY	
DP-3	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**29-31' bgs**	**29-31' bgs**	**31-33' bgs**	**31-33' bgs**	**29-33' bgs**	**29-33' bgs**
Duration of Fracture (seconds):	**2**	**5**	**2**	**5**		
Pressure of Pre-injection pathway development	**150**	**150**	**150**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**1.8**	**1.8**	**1.8**	**1.8**	**3.6**	**3.6**
Gallons of 40% Sodium Permanganate Soln	**4.5**	**4.5**	**4.5**	**4.5**	**9**	**9**
Pounds of $FeCO_3$	**10.2**	**10.2**	**10.2**	**10.2**	**20.4**	**20.4**
Pounds of $CaCl_2$	**10.2**	**10.2**	**10.2**	**10.2**	**20.4**	**20.4**
Gallons of Water	**43**	**43**	**43**	**43**	**86**	**86**
Gallons of 4.5% ISGS Solution	**49.5**	**49.5**	**49.5**	**49.5**	**99**	**99**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up 40 psi @ 29'-31'

35 psi @ 31'-33'

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

Date of Injection: 11/11/14 12:13 To 12:21 12:13 To 12:21

Grid Point: DP-4

					SUMMARY	
DP-4	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**29-31' bgs**	**29-31' bgs**	**31-33' bgs**	**31-33' bgs**	**29-31' bgs**	**29-33' bgs**
Duration of Fracture (seconds):	**5**	**5**	**0**	**5**		
Pressure of Pre-injection pathway development	**150**	**150**	**0**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**0**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**3.6**	**1.8**	**0**	**1.8**	**3.6**	**3.6**
Gallons of 40% Sodium Permanganate Soln	**9**	**4.5**	**0**	**4.5**	**9**	**9**
Pounds of $FeCO_3$	**20.4**	**10.2**	**0**	**10.2**	**20.4**	**20.4**
Pounds of $CaCl_2$	**20.4**	**10.2**	**0**	**10.2**	**20.4**	**20.4**
Gallons of Water	**86**	**43**	**0**	**43**	**86**	**86**
Gallons of 4.5% ISGS Solution	**99**	**49.5**	**0**	**49.5**	**99**	**99**
Pressure of Post-injection pathway development	**50**	**50**	**0**	**50**		

ODORS: ____________

Other Field Observations: Bottom up, Liquid pressure = 40 psi

2 intervals consolidated into one @ 29'-31'

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

		14:12 To 14:16	14:05 To 14:10	13:58 To 14:03	13:58 To 14:16
Date of Injection:	11/11/14				
Grid Point:	DP-5				

							SUMMARY	
DP-5	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**25-27' bgs**	**25-27' bgs**	**27-29' bgs**	**27-29' bgs**	**30-32' bgs**	**30-32' bgs**	**25-32' bgs**	**25-32' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**	**5**	**5**		
Pressure of Pre-injection pathway development	**135**	**150**	**135**	**150**	**140**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**5.4**	**5.4**
Gallons of 40% Sodium Permanganate Soln	**4.5**	**4.5**	**4.5**	**4.5**	**4.5**	**4.5**	**13.5**	**13.5**
Pounds of $FeCO_3$	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**30.6**	**30.6**
Pounds of $CaCl_2$	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**30.6**	**30.6**
Gallons of Water	**43**	**43**	**43**	**43**	**43**	**43**	**129**	**129**
Gallons of 4.5% ISGS Solution	**49.5**	**49.5**	**49.5**	**49.5**	**49.5**	**49.5**	**148.5**	**148.5**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up. Liquid Pressure 40 psi for all intervals.

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

		14:52 To 15:00	14:48 To 14:52	14:29 To 14:41	14:29 To 15:00
Date of Injection:	11/13/14				
Grid Point:	DP-6				

							SUMMARY	
DP-6	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**24-26' bgs**	**24-26' bgs**	**26-28' bgs**	**26-28' bgs**	**30-32' bgs**	**30-32' bgs**	**24-32' bgs**	**24-32' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**	**5**	**5**		
Pressure of Pre-injection pathway development	**150**	**150**	**150**	**150**	**150**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**6.9**	**6.9**
Gallons of 40% Sodium Permanganate Soln	**5.8**	**5.8**	**5.8**	**5.8**	**5.8**	**5.8**	**17.4**	**17.4**
Pounds of $FeCO_3$	**13**	**13**	**13**	**13**	**13**	**13**	**39**	**39**
Pounds of $CaCl_2$	**13**	**13**	**13**	**13**	**13**	**13**	**39**	**39**
Gallons of Water	**55**	**55**	**55**	**55**	**55**	**55**	**165**	**165**
Gallons of 4.5% ISGS Solution	**62.5**	**62.5**	**62.5**	**62.5**	**62.5**	**62.5**	**187.5**	**187.5**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up. Liquid pressure 35 psi.

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

		14:04	13:50		13:14	13:14
Date of Injection:	11/13/14	To	To	To		To
		14:10	14:03		13:31	14:10
Grid Point:	DP-7					

									SUMMARY	
DP-7	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**25-27' bgs**	**25-27' bgs**	**27-29' bgs**	**27-29' bgs**	**29-31' bgs**	**29-31' bgs**	**31-33' bgs**	**31-33' bgs**	**25-31' bgs**	**25-31' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**	**0**	**5**	**0**	**5**		
Pressure of Pre-injection pathway development	**150**	**150**	**150**	**150**	**0**	**150**	**150**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**	**0**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**2.3**	**2.3**	**4.6**	**2.3**	**0**	**2.3**	**2.3**	**2.3**	**9.2**	**9.2**
Gallons of 40% Sodium Permanganate Soln	**5.8**	**5.8**	**11.6**	**5.8**	**0**	**5.8**	**5.8**	**5.8**	**23.2**	**23.2**
Pounds of $FeCO_3$	**13**	**13**	**26**	**13**	**0**	**13**	**13**	**13**	**52**	**52**
Pounds of $CaCl_2$	**13**	**13**	**26**	**13**	**0**	**13**	**13**	**13**	**52**	**52**
Gallons of Water	**55**	**55**	**110**	**55**	**0**	**55**	**55**	**55**	**220**	**220**
Gallons of 4.5% ISGS Solution	**62.5**	**62.5**	**125**	**62.5**	**0**	**62.5**	**62.5**	**62.5**	**250**	**250**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**	**0**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations:

Bottom up. Screen clogged @ 29'-31', pulled up 2 ft to apply 2x dosage

27'-29' Able to Clear Screen. Assumed Less permable zone @ 29'-31', could not inject

35 psi

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

		10:15	10:03	9:43	9:43
Date of Injection:	11/13/14	To	To	To	To
		10:21	10:10	9:51	10:21
Grid Point:	DP-8				

							SUMMARY	
DP-8	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**25-27' bgs**	**25-27' bgs**	**29-31' bgs**	**29-31' bgs**	**31-33' bgs**	**31-33' bgs**	**25-33' bgs**	**25-33' bgs**
Duration of Fracture (seconds):	5	5	5	5	5	5		
Pressure of Pre-injection pathway development	150	150	150	150	150	150		
Estimated Radius of Influence	10'	10'	10'	10'	10'	10'		
Gallons of 37.5% Sodium Silicate Soln	2.3	2.3	2.3	2.3	2.3	2.3	6.9	6.9
Gallons of 40% Sodium Permanganate Soln	5.8	5.8	5.8	5.8	5.8	5.8	17.4	17.4
Pounds of $FeCO_3$	13	13	13	13	13	13	39	39
Pounds of $CaCl_2$	13	13	13	13	13	13	39	39
Gallons of Water	55	55	55	55	55	55	165	165
Gallons of 4.5% ISGS Solution	62.5	62.5	62.5	62.5	62.5	62.5	187.5	187.5
Pressure of Post-injection pathway development	50	50	50	50	50	50		

ODORS: ____________

Other Field Observations: Bottom up.

Liquid pressure 35 psi

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

Date of Injection:	11/13/14	9:30 To 9:36	9:23 To 9:30	9:23 To 9:36
Grid Point:	DP-9			

					SUMMARY	
DP-9	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**29-31' bgs**	**29-31' bgs**	**31-33' bgs**	**31-33' bgs**	**29-33' bgs**	**29-33' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**		
Pressure of Pre-injection pathway development	**150**	**150**	**150**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**2.3**	**2.3**	**2.3**	**2.3**	**4.6**	**4.6**
Gallons of 40% Sodium Permanganate Soln	**5.8**	**5.8**	**5.8**	**5.8**	**11.6**	**11.6**
Pounds of $FeCO_3$	**13**	**13**	**13**	**13**	**26**	**26**
Pounds of $CaCl_2$	**13**	**13**	**13**	**13**	**26**	**26**
Gallons of Water	**55**	**55**	**55**	**55**	**110**	**110**
Gallons of 4.5% ISGS Solution	**62.5**	**62.5**	**62.5**	**62.5**	**125**	**125**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up. Liquid pressure 35 psi

IET

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH

2014 Injections

In-Situ Geochemical Stabilization of Soil and Groundwater

Date of Injection:	11/12/14	8:06 To 8:09	7:56 To 8:05	7:56 To 8:09
Grid Point:	DP-10			

					SUMMARY	
DP-10	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**29-31' bgs**	**29-31' bgs**	**31-33' bgs**	**31-33' bgs**	**29-33' bgs**	**29-33' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**		
Pressure of Pre-injection pathway development	**150**	**150**	**150**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**1.8**	**1.8**	**1.8**	**1.8**	**3.6**	**3.6**
Gallons of 40% Sodium Permanganate Soln	**4.5**	**4.5**	**4.5**	**4.5**	**9**	**9**
Pounds of $FeCO_3$	**10.2**	**10.2**	**10.2**	**10.2**	**20.4**	**20.4**
Pounds of $CaCl_2$	**10.2**	**10.2**	**10.2**	**10.2**	**20.4**	**20.4**
Gallons of Water	**43**	**43**	**43**	**43**	**86**	**86**
Gallons of 4.5% ISGS Solution	**49.5**	**49.5**	**49.5**	**49.5**	**99**	**99**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up. Pump pressure 40 psi @ both intervals

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

Date of Injection:	11/12/14	11:50 To 11:55	11:45 To 11:50	11:38 To 11:45	11:38 To 11:55
Grid Point:	DP-11				

							SUMMARY	
DP-11	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**26-28' bgs**	**26-28' bgs**	**28-30' bgs**	**28-30' bgs**	**30-32' bgs**	**30-32' bgs**	**26-32' bgs**	**26-32' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**	**5**	**5**		
Pressure of Pre-injection pathway development	**150**	**150**	**150**	**150**	**150**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**5.4**	**5.4**
Gallons of 40% Sodium Permanganate Soln	**4.5**	**4.5**	**4.5**	**4.5**	**4.5**	**4.5**	**13.5**	**13.5**
Pounds of $FeCO_3$	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**30.6**	**30.6**
Pounds of $CaCl_2$	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**30.6**	**30.6**
Gallons of Water	**43**	**43**	**43**	**43**	**43**	**43**	**129**	**129**
Gallons of 4.5% ISGS Solution	**49.5**	**49.5**	**49.5**	**49.5**	**49.5**	**49.5**	**148.5**	**148.5**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up.

pump @ 30 psi

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

Date of Injection:	11/12/14	12:40 To 12:48	12:32 To 12:38	12:26 To 12:32	12:26 To 12:48
Grid Point:	DP-12				

							SUMMARY	
DP-12	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**25-27' bgs**	**25-27' bgs**	**29-31' bgs**	**29-31' bgs**	**31-33' bgs**	**31-33' bgs**	**25-33' bgs**	**25-33' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**	**5**	**5**		
Pressure of Pre-injection pathway development	**150**	**150**	**150**	**150**	**150**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**5.4**	**5.4**
Gallons of 40% Sodium Permanganate Soln	**4.5**	**4.5**	**4.5**	**4.5**	**4.5**	**4.5**	**13.5**	**13.5**
Pounds of FeCO$_3$	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**30.6**	**30.6**
Pounds of CaCl$_2$	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**30.6**	**30.6**
Gallons of Water	**43**	**43**	**43**	**43**	**43**	**43**	**129**	**129**
Gallons of 4.5% ISGS Solution	**49.5**	**49.5**	**49.5**	**49.5**	**49.5**	**49.5**	**148.5**	**148.5**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up. Liquid pressure @ 35 psi

IET

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

Date of Injection: 11/13/14

12:58 To 13:05

12:44 To 12:52

12:44 To 13:05

Grid Point: DP-13

					SUMMARY	
DP-13	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**26-28' bgs**	**26-28' bgs**	**31-33' bgs**	**31-33' bgs**	**26-33' bgs**	**26-33' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**		
Pressure of Pre-injection pathway development	**150**	**150**	**150**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**2.3**	**2.3**	**2.3**	**2.3**	**4.6**	**4.6**
Gallons of 40% Sodium Permanganate Soln	**5.8**	**5.8**	**5.8**	**5.8**	**11.6**	**11.6**
Pounds of $FeCO_3$	**13**	**13**	**13**	**13**	**26**	**26**
Pounds of $CaCl_2$	**13**	**13**	**13**	**13**	**26**	**26**
Gallons of Water	**55**	**55**	**55**	**55**	**110**	**110**
Gallons of 4.5% ISGS Solution	**62.5**	**62.5**	**62.5**	**62.5**	**125**	**125**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up. Liquid pressure 35 psi

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

Date of Injection: 11/12/14

9:20 To 9:27

9:10 To 9:19

9:10 To 9:27

Grid Point: DP-14

					SUMMARY	
DP-14	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**24-26' bgs**	**24-26' bgs**	**26-28' bgs**	**26-28' bgs**	**24-28' bgs**	**24-28' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**		
Pressure of Pre-injection pathway development	**150**	**150**	**150**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**1.8**	**1.8**	**1.8**	**1.8**	**3.6**	**3.6**
Gallons of 40% Sodium Permanganate Soln	**4.5**	**4.5**	**4.5**	**4.5**	**9**	**9**
Pounds of $FeCO_3$	**10.2**	**10.2**	**10.2**	**10.2**	**20.4**	**20.4**
Pounds of $CaCl_2$	**10.2**	**10.2**	**10.2**	**10.2**	**20.4**	**20.4**
Gallons of Water	**43**	**43**	**43**	**43**	**86**	**86**
Gallons of 4.5% ISGS Solution	**49.5**	**49.5**	**49.5**	**49.5**	**99**	**99**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up. Liquid Pressure @25 psi 26'-28'

Liquid Pressure @40 psi 24'-26'

Too much back pressure

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

	8:54	8:49	8:39	8:39
Date of Injection: 11/12/14	To	To	To	To
	8:59	8:53	8:47	8:59

Grid Point: DP-15

							SUMMARY	
DP-15	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**26-28' bgs**	**26-28' bgs**	**28-30' bgs**	**28-30' bgs**	**30-32' bgs**	**30-32' bgs**	**26-32' bgs**	**26-32' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**	**5**	**5**		
Pressure of Pre-injection pathway development	**150**	**150**	**150**	**150**	**150**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**5.4**	**5.4**
Gallons of 40% Sodium Permanganate Soln	**4.5**	**4.5**	**4.5**	**4.5**	**4.5**	**4.5**	**13.5**	**13.5**
Pounds of $FeCO_3$	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**30.6**	**30.6**
Pounds of $CaCl_2$	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**10.2**	**30.6**	**30.6**
Gallons of Water	**43**	**43**	**43**	**43**	**43**	**43**	**129**	**129**
Gallons of 4.5% ISGS Solution	**49.5**	**49.5**	**49.5**	**49.5**	**49.5**	**49.5**	**148.5**	**148.5**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up. Liquid pressure 40 psi @ 30'-32' and 28'-30'

liquid pressure 25 psi @ 26'-28'

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

8:24
To
8:28

Date of Injection: 11/12/14

Grid Point: DP-16

			SUMMARY	
DP-16	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	29-31' bgs	29-31' bgs	29-31' bgs	29-31' bgs
Duration of Fracture (seconds):	5	5		5
Pressure of Pre-injection pathway development	150	150		150
Estimated Radius of Influence	10'	10'		10'
Gallons of 37.5% Sodium Silicate Soln	1.8	1.8	1.8	1.8
Gallons of 40% Sodium Permanganate Soln	4.5	4.5	4.5	4.5
Pounds of $FeCO_3$	10.2	10.2	10.2	10.2
Pounds of $CaCl_2$	10.2	10.2	10.2	10.2
Gallons of Water	43	43	43	43
Gallons of 4.5% ISGS Solution	49.5	49.5	49.5	49.5
Pressure of Post-injection pathway development	50	50		

ODORS: ____________

Other Field Observations: Bottom up. Liquid pressure 40 psi

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH

2014 Injections

In-Situ Geochemical Stabilization of Soil and Groundwater

Date of Injection: 11/12/14

13:19 To 13:25

13:06 To 13:12

13:06 To 13:25

Grid Point: DP-17

					SUMMARY	
DP-17	Actual	Proposed	Actual	Proposed	Actual	Proposed
Injection Zone	**26-28' bgs**	**26-28' bgs**	**30-32' bgs**	**30-32' bgs**	**26-32' bgs**	**26-32' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**		
Pressure of Pre-injection pathway development	**150**	**150**	**150**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**1.8**	**1.8**	**1.8**	**1.8**	**3.6**	**3.6**
Gallons of 40% Sodium Permanganate Soln	**4.5**	**4.5**	**4.5**	**4.5**	**9**	**9**
Pounds of $FeCO_3$	**10.2**	**10.2**	**10.2**	**10.2**	**20.4**	**20.4**
Pounds of $CaCl_2$	**10.2**	**10.2**	**10.2**	**10.2**	**20.4**	**20.4**
Gallons of Water	**43**	**43**	**43**	**43**	**86**	**86**
Gallons of 4.5% ISGS Solution	**49.5**	**49.5**	**49.5**	**49.5**	**99**	**99**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up. Liquid pressure = 35 psi

IET

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

Date of Injection:	11/12/14	9:46 To 9:53	9:37 To 9:45	9:37 To 9:53
Grid Point:	DP-18			

					SUMMARY	
DP-18	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**24-26' bgs**	**24-26' bgs**	**26-28' bgs**	**26-28' bgs**	**24-28' bgs**	**24-28' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**		
Pressure of Pre-injection pathway development	**150**	**150**	**150**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**1.8**	**1.8**	**1.8**	**1.8**	**3.6**	**3.6**
Gallons of 40% Sodium Permanganate Soln	**4.5**	**4.5**	**4.5**	**4.5**	**9**	**9**
Pounds of $FeCO_3$	**10.2**	**10.2**	**10.2**	**10.2**	**20.4**	**20.4**
Pounds of $CaCl_2$	**10.2**	**10.2**	**10.2**	**10.2**	**20.4**	**20.4**
Gallons of Water	**43**	**43**	**43**	**43**	**86**	**86**
Gallons of 4.5% ISGS Solution	**49.5**	**49.5**	**49.5**	**49.5**	**99**	**99**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up. Liquid pressure 35 psi

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

		7:59	7:52	7:52
Date of Injection:	11/13/14	To	To	To
		8:05	7:58	8:05
Grid Point:	DP-19			

					SUMMARY	
DP-19	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**26-28' bgs**	**26-28' bgs**	**30-32' bgs**	**30-32' bgs**	**26-32' bgs**	**26-32' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**		
Pressure of Pre-injection pathway development	**150**	**150**	**150**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**2.3**	**2.3**	**2.3**	**2.3**	**4.6**	**4.6**
Gallons of 40% Sodium Permanganate Soln	**5.8**	**5.8**	**5.8**	**5.8**	**11.6**	**11.6**
Pounds of $FeCO_3$	**13**	**13**	**13**	**13**	**26**	**26**
Pounds of $CaCl_2$	**13**	**13**	**13**	**13**	**26**	**26**
Gallons of Water	**55**	**55**	**55**	**55**	**110**	**110**
Gallons of 4.5% ISGS Solution	**62.5**	**62.5**	**62.5**	**62.5**	**125**	**125**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up. 62.50 gallon batches, 2 intervals.

liquid pressure 35 psi

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

		8:58	8:47	8:37	8:14	8:14
Date of Injection:	11/13/14	To	To	To	To	To
		9:05	8:54	8:44	8:20	9:05
Grid Point:	DP-20					

									SUMMARY	
DP-20	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**25-27' bgs**	**25-27' bgs**	**30-32' bgs**	**30-32' bgs**	**32-34' bgs**	**32-34' bgs**	**36-38' bgs**	**36-38' bgs**	**25-38' bgs**	**25-38' bgs**
Duration of Fracture (seconds):	5	5	5	5	5	5	5	5		
Pressure of Pre-injection pathway development	**150**	**150**	**150**	**150**	**150**	**150**	**150**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**9.2**	**9.2**
Gallons of 40% Sodium Permanganate Soln	**5.8**	**5.8**	**5.8**	**5.8**	**5.8**	**5.8**	**5.8**	**5.8**	**23.2**	**23.2**
Pounds of $FeCO_3$	**13**	**13**	**13**	**13**	**13**	**13**	**13**	**13**	**52**	**52**
Pounds of $CaCl_2$	**13**	**13**	**13**	**13**	**13**	**13**	**13**	**13**	**52**	**52**
Gallons of Water	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**220**	**220**
Gallons of 4.5% ISGS Solution	**62.5**	**62.5**	**62.5**	**62.5**	**62.5**	**62.5**	**62.5**	**62.5**	**250**	**250**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: 62.50 gallon batches

Liquid 35 psi

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

		10:48	10:26	10:26
Date of Injection:	11/13/14	To	To	To
		10:55	10:33	10:55
Grid Point:	DP-21			

					SUMMARY	
DP-21	**Actual**	**Proposed**	**Actual**	**Proposed**	**Actual**	**Proposed**
Injection Zone	**25-27' bgs**	**25-27' bgs**	**31-33' bgs**	**31-33' bgs**	**25-33' bgs**	**25-33' bgs**
Duration of Fracture (seconds):	**5**	**5**	**5**	**5**		
Pressure of Pre-injection pathway development	**150**	**150**	**150**	**150**		
Estimated Radius of Influence	**10'**	**10'**	**10'**	**10'**		
Gallons of 37.5% Sodium Silicate Soln	**2.3**	**2.3**	**2.3**	**2.3**	**4.6**	**4.6**
Gallons of 40% Sodium Permanganate Soln	**5.8**	**5.8**	**5.8**	**5.8**	**11.6**	**11.6**
Pounds of $FeCO_3$	**13**	**13**	**13**	**13**	**26**	**26**
Pounds of $CaCl_2$	**13**	**13**	**13**	**13**	**26**	**26**
Gallons of Water	**55**	**55**	**55**	**55**	**110**	**110**
Gallons of 4.5% ISGS Solution	**62.5**	**62.5**	**62.5**	**62.5**	**125**	**125**
Pressure of Post-injection pathway development	**50**	**50**	**50**	**50**		

ODORS: ____________

Other Field Observations: Bottom up.

Liquid pressure 35 psi

Have to pull tooling to complete last 4 points.

IET

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

In-Situ Geochemical Stabilization of Soil and Groundwater

		12:21	12:13	12:13
Date of Injection:	11/13/14	To	To	To
		12:29	12:20	12:29
Grid Point:	DP-22			

					SUMMARY	
DP-22	Actual	Proposed	Actual	Proposed	Actual	Proposed
Injection Zone	26-28' bgs	26-28' bgs	28-30' bgs	28-30' bgs	26-30' bgs	26-30' bgs
Duration of Fracture (seconds):	5	5	5	5		
Pressure of Pre-injection pathway development	150	150	150	150		
Estimated Radius of Influence	10'	10'	10'	10'		
Gallons of 37.5% Sodium Silicate Soln	2.3	2.3	2.3	2.3	4.6	4.6
Gallons of 40% Sodium Permanganate Soln	5.8	5.8	5.8	5.8	11.6	11.6
Pounds of $FeCO_3$	13	13	13	13	26	26
Pounds of $CaCl_2$	13	13	13	13	26	26
Gallons of Water	55	55	55	55	110	110
Gallons of 4.5% ISGS Solution	62.5	62.5	62.5	62.5	125	125
Pressure of Post-injection pathway development	50	50	50	50		

ODORS: ____________

Other Field Observations: Bottom up. Liquid pressure 35 psi

slight escape from IP 13-07.

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: Beazer, Nashua, NH **2014 Injections**

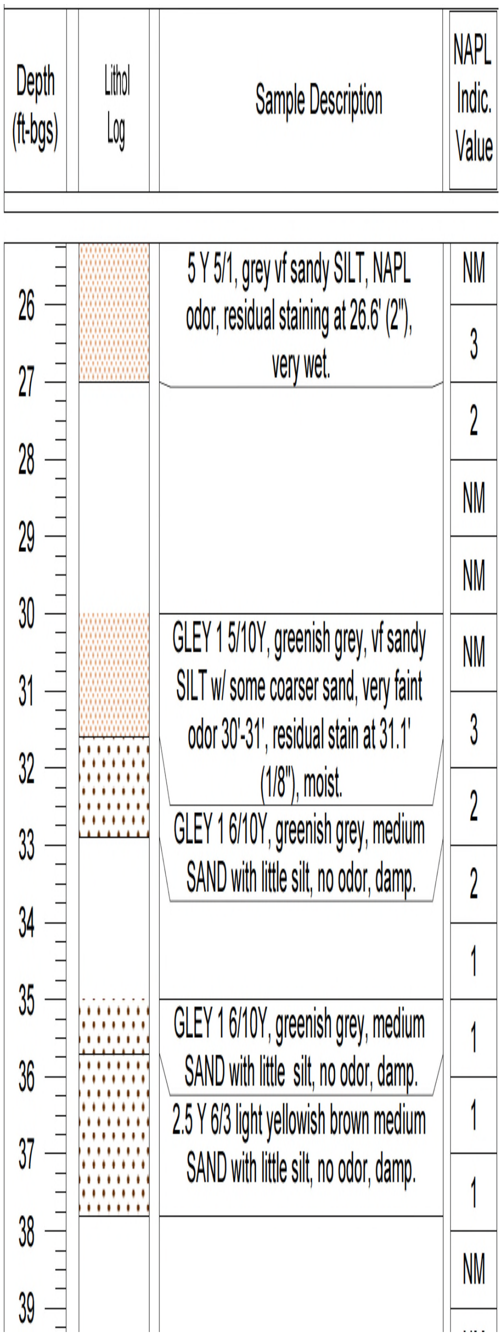
In-Situ Geochemical Stabilization of Soil and Groundwater

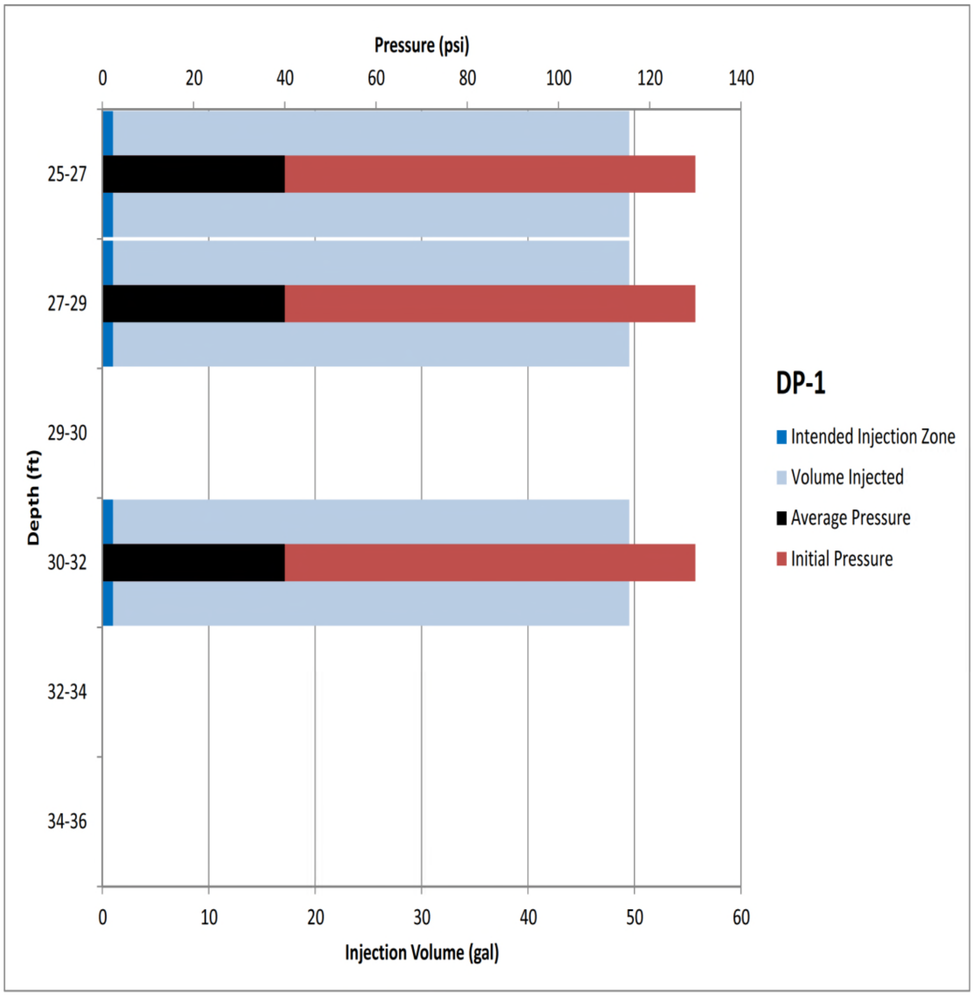
Dates of Injections: 11/11/14-11/13/14

Summary	ACTUAL	PROPOSED
Injection Zone	24-38' bgs	24-38' bgs
Gallons of 37.5% Sodium Silicate Soln	109.2	109.2
Gallons of 40% Sodium Permanganate Soln	274.2	274.2
Pounds of $FeCO_3$	618	618
Pounds of $CaCl_2$	618	618
Gallons of Water	2610	2610
Gallons of 4.5% ISGS Solution	2985	2985

APPENDIX C

INJECTION VOLUMES AND FLOW RATES





Note:
Borehole log on left is for adjacent TIP IP13-12.

TITLE:
REAGENT VOLUME INJECTED INTO DP-1
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:
Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-1**
PROJECT #	117-2201346	
DATE	12-23-14	

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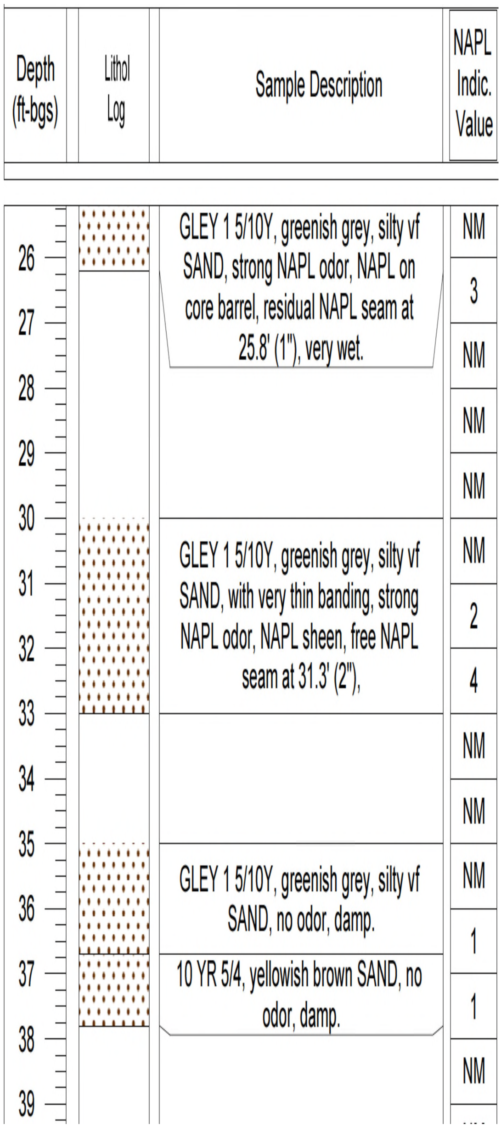
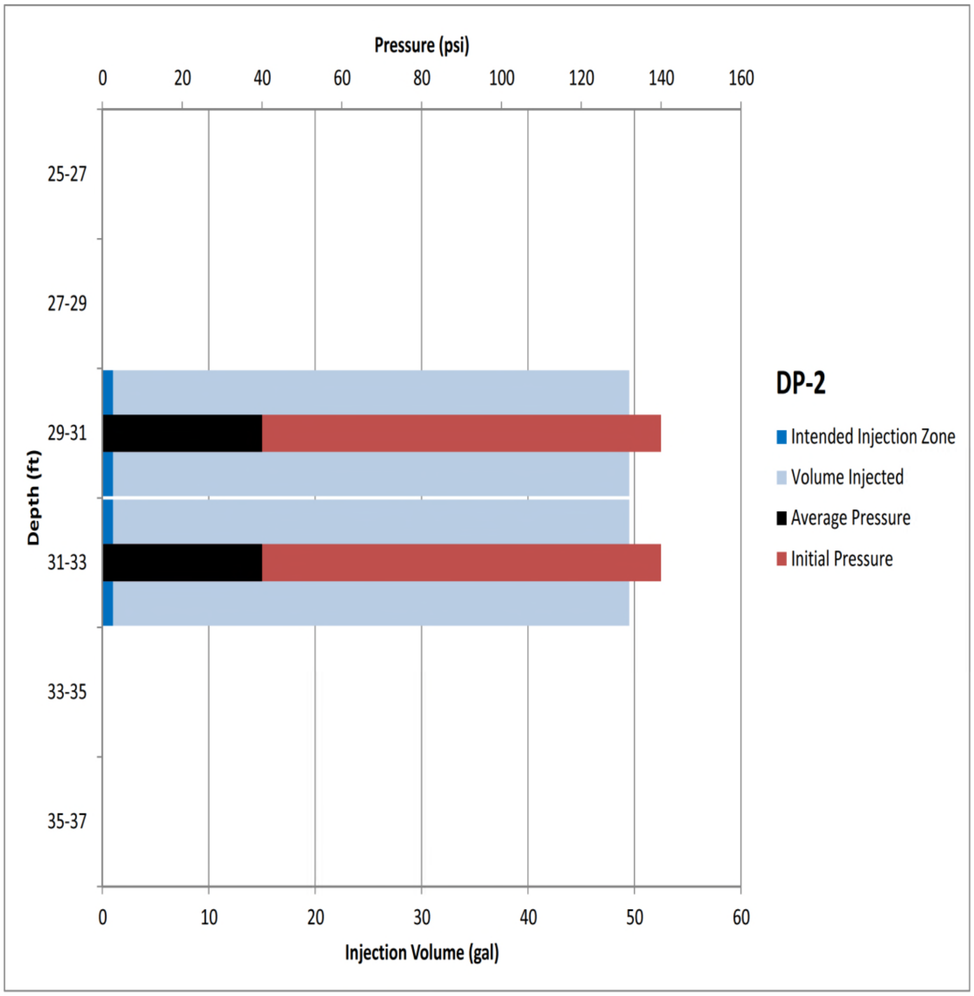


GLEY 1 5/10Y, greenish grey, silty vf SAND, strong NAPL odor, NAPL on core barrel, residual NAPL seam at 25.8' (1"), very wet.

GLEY 1 5/10Y, greenish grey, silty vf SAND, with very thin banding, strong NAPL odor, NAPL sheen, free NAPL seam at 31.3' (2"),

GLEY 1 5/10Y, greenish grey, silty vf SAND, no odor, damp.

10 YR 5/4, yellowish brown SAND, no odor, damp.



TITLE:

REAGENT VOLUME INJECTED INTO DP-2
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:

Former Koppers Company Inc. Site
Nashua, NH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-2**
PROJECT #	117-2201346	
DATE	12-23-14	

Note:
Borehole log on left is for adjacent TIP IP13-04.

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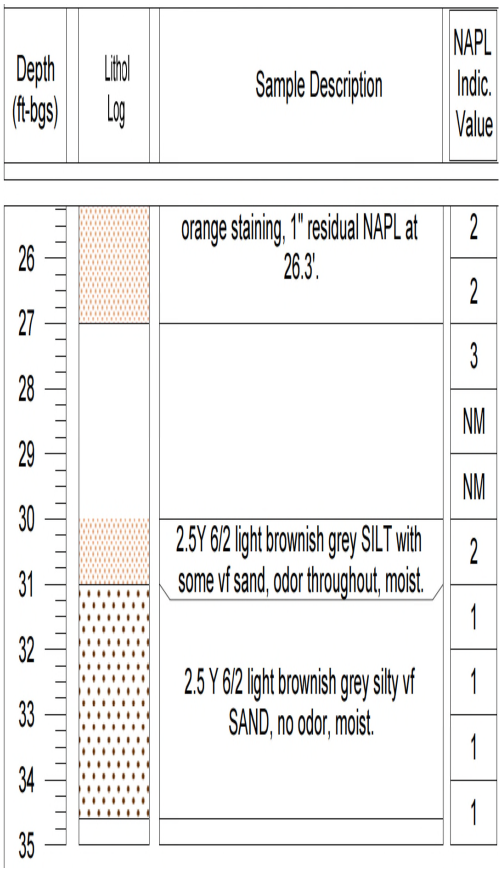

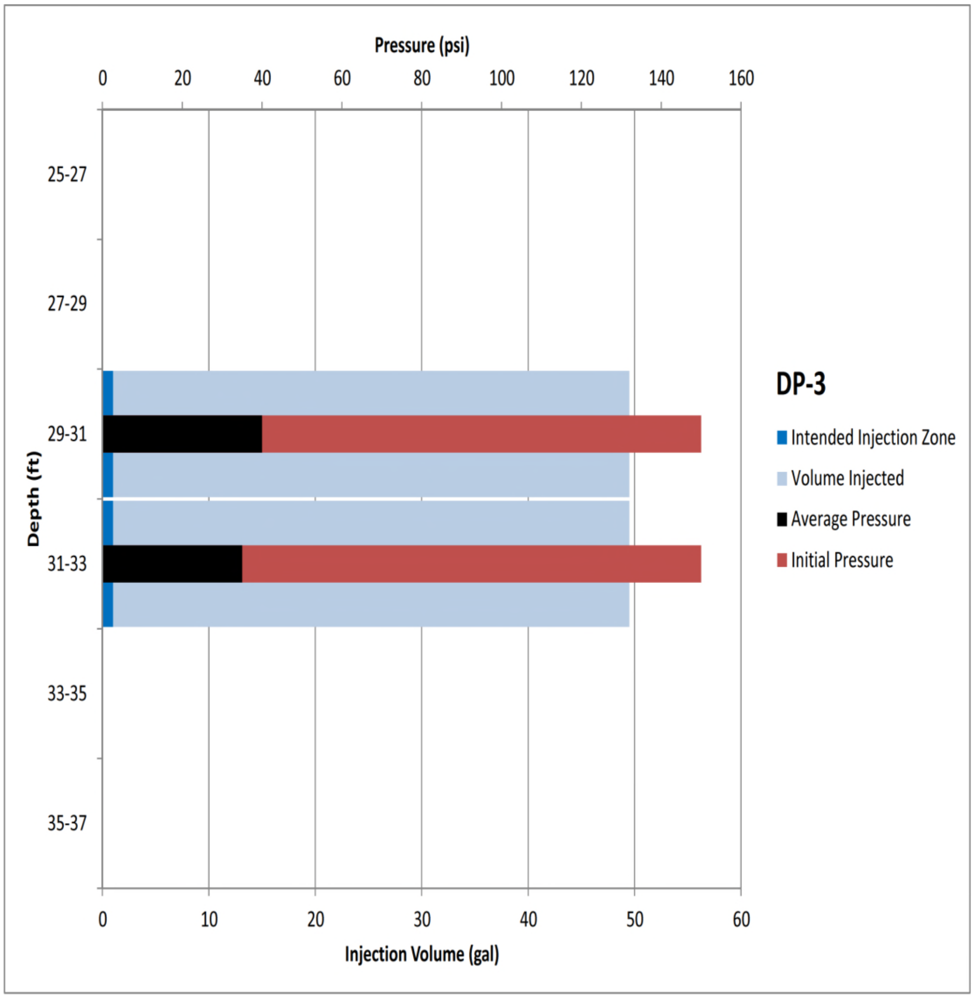

TITLE:
REAGENT VOLUME INJECTED INTO DP-3
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:
Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-3**
PROJECT #	117-2201346	
DATE	12-23-14	

Note:
Borehole log on left is for adjacent TIP IP13-02.

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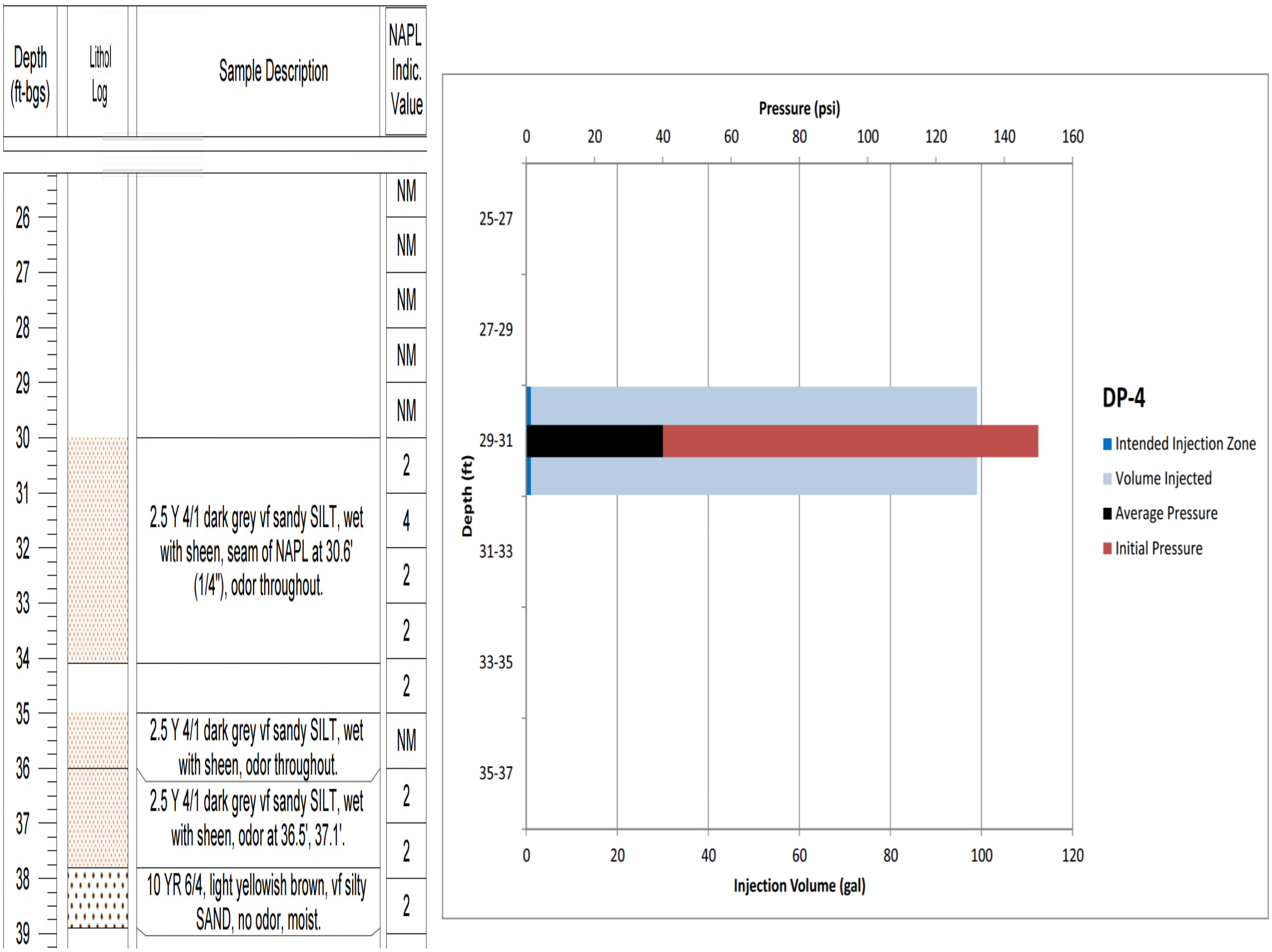

Note:
Borehole log on left is for adjacent TIP IP13-01.

TITLE:
REAGENT VOLUME INJECTED INTO DP-4
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:
Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-4**
PROJECT #	117-2201346	
DATE	12-23-14	

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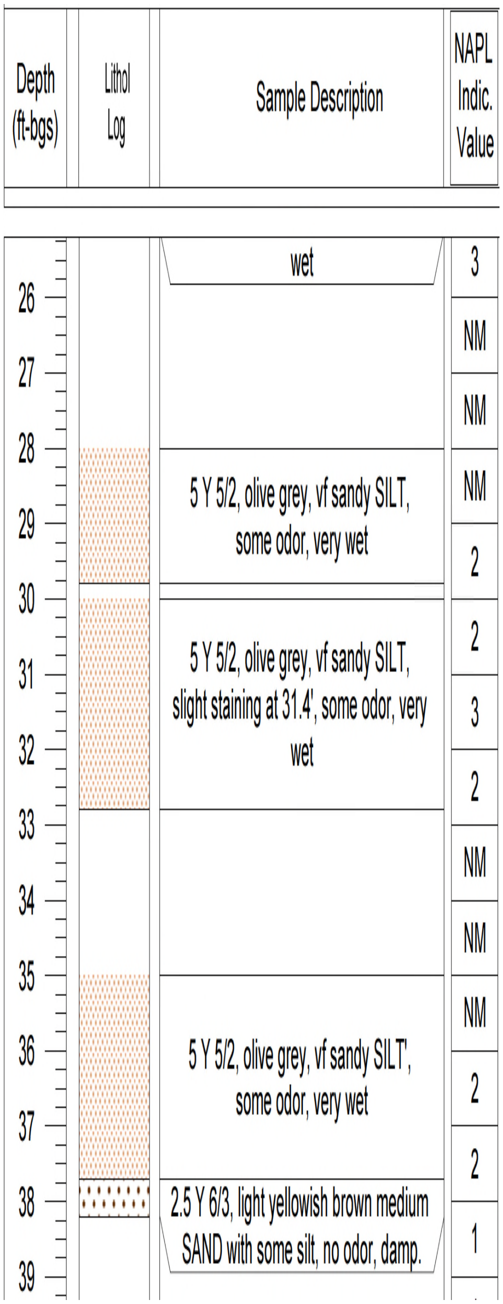

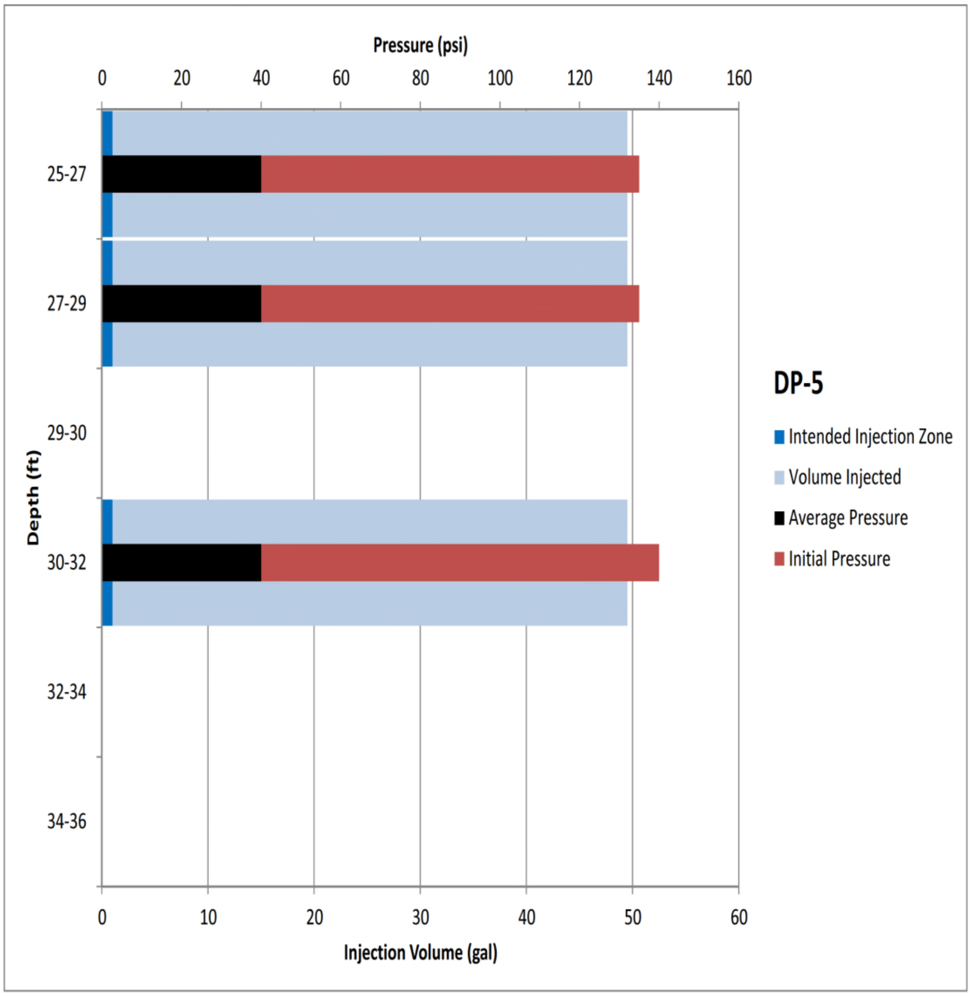

TITLE:

REAGENT VOLUME INJECTED INTO DP-5
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:

Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-5**
PROJECT #	117-2201346	
DATE	12-23-14	

Note:
Borehole log on left is for adjacent TIP IP13-11.

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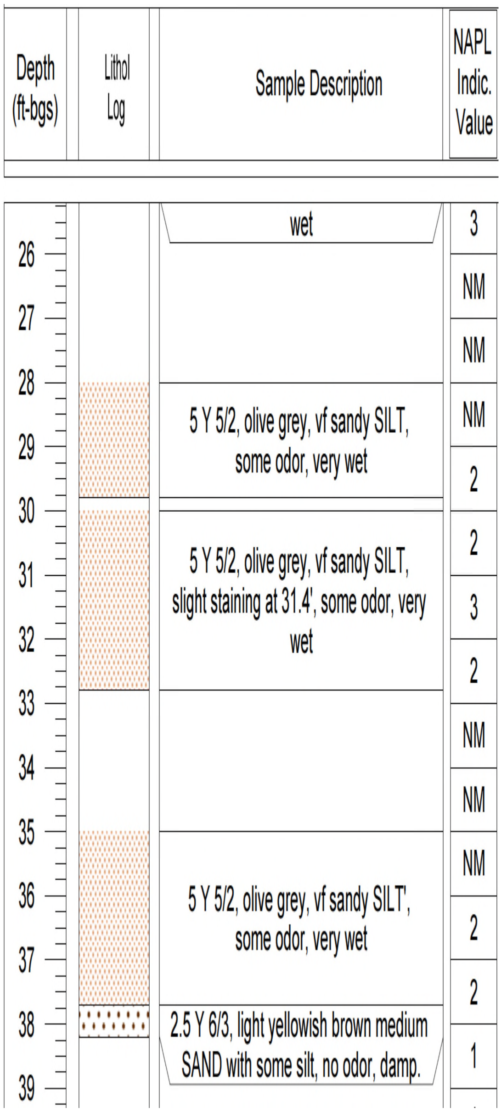

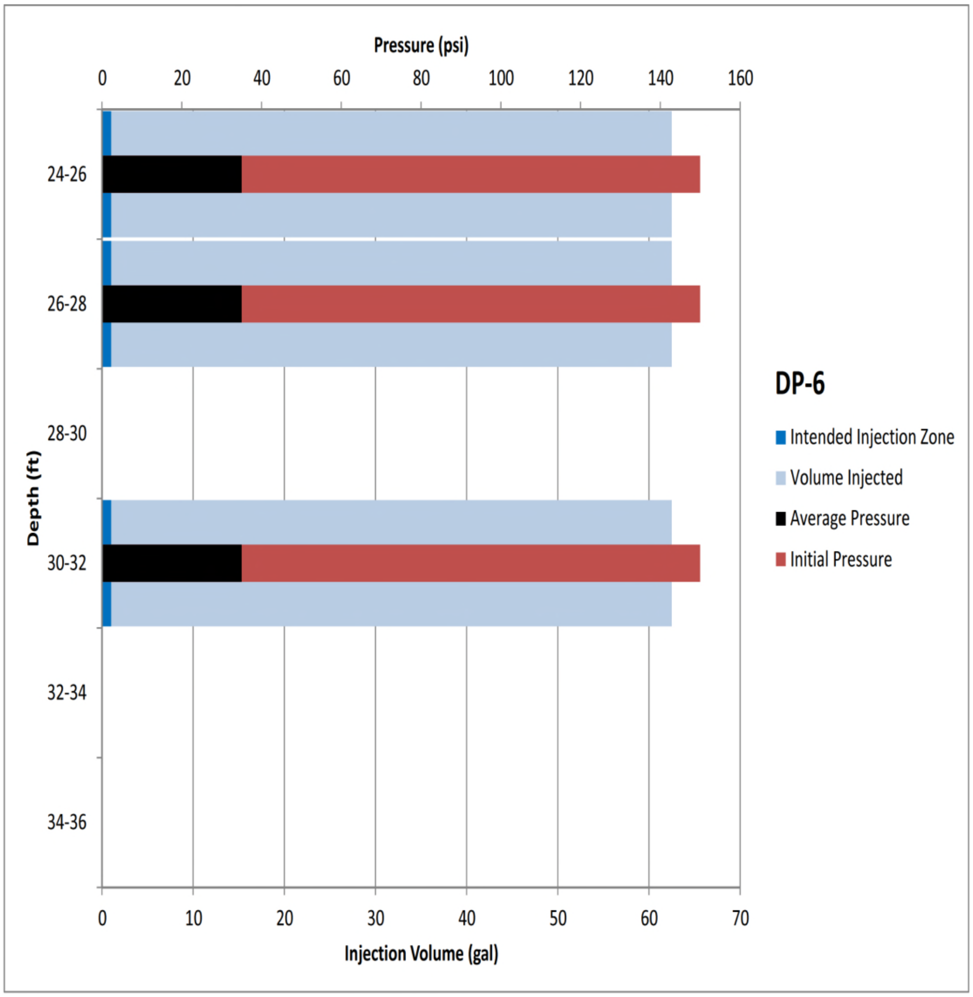

TITLE:

REAGENT VOLUME INJECTED INTO DP-6
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:

Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-6**
PROJECT #	117-2201346	
DATE	12-23-14	

Note:
Borehole log on left is for adjacent TIP IP13-11.

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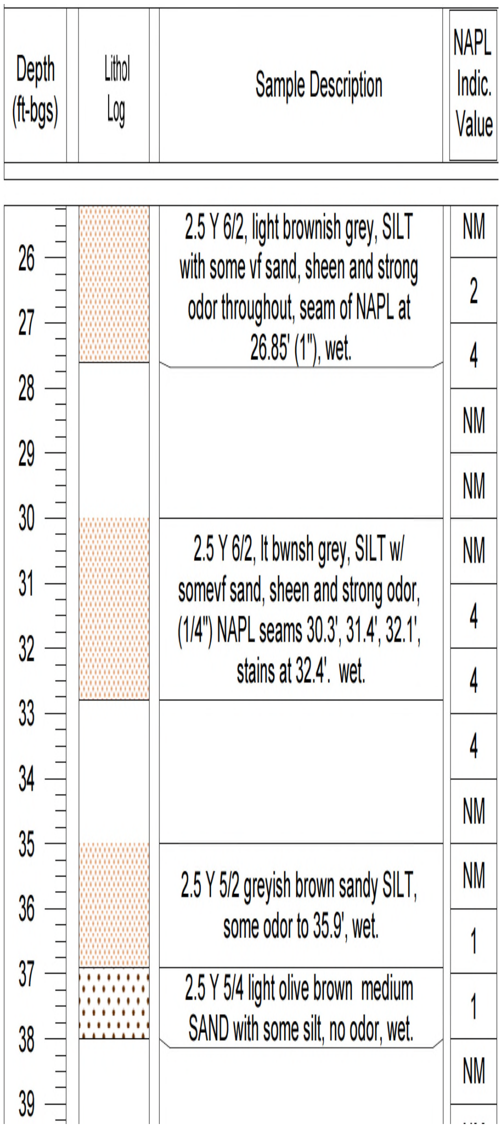
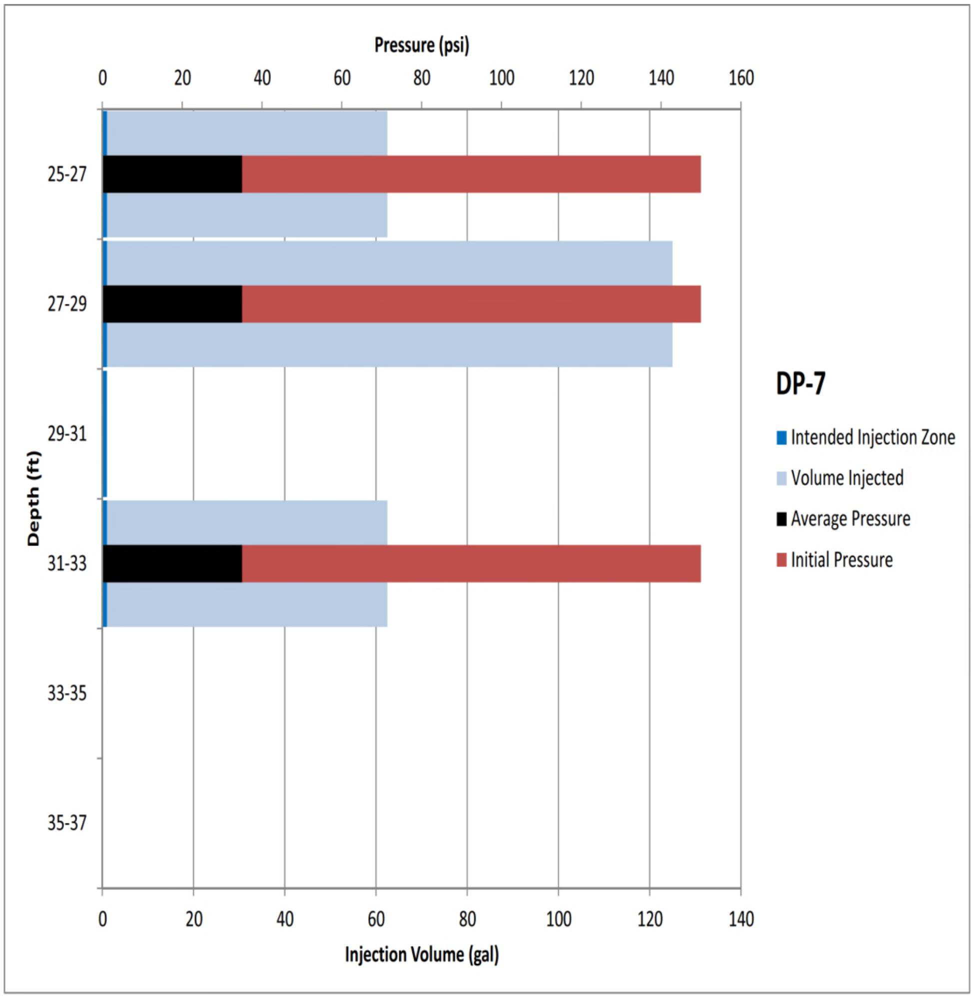


2.5 Y 6/2, light brownish grey, SILT with some vf sand, sheen and strong odor throughout, seam of NAPL at 26.85' (1"), wet.

2.5 Y 6/2, lt bwnsh grey, SILT w/ somevf sand, sheen and strong odor, (1/4") NAPL seams 30.3', 31.4', 32.1', stains at 32.4'. wet.

2.5 Y 5/2 greyish brown sandy SILT, some odor to 35.9', wet.

2.5 Y 5/4 light olive brown medium SAND with some silt, no odor, wet.



TITLE:

REAGENT VOLUME INJECTED INTO DP-7
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:

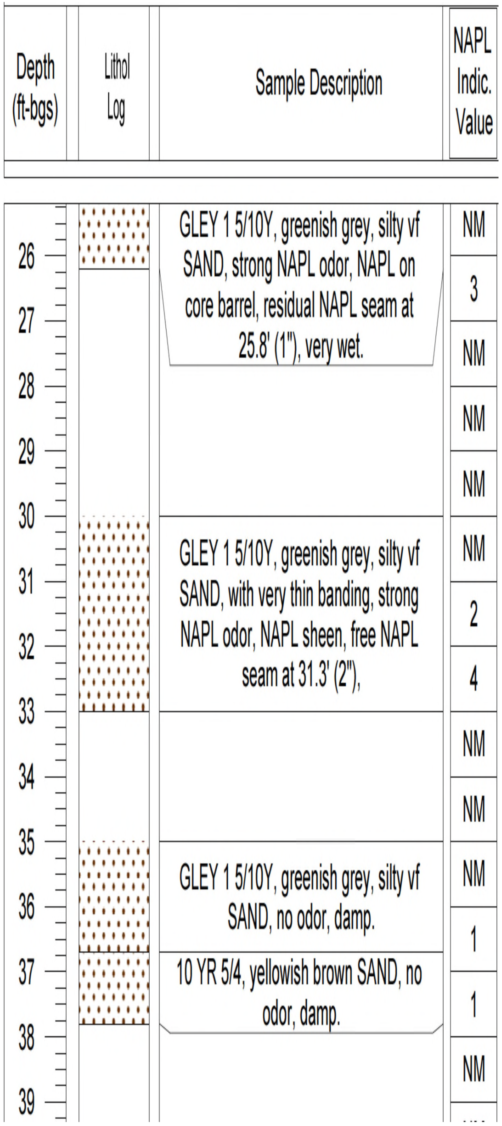
Former Koppers Company Inc. Site
Nashua, NH

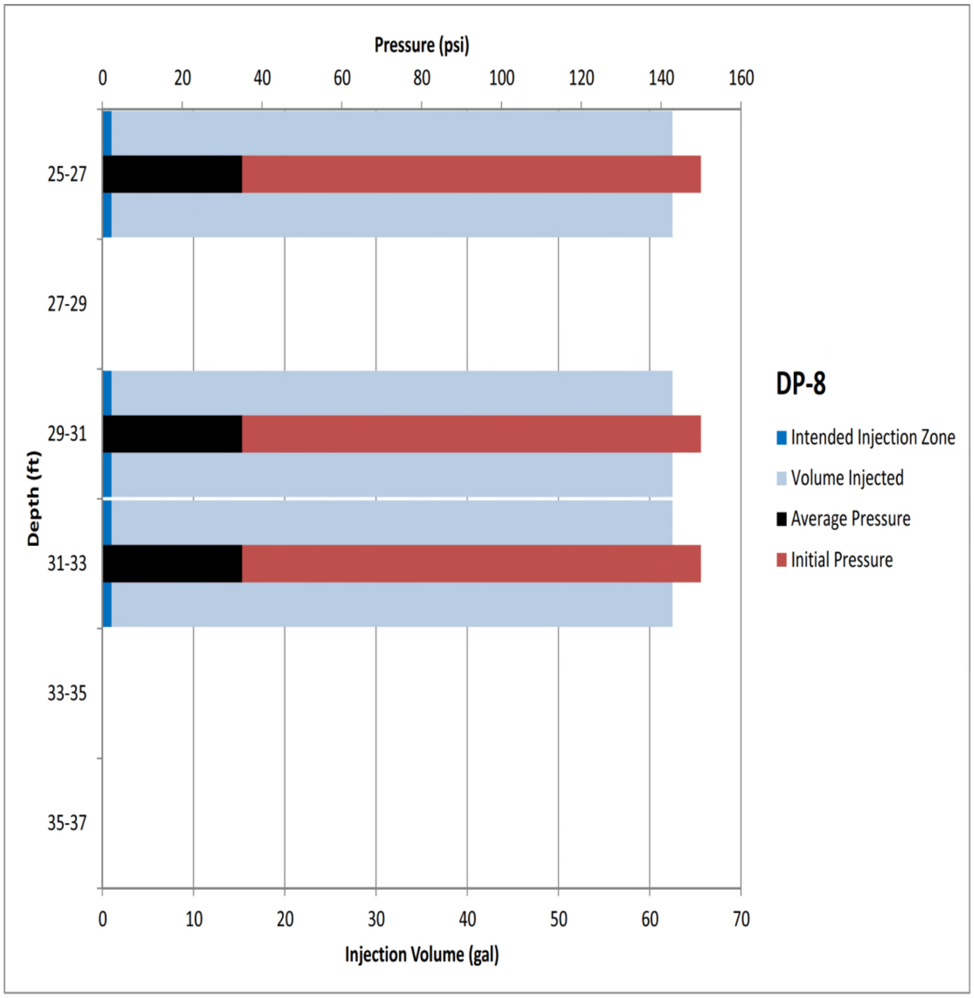
TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-7**
PROJECT #	117-2201346	
DATE	12-23-14	

Note:
Borehole log on left is for adjacent TIP IP13-09.

T:\Beazer_Nashua\ISGS_Pilot Test\Report\Figures\DP Injection Figures.pptx





TITLE:

REAGENT VOLUME INJECTED INTO DP-8
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:

Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE
DRAFTED	LD
PROJECT #	117-2201346
DATE	12-23-14

FIGURE

DP-8

Note:
Borehole log on left is for adjacent TIP IP13-04.

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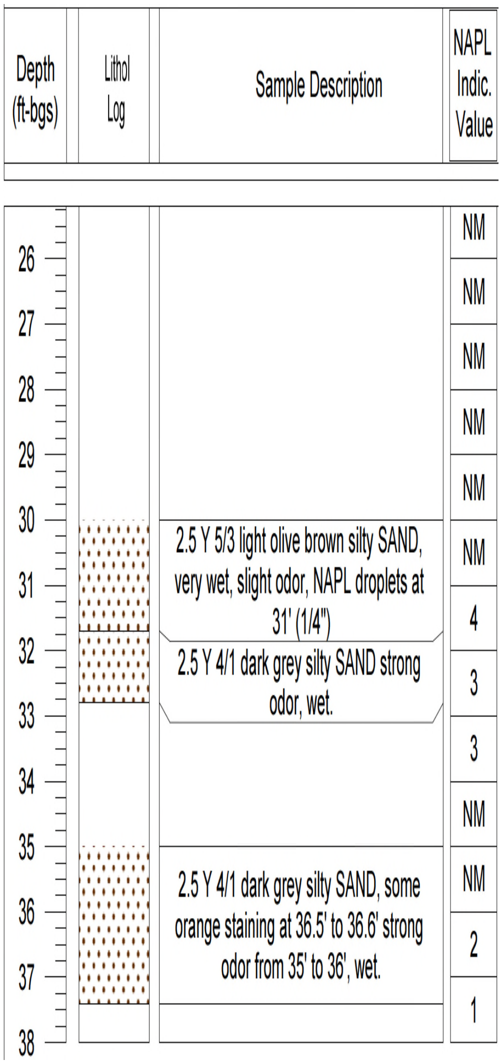

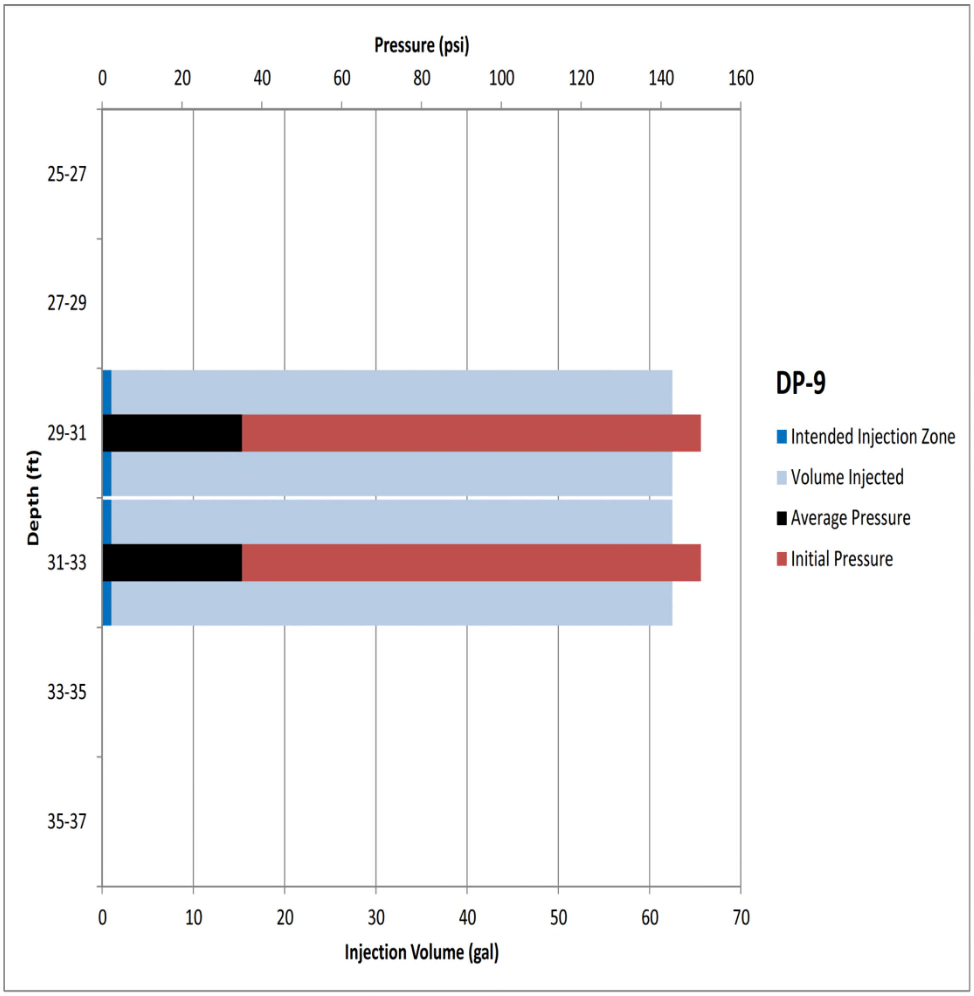

Note:
Borehole log on left is for adjacent TIP IP13-03.

TITLE:
REAGENT VOLUME INJECTED INTO DP-9
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:
Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-9**
PROJECT #	117-2201346	
DATE	12-23-14	

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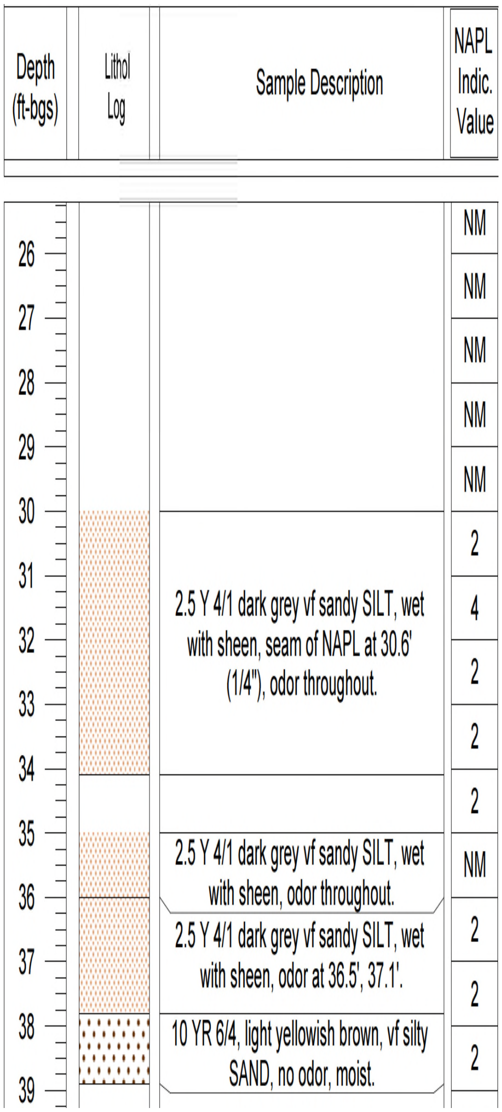

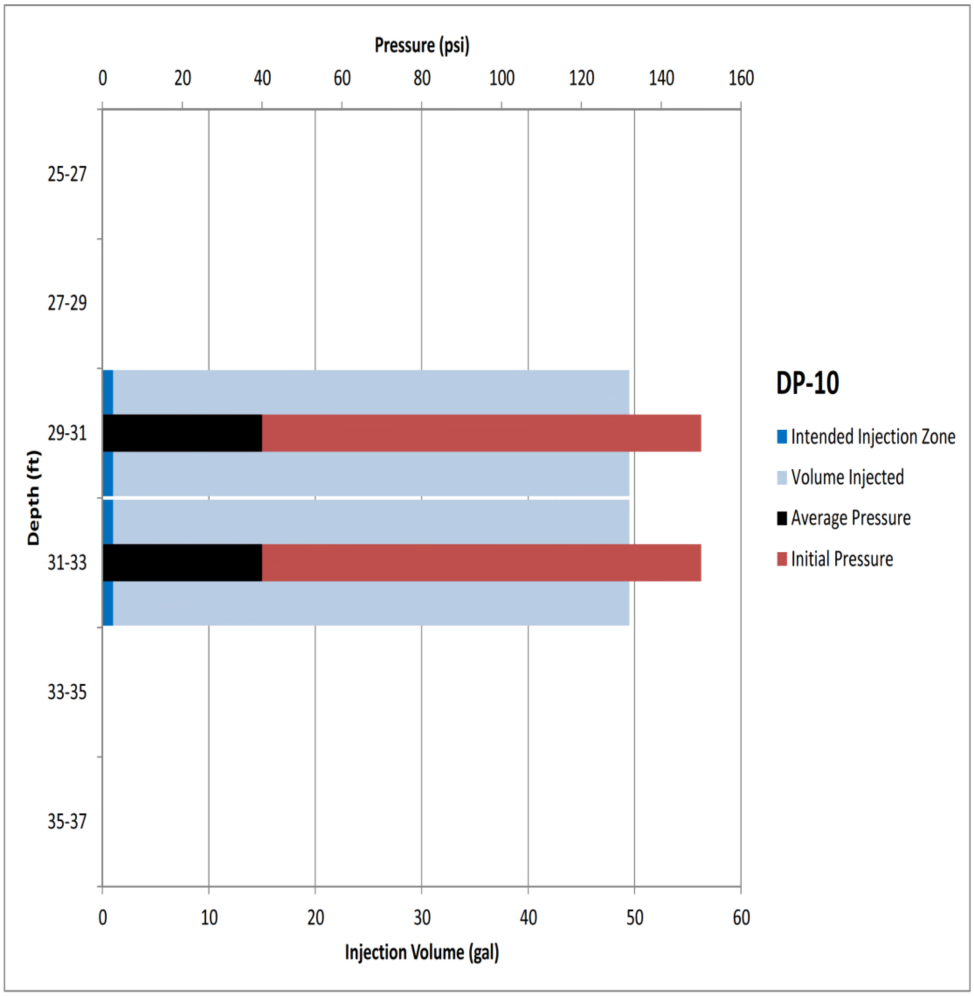

TITLE:

REAGENT VOLUME INJECTED INTO DP-10
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:

Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-10**
PROJECT #	117-2201346	
DATE	12-23-14	

Note:
Borehole log on left is for adjacent TIP IP13-01.

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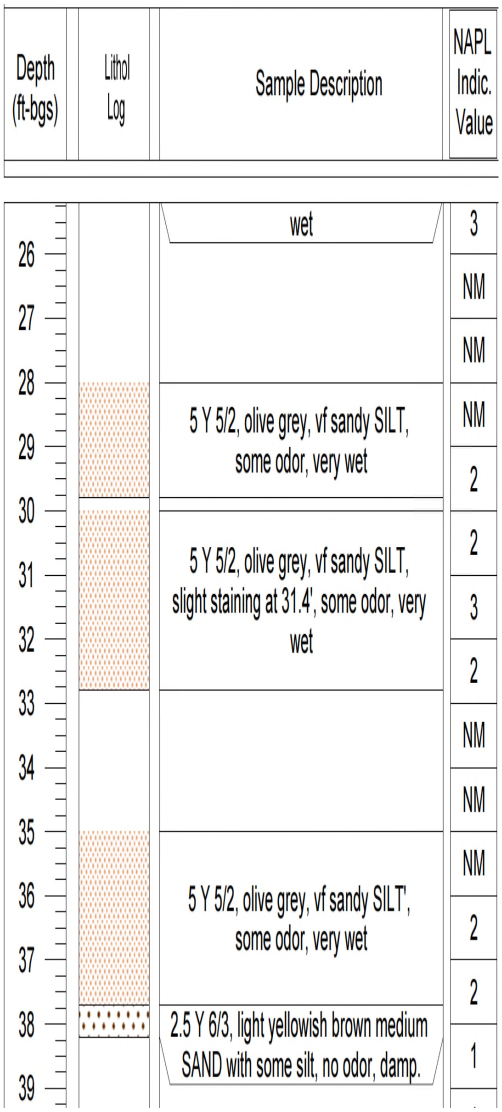

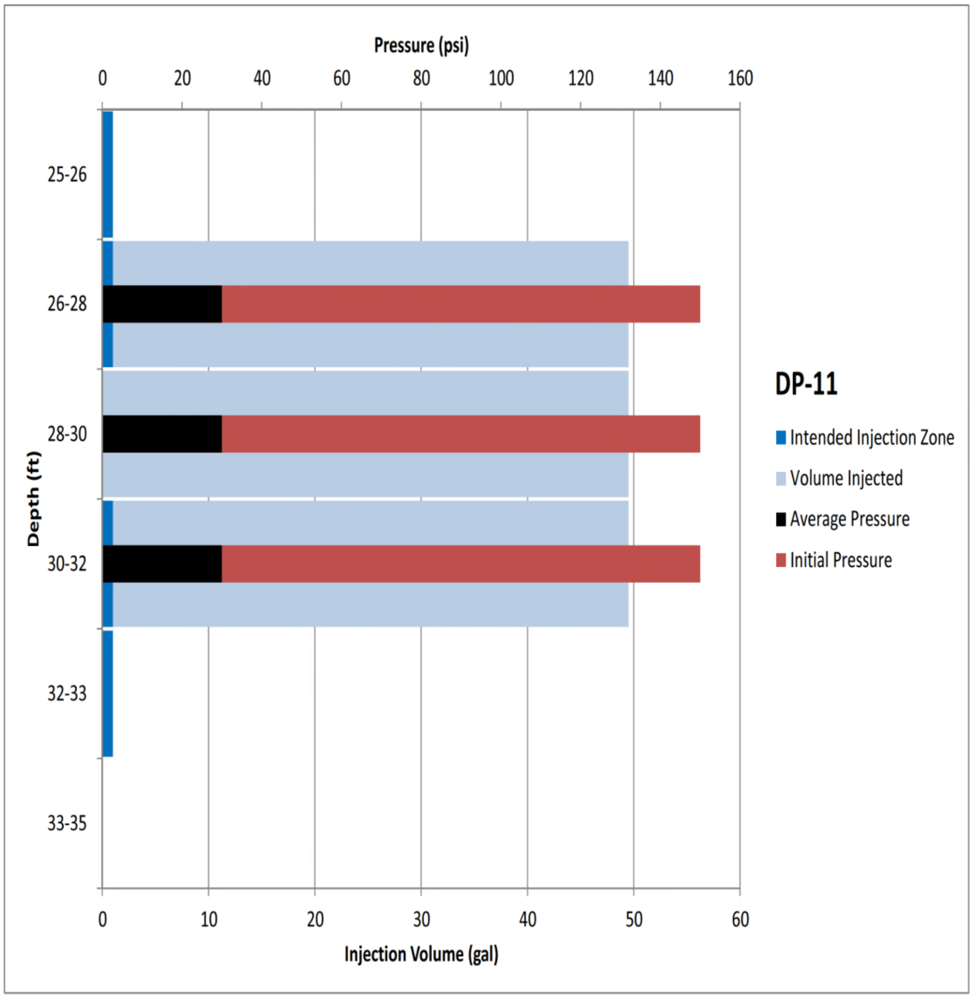

Note:
Borehole log on left is for adjacent TIP IP13-11.

TITLE:
REAGENT VOLUME INJECTED INTO DP-11
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:
Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-11**
PROJECT #	117-2201346	
DATE	12-23-14	

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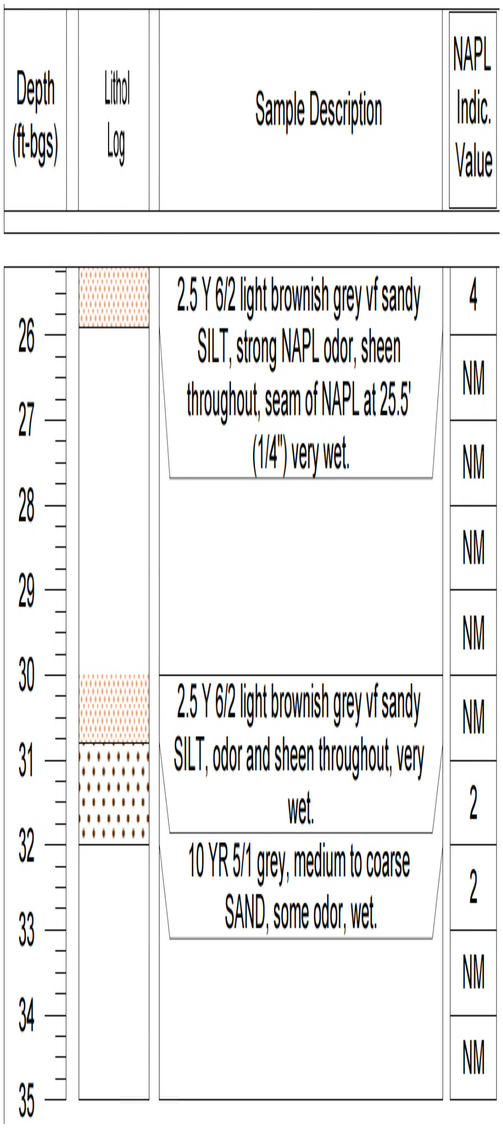

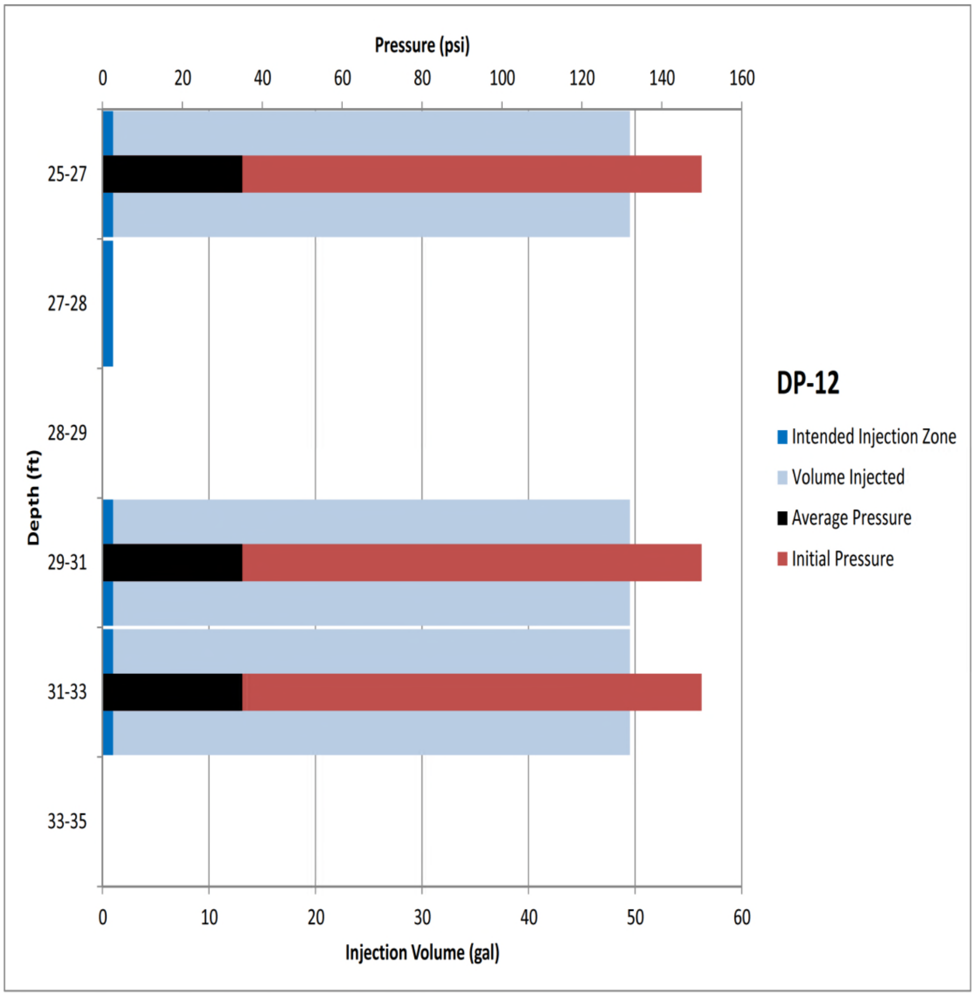

TITLE:

REAGENT VOLUME INJECTED INTO DP-12
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:

Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-12**
PROJECT #	117-2201346	
DATE	12-23-14	

Note:
Borehole log on left is for adjacent TIP IP13-10.

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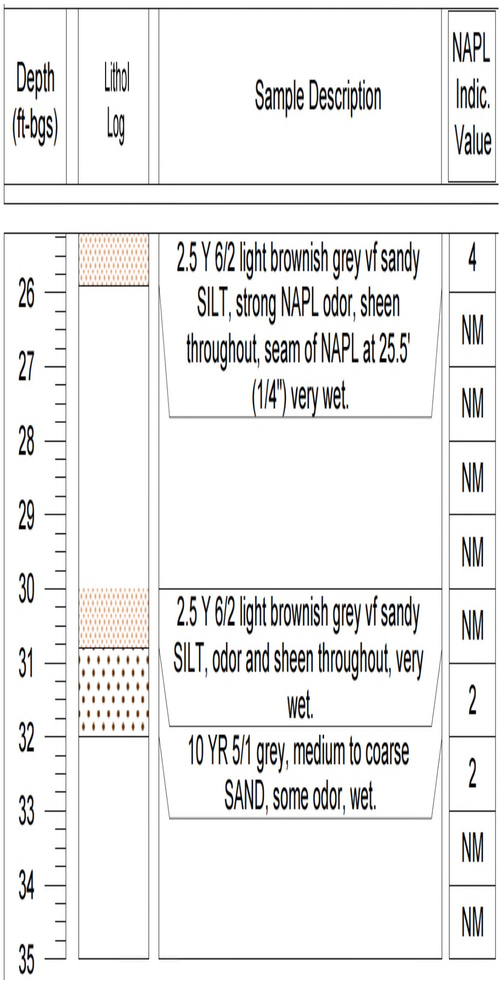
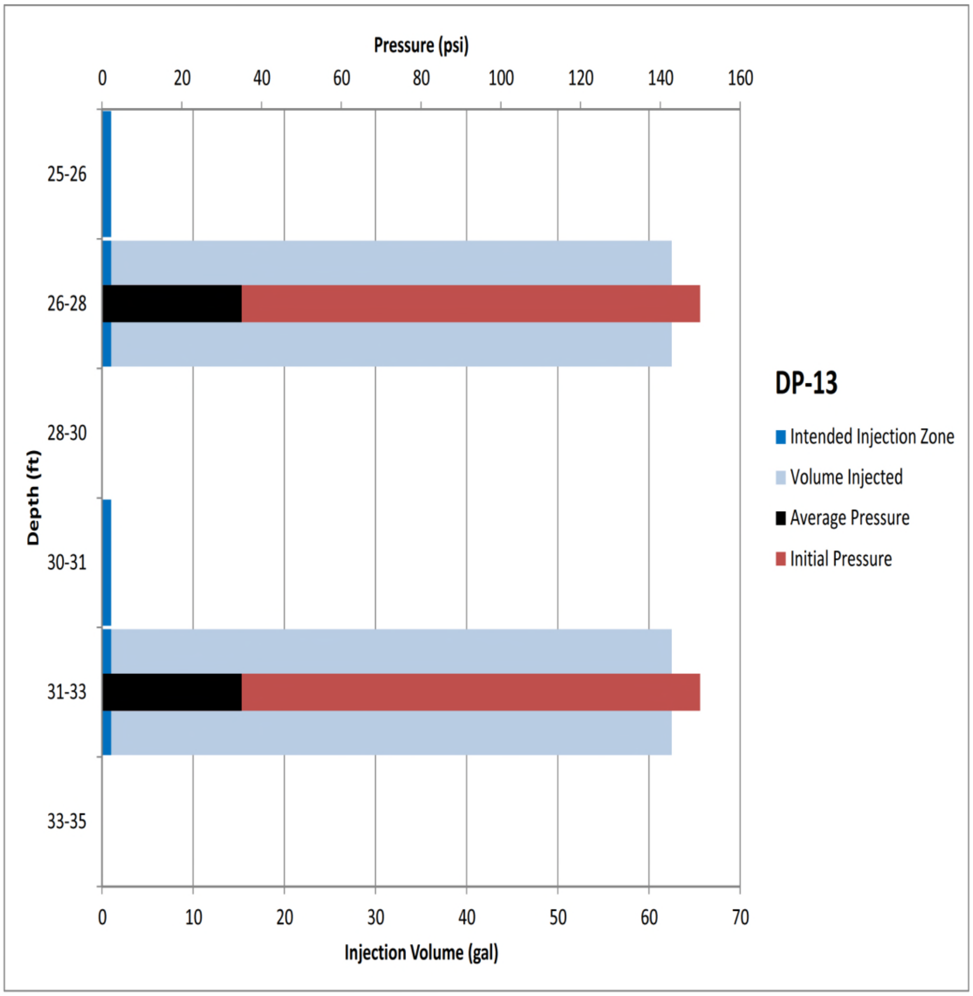


2.5 Y 6/2 light brownish grey vf sandy SILT, strong NAPL odor, sheen throughout, seam of NAPL at 25.5' (1/4") very wet.

2.5 Y 6/2 light brownish grey vf sandy SILT, odor and sheen throughout, very wet.

10 YR 5/1 grey, medium to coarse SAND, some odor, wet.



TITLE:
REAGENT VOLUME INJECTED INTO DP-13
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:
Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-13**
PROJECT #	117-2201346	
DATE	12-23-14	

Note:
Borehole log on left is for adjacent TIP IP13-10.

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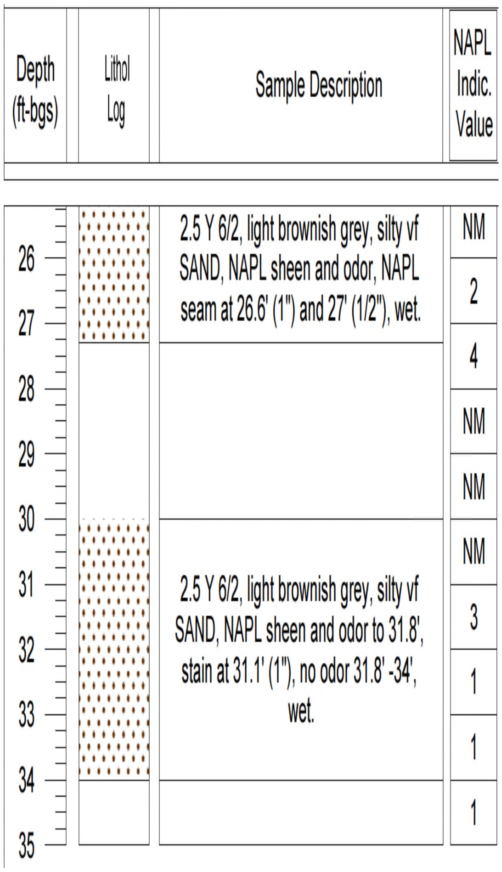
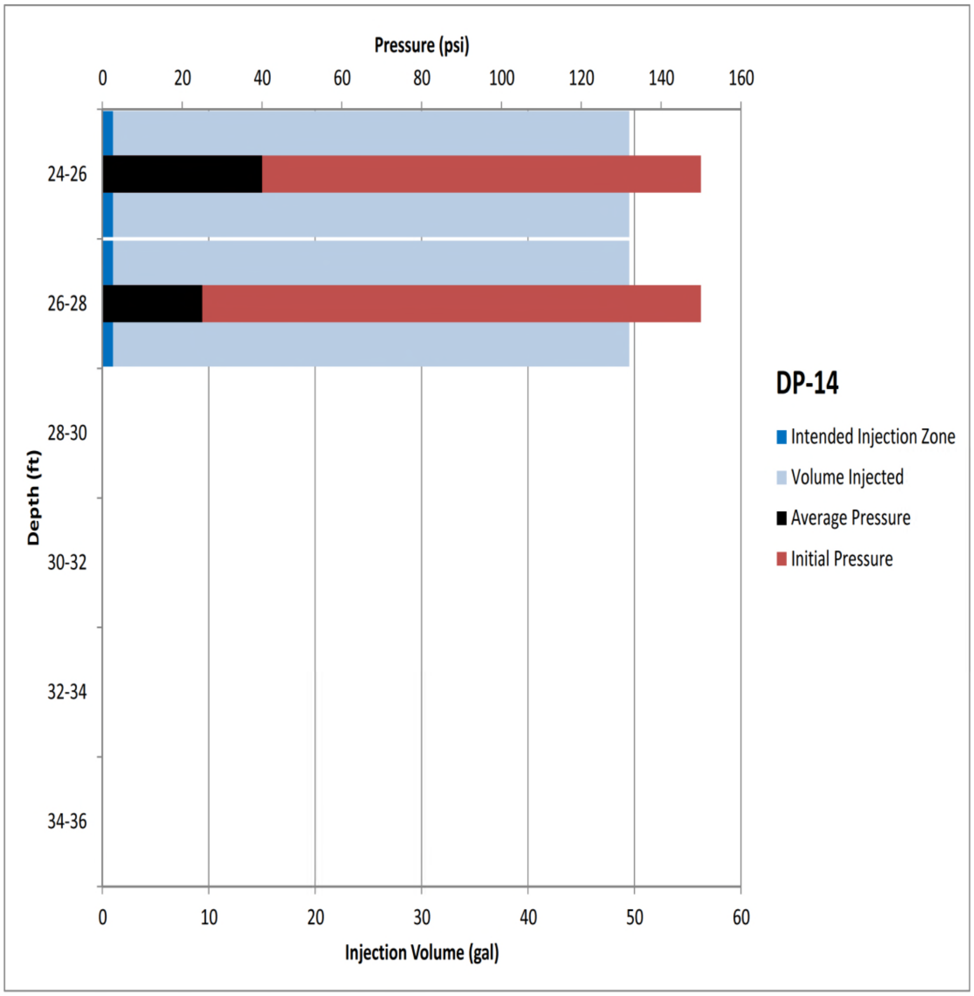


2.5 Y 6/2, light brownish grey, silty vf SAND, NAPL sheen and odor, NAPL seam at 26.6' (1") and 27' (1/2"), wet.

2.5 Y 6/2, light brownish grey, silty vf SAND, NAPL sheen and odor to 31.8', stain at 31.1' (1"), no odor 31.8' -34', wet.



TITLE:
REAGENT VOLUME INJECTED INTO DP-14
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:
Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-14**
PROJECT #	117-2201346	
DATE	12-23-14	

Note:
Borehole log on left is for adjacent TIP IP13-05.

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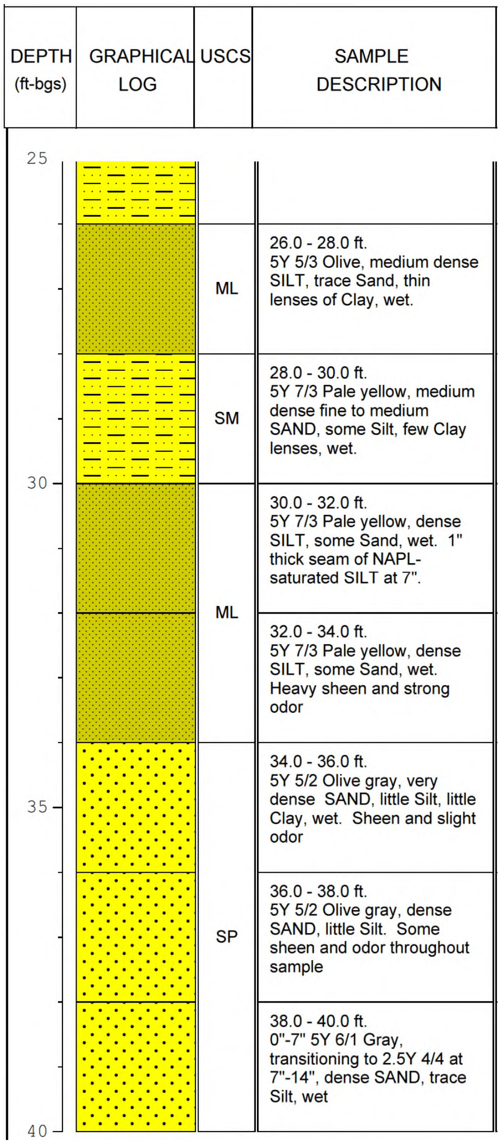
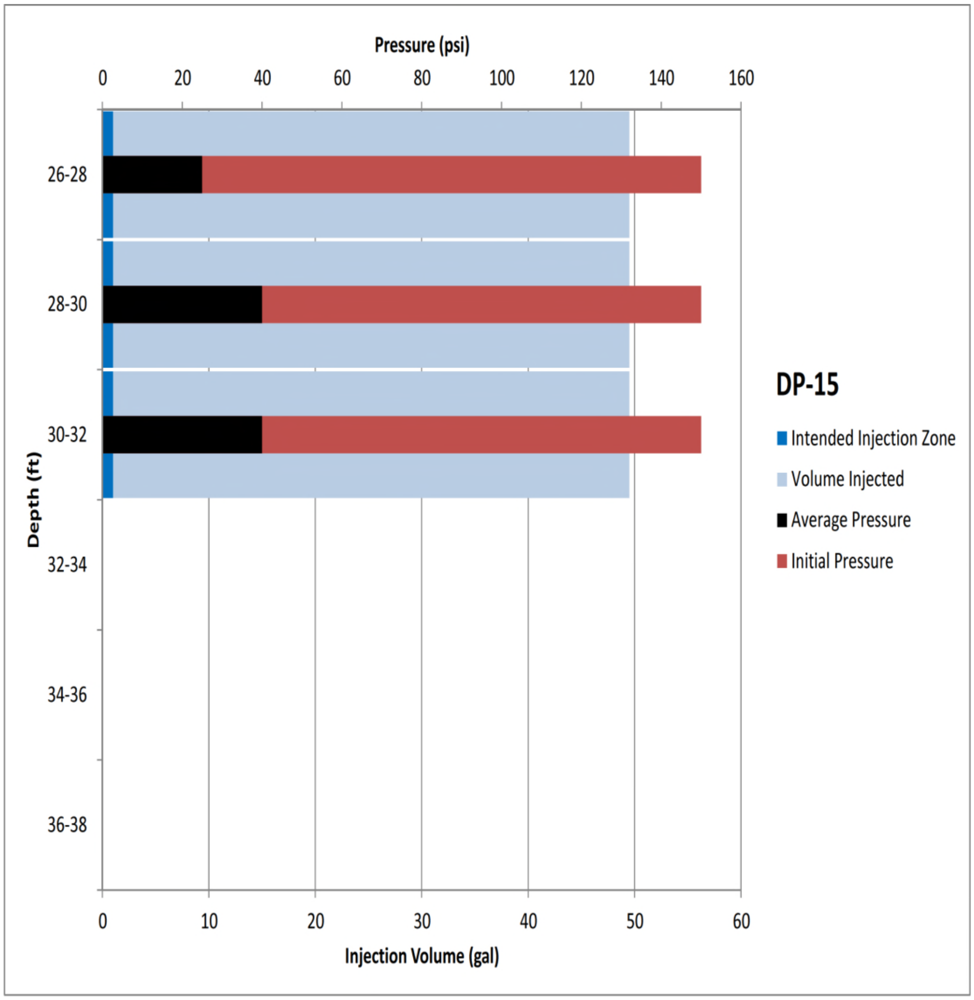


DEPTH (ft-bgs)	GRAPHICAL LOG	USCS	SAMPLE DESCRIPTION
25			
		ML	26.0 - 28.0 ft. 5Y 5/3 Olive, medium dense SILT, trace Sand, thin lenses of Clay, wet.
		SM	28.0 - 30.0 ft. 5Y 7/3 Pale yellow, medium dense fine to medium SAND, some Silt, few Clay lenses, wet.
30		ML	30.0 - 32.0 ft. 5Y 7/3 Pale yellow, dense SILT, some Sand, wet. 1" thick seam of NAPL-saturated SILT at 7".
			32.0 - 34.0 ft. 5Y 7/3 Pale yellow, dense SILT, some Sand, wet. Heavy sheen and strong odor
35		SP	34.0 - 36.0 ft. 5Y 5/2 Olive gray, very dense SAND, little Silt, little Clay, wet. Sheen and slight odor
			36.0 - 38.0 ft. 5Y 5/2 Olive gray, dense SAND, little Silt. Some sheen and odor throughout sample
40			38.0 - 40.0 ft. 0"-7" 5Y 6/1 Gray, transitioning to 2.5Y 4/4 at 7"-14", dense SAND, trace Silt, wet



TITLE:

REAGENT VOLUME INJECTED INTO DP-15
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:

Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-15**
PROJECT #	117-2201346	
DATE	12-23-14	

Note:
Borehole log on left is for adjacent well OW-55R.

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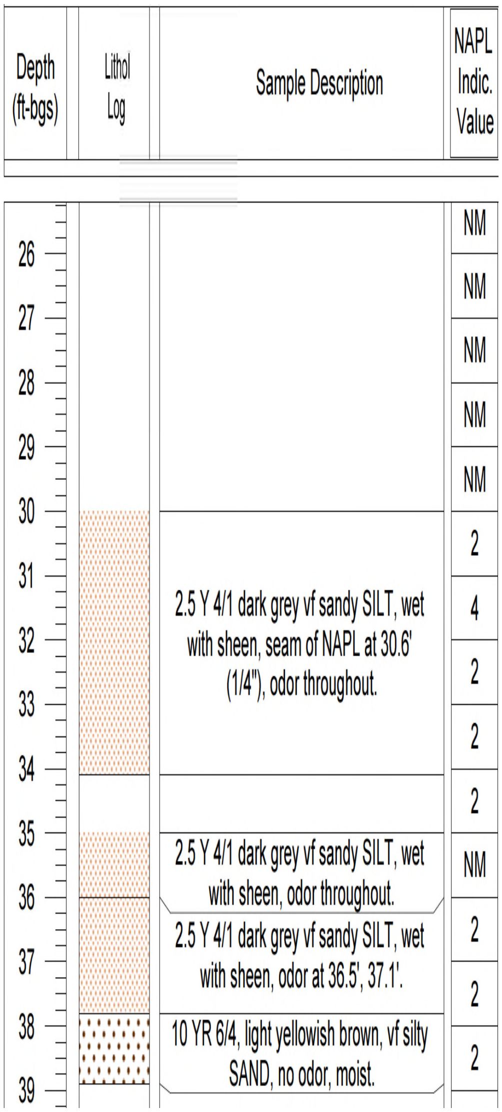

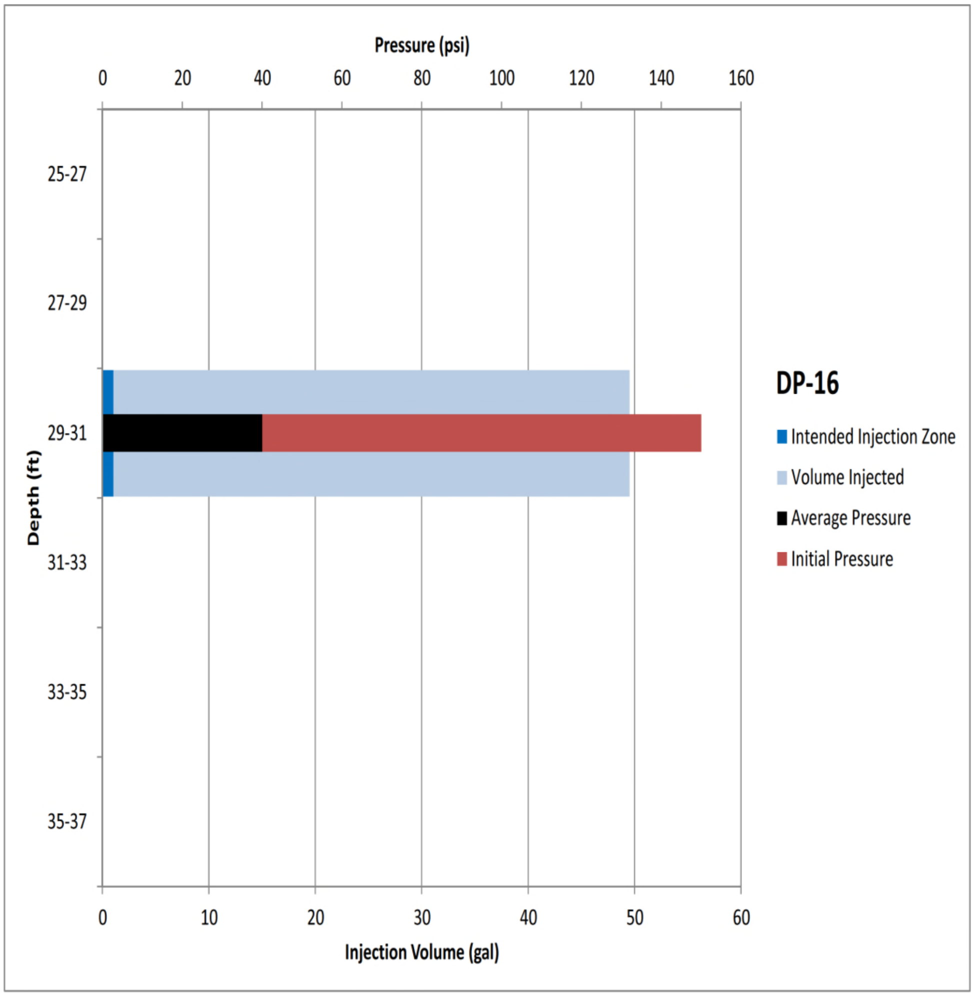

Note:
Borehole log on left is for adjacent TIP IP13-01.

TITLE:
REAGENT VOLUME INJECTED INTO DP-16
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:
Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-16**
PROJECT #	117-2201346	
DATE	12-23-14	

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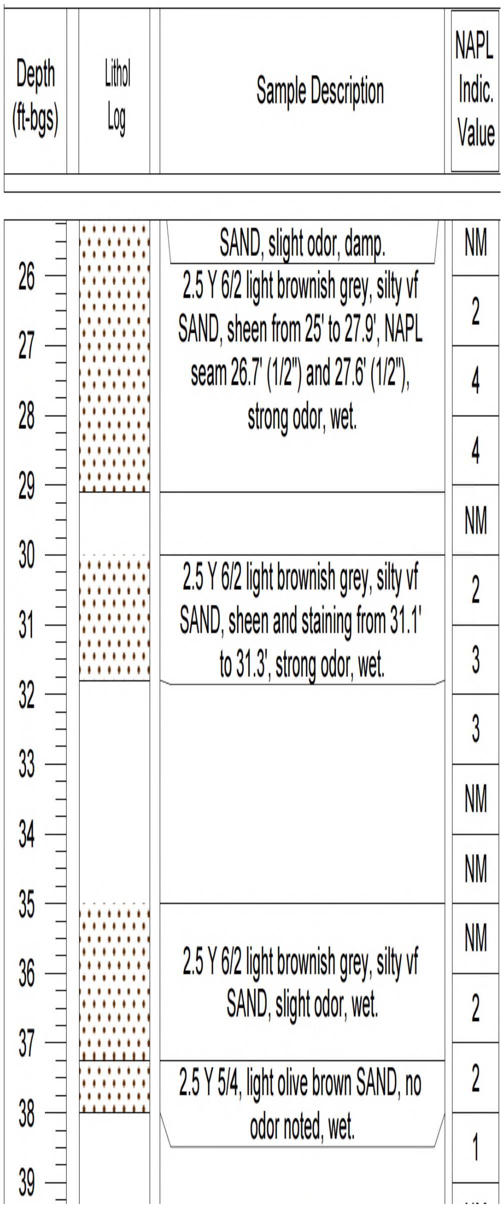
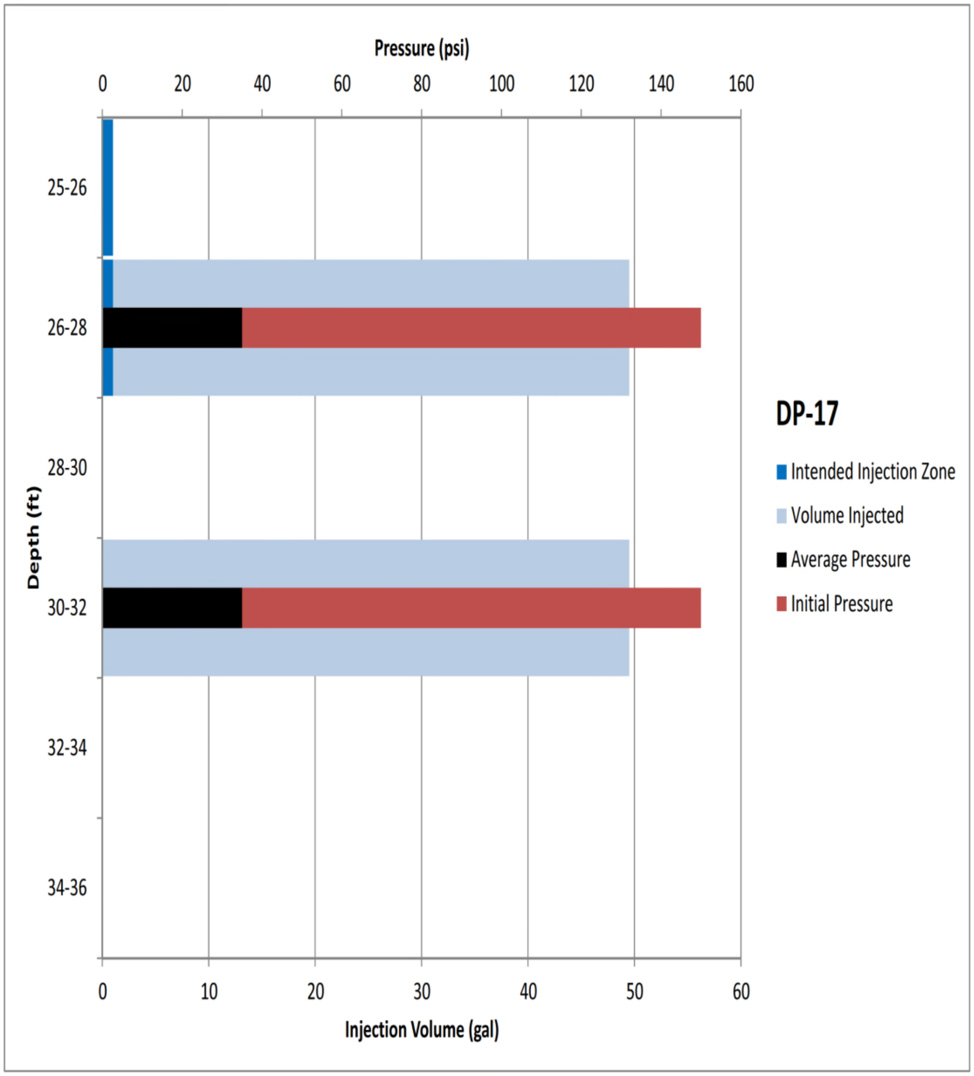


Depth (ft-bgs)	Lithol Log	Sample Description	NAPL Indic. Value
		SAND, slight odor, damp.	NM
26		2.5 Y 6/2 light brownish grey, silty vf SAND, sheen from 25' to 27.9', NAPL seam 26.7' (1/2") and 27.6' (1/2"), strong odor, wet.	2
27			4
28			4
29			NM
30		2.5 Y 6/2 light brownish grey, silty vf SAND, sheen and staining from 31.1' to 31.3', strong odor, wet.	2
31			3
32			3
33			NM
34			NM
35		2.5 Y 6/2 light brownish grey, silty vf SAND, slight odor, wet.	NM
36			2
37		2.5 Y 5/4, light olive brown SAND, no odor noted, wet.	2
38			1
39			



TITLE:

REAGENT VOLUME INJECTED INTO DP-17
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:

Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-17**
PROJECT #	117-2201346	
DATE	12-23-14	

Note:
Borehole log on left is for adjacent TIP IP13-06.

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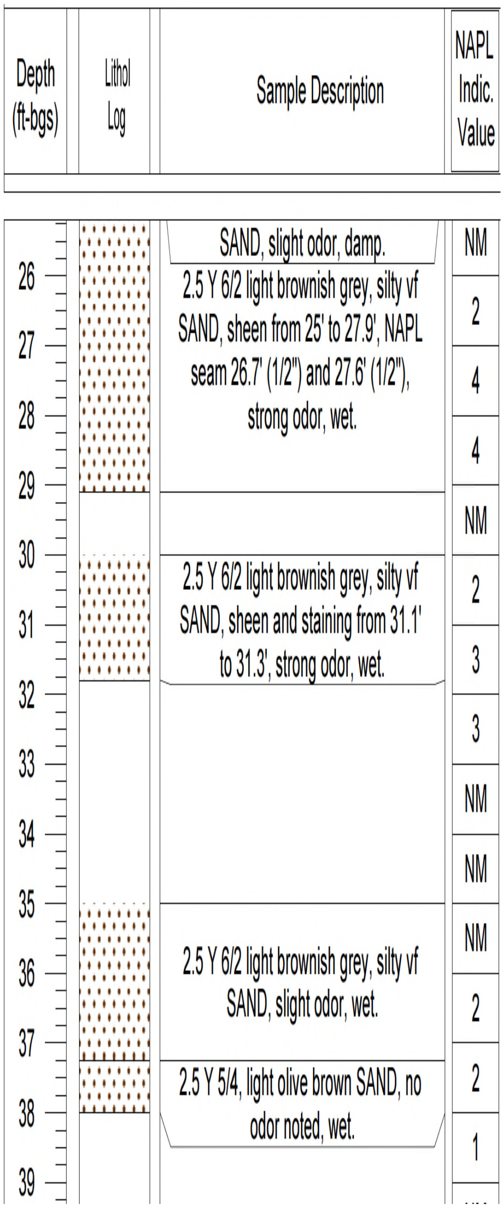
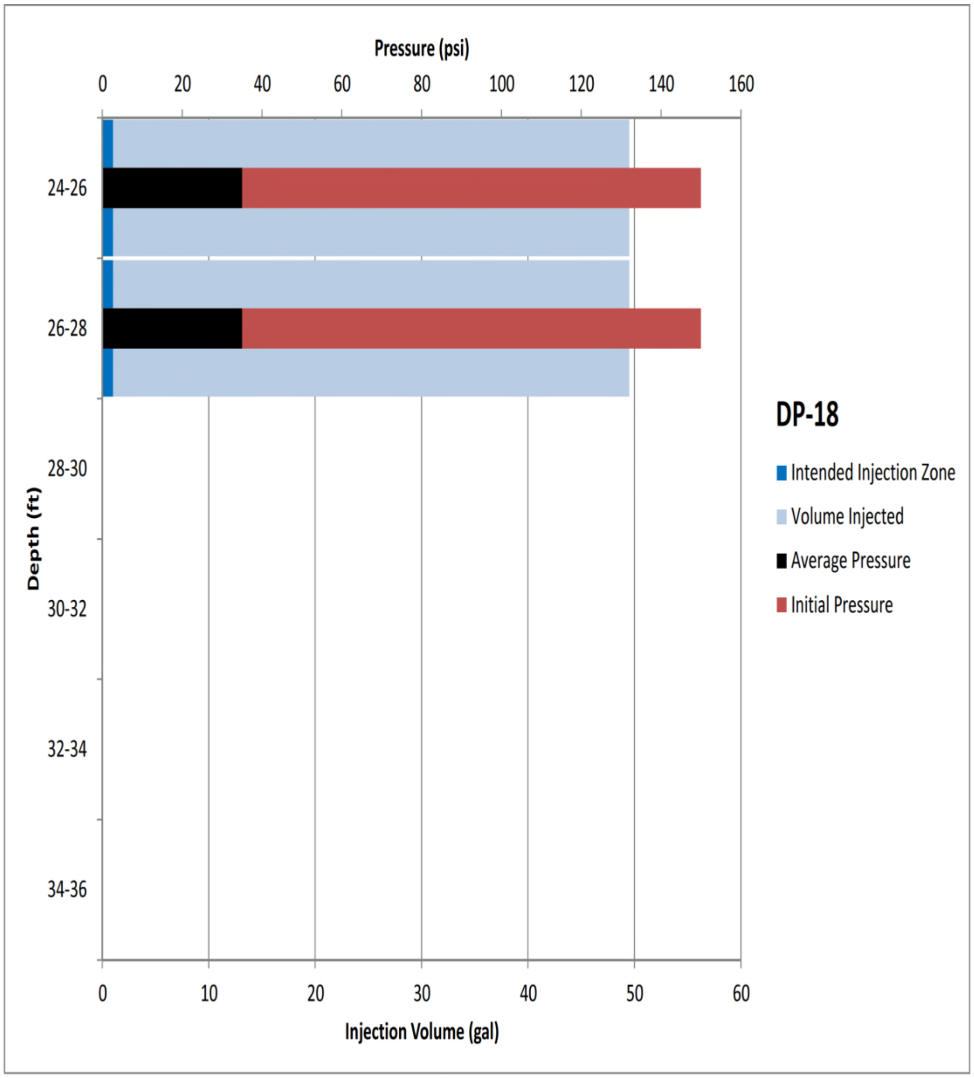


Depth (ft-bgs)	Lithol Log	Sample Description	NAPL Indic. Value
25		SAND, slight odor, damp. 2.5 Y 6/2 light brownish grey, silty vf SAND, sheen from 25' to 27.9', NAPL seam 26.7' (1/2") and 27.6' (1/2"), strong odor, wet.	NM
26			2
27			4
28			4
29			NM
30		2.5 Y 6/2 light brownish grey, silty vf SAND, sheen and staining from 31.1' to 31.3', strong odor, wet.	2
31			3
32			3
33			NM
34			NM
35		2.5 Y 6/2 light brownish grey, silty vf SAND, slight odor, wet.	NM
36			2
37		2.5 Y 5/4, light olive brown SAND, no odor noted, wet.	2
38			1
39			



Note:
Borehole log on left is for adjacent TIP IP13-06.

TITLE:
REAGENT VOLUME INJECTED INTO DP-18
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:
Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-18**
PROJECT #	117-2201346	
DATE	12-23-14	

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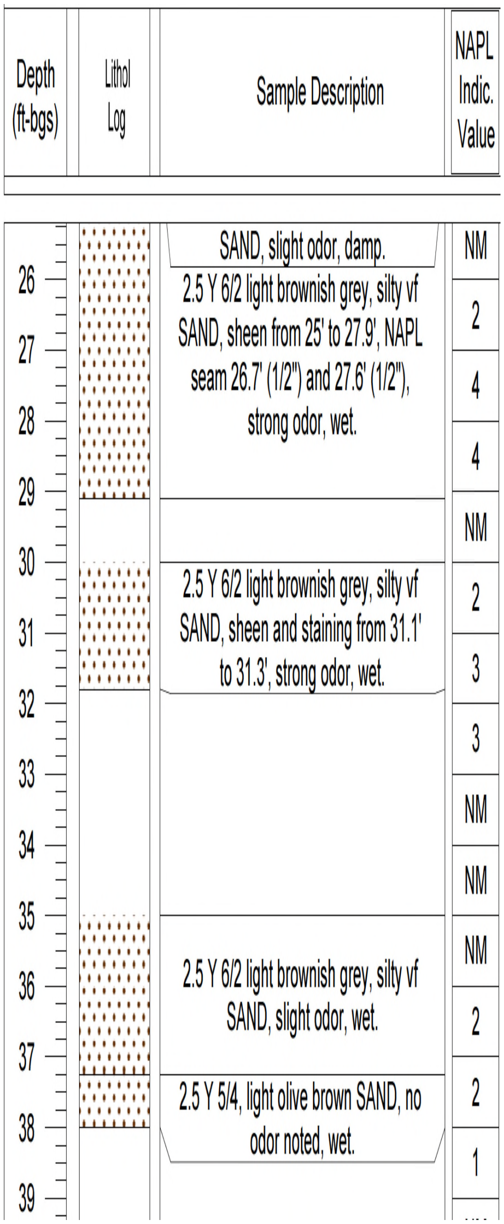


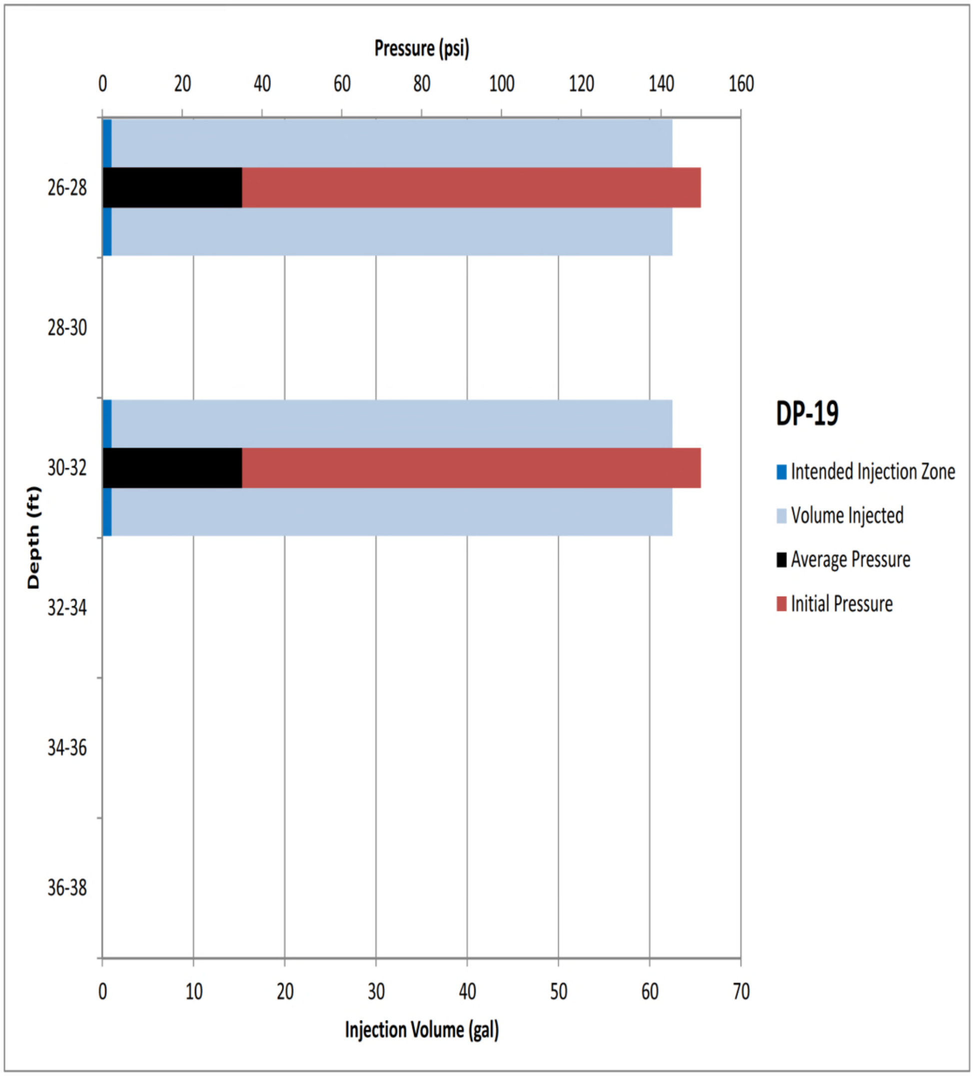
SAND, slight odor, damp.

2.5 Y 6/2 light brownish grey, silty vf SAND, sheen from 25' to 27.9', NAPL seam 26.7' (1/2") and 27.6' (1/2"), strong odor, wet.

2.5 Y 6/2 light brownish grey, silty vf SAND, sheen and staining from 31.1' to 31.3', strong odor, wet.

2.5 Y 6/2 light brownish grey, silty vf SAND, slight odor, wet.

2.5 Y 5/4, light olive brown SAND, no odor noted, wet.



Note:
Borehole log on left is for adjacent TIP IP13-06.

TITLE:

REAGENT VOLUME INJECTED INTO DP-19
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:

Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-19**
PROJECT #	117-2201346	
DATE	12-23-14	

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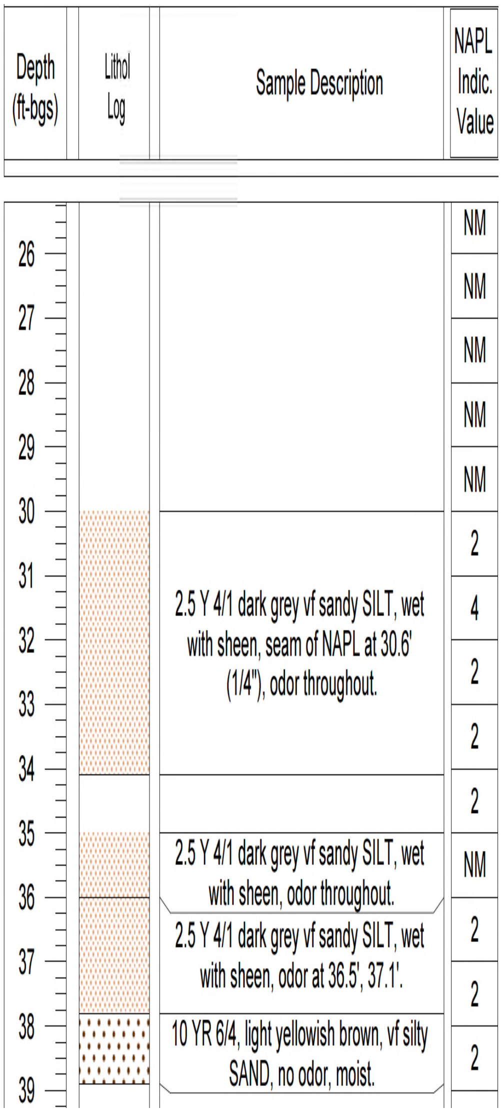
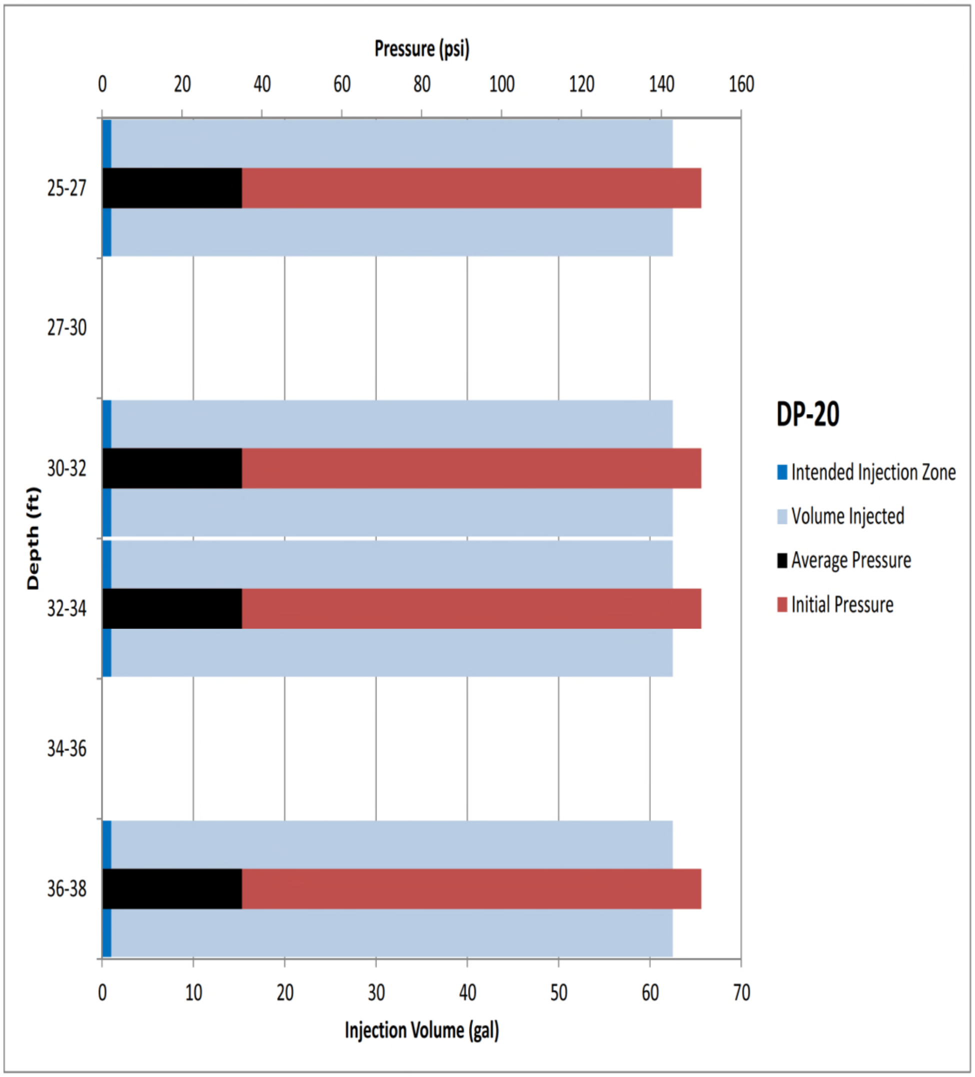


2.5 Y 4/1 dark grey vf sandy SILT, wet with sheen, seam of NAPL at 30.6' (1/4"), odor throughout.

2.5 Y 4/1 dark grey vf sandy SILT, wet with sheen, odor throughout.

2.5 Y 4/1 dark grey vf sandy SILT, wet with sheen, odor at 36.5', 37.1'.

10 YR 6/4, light yellowish brown, vf silty SAND, no odor, moist.



Note:
Borehole log on left is for adjacent TIP IP13-01.

TITLE:
REAGENT VOLUME INJECTED INTO DP-20
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:
Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-20**
PROJECT #	117-2201346	
DATE	12-23-14	

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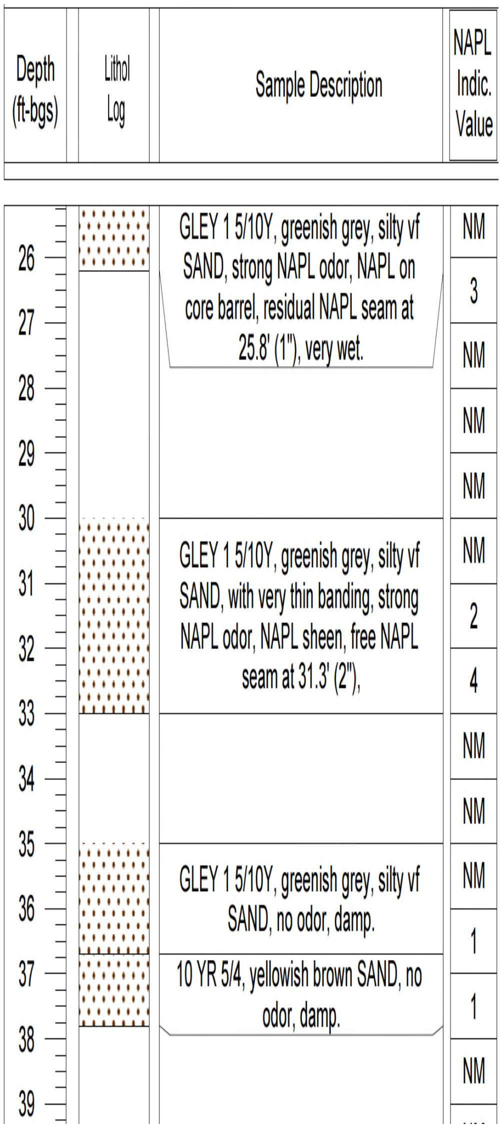
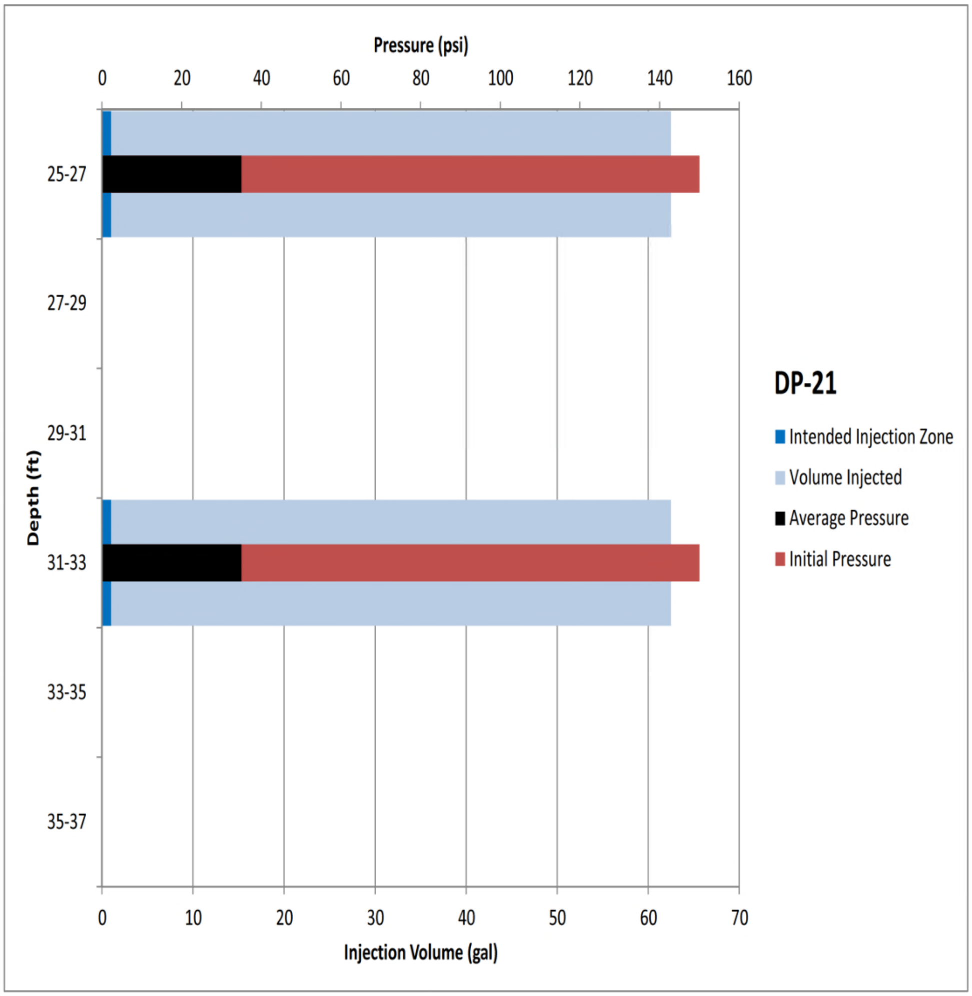


GLEY 1 5/10Y, greenish grey, silty vf SAND, strong NAPL odor, NAPL on core barrel, residual NAPL seam at 25.8' (1"), very wet.

GLEY 1 5/10Y, greenish grey, silty vf SAND, with very thin banding, strong NAPL odor, NAPL sheen, free NAPL seam at 31.3' (2"),

GLEY 1 5/10Y, greenish grey, silty vf SAND, no odor, damp.

10 YR 5/4, yellowish brown SAND, no odor, damp.



TITLE:
REAGENT VOLUME INJECTED INTO DP-21
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:
Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-21**
PROJECT #	117-2201346	
DATE	12-23-14	

Note:
Borehole log on left is for adjacent TIP IP13-04.

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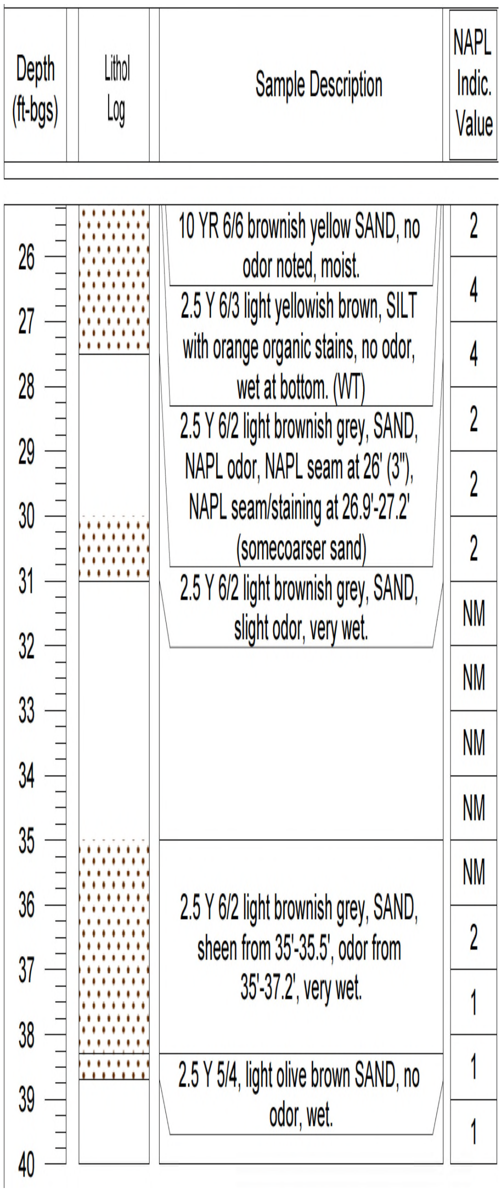


10 YR 6/6 brownish yellow SAND, no odor noted, moist.

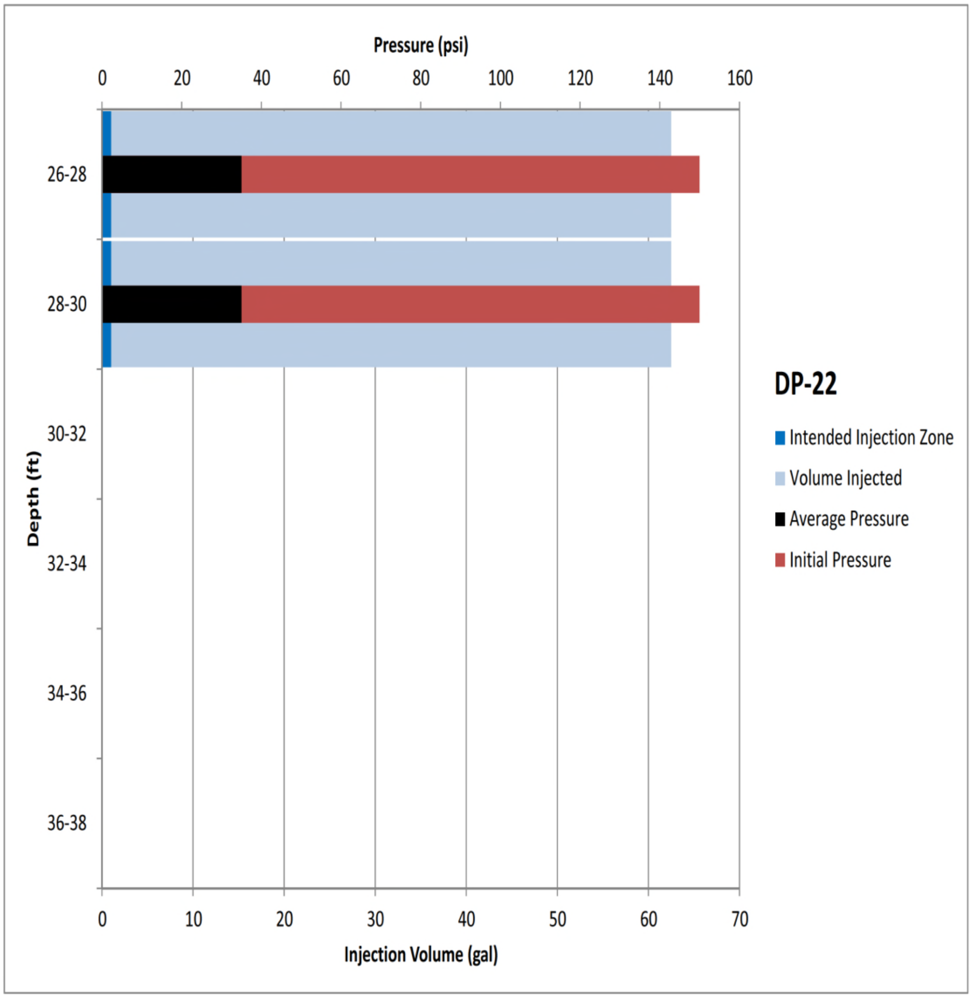
2.5 Y 6/3 light yellowish brown, SILT with orange organic stains, no odor, wet at bottom. (WT)

2.5 Y 6/2 light brownish grey, SAND, NAPL odor, NAPL seam at 26' (3"), NAPL seam/staining at 26.9'-27.2' (somecoarser sand)

2.5 Y 6/2 light brownish grey, SAND, slight odor, very wet.

2.5 Y 6/2 light brownish grey, SAND, sheen from 35'-35.5', odor from 35'-37.2', very wet.

2.5 Y 5/4, light olive brown SAND, no odor, wet.



Note:
Borehole log on left is for adjacent TIP IP13-07.

TITLE:
REAGENT VOLUME INJECTED INTO DP-22
WITH AVERAGE AND MAXIMUM INITIAL INJECTION PRESSURES

LOCATION:
Former Koppers Company Inc. Site
Nashua, NH

TETRA TECH

APPROVED	JE	FIGURE
DRAFTED	LD	**DP-22**
PROJECT #	117-2201346	
DATE	12-23-14	

APPENDIX D

NHDES TEMPORARY DISCHARGE PERMIT AND APPROVAL DOCUMENTATION

NHDES Temporary Groundwater Discharge Permit

November 4, 2014

NHDES

The State of New Hampshire
Department of Environmental Services

Thomas A. Burack - Commissioner

November 4, 2014

PETER SAWCHUCK
KEY ENVIRONMENTAL INC.
120 EXCHANGE STREET
SUITE 300
PORTLAND ME 04101

TEMPORARY DISCHARGE PERMIT

SUBJECT: **NASHUA** – Beazer East (former Koppers Co.), Hills Ferry Road, Temporary Groundwater Discharge Permit for remedial Injections
Site# 198708017 / RSN# 34017 / Activity# 212657

Dear Mr. Sawchuck:

Please find enclosed the Temporary Groundwater Discharge Permit Number TGP-TGP-198708017-N-001, approved by the Water Division of the Department of Environmental Services for the discharge of remedial fluids and materials into the subsurface as outlined in the Remedial Action Plan (RAP) approved by the Department's Waste Management Division.

The discharge shall not result in erosion or sedimentation on site or into any surface water or wetland.

Should you have any questions, please contact me at the Water Division at (603) 271-2858 or by e-mail at mitchell.locker@des.nh.gov.

Sincerely,

Mitchell Locker

Mitchell Locker, P.G.
Drinking Water & Groundwater Bureau

MDL/ml H:\common\hydrology & conservation\programs\uic\2015mdl\permits\198708017-N-001 reminj 5B6.doc
e-copy: Steve Roy, DWGB
File

NEW HAMPSHIRE
DEPARTMENT OF
Environmental
Services

The

NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES

WATER DIVISION

hereby issues

TEMPORARY GROUNDWATER DISCHARGE PERMIT

NO. TGP-198708017-N-001

to the permittee

BEAZER EAST INC. & THE CITY OF NASHUA

for the injection of remedial fluids into the groundwater

for the In-Situ Geochemical Stabilization Remediation Pilot Test

at 2 HILLS FERRY ROAD

in NASHUA, NH

TO: BEAZER EAST INC.
MANOR OAK ONE
1910 COCHRAN ROAD - SUITE 200
PITTSBURGH PA 15220

Date of Issuance: November 4, 2014
Date of Expiration: March 4, 2015

(continued)

Pursuant to authority in N.H. RSA 485-A:13, I(a), the New Hampshire Department of Environmental Services (Department), hereby grants this permit to discharge materials for in-situ remediation to the groundwater at the above described location subject to the following conditions:

STANDARD PERMIT CONDITIONS

1. The permittee shall not violate surface water quality standards (N.H. Admin. Rules, Env-Wq 1700) in any surface water body.
2. The permittee shall conduct activities and discharges in accordance with the Temporary Discharge Permit application and supporting information submitted on October 28, 2014 and the Remedial Action Plan (RAP) approved by the Department's waste Management Division.
3. The discharge shall not result in erosion or sedimentation on site or into any surface water or wetland.
4. The discharge shall not violate Ambient Groundwater Quality Standards adopted by the Department (N.H. Admin. Rules, Env-Wq-402).
5. The permittee shall allow an authorized member of the Department staff, or its agent, to enter the property covered by this permit for the purpose of collecting information, examining records, collecting samples, or undertaking other action associated with this permit.
6. The permittee shall comply with any conditions associated with this discharge that are stipulated by the municipality in which it is located.
7. The Department reserves the right under RSA 485-A, to require additional sampling of the discharge and/or discharge area.
8. The permittee shall cease discharge immediately if water quality standards are violated. The Department's Groundwater Discharge Permits Coordinator shall be notified, by telephone within one working day and in writing within 72 hours, of water quality standard violations.
9. Any changes to the discharge or modification of the Remedial Action Plan shall be approved by the Department.
10. This permit expires four (4) months after the date of issuance.

Rene Pelletier, P.G.,
Assistant Director, Water Division

Under RSA 21-0:14 and 21-0:7-IV, any person aggrieved by any terms or conditions of this permit may appeal to the Water Council in accordance with RSA 541-A and N.H. Admin. Rules, Env-WC 200. Such appeal must be made to the Council within 30 days and must be addressed to the Chairman, Water Council, 29 Hazen Drive, PO Box 95, Concord, NH 03302-0095.

NHDES ISGS Implementation Approval Letter

November 6, 2014

The State of New Hampshire
Department of Environmental Services

Thomas S. Burack, Commissioner

November 6, 2014

Mike Bollinger
Beazer East, Inc.
Manor Oak One, Suite 200
1910 Cochran Road
Pittsburgh, PA 15220

Subject: **Nashua** – Beazer East (Former Koppers Company), Hills Ferry Road
DES Site #**198708017**, Project #346

OW-5/55R Area In-Situ Geochemical Stabilization Remediation Pilot Test Workplan, Response to Comments and Final Workplan, prepared by Key Environmental, Inc. and Tetra Tech, dated October 21, 2014

Consent Decree, Docket No. 04-E-0151

Dear Mr. Bollinger:

The New Hampshire Department of Environmental Services (Department) has reviewed the subject correspondence that was prepared by Key Environmental, Inc. and Tetra Tech in response to the Sanborn Head & Associates, Inc. comment letter dated September 18, 2014. The Department also received clarification from Tetra Tech, Inc. regarding one of the comments in an e-mail dated November 4, 2014. The Department finds the responses to be acceptable and hereby approves the implementation of the revised Workplan dated October 20, 2014.

Should you have any questions, please contact me at the Department's Waste Management Division.

Sincerely,

Michael McCluskey

Michael McCluskey, P.E.
Hazardous Waste Remediation Bureau
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ec: Peter Sawchuck, P.E., Key Environmental, Inc.
James Erickson, P.G., Tetra Tech
Charles Crocetti, P.G., Sanborn Head & Associates, Inc.
Timothy White, P.G., Sanborn Head & Associates, Inc.
Attention Health Officer, City of Nashua
Thomas Galligani, City of Nashua
Gene Porter, Lower Merrimack LAC
John Regan, P.G., DES-HWRB
Rebecca Williams, P.G., DES-HWRB
Jacquie Colburn, DES Rivers Coordinator

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