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Rockaway Park Former Manufactured Gas Plant (MGP) Site
Rockaway Park, Queens County, New York

July 16, 2010 Field Change Request: FCR-06a

Phase 3: Composite 120-Foot Deep DNAPL Migration Barrier Installation Procedures

1.0 FCR-06a OVERVIEW

On behalf of National Grid NY, Paulus, Sokolowski and Sartor Engineering, PC (PS&S) has prepared this Field Change Request # 6a (FCR-06a) to address the proposed Phase 3 Composite 120-foot Deep Dense Non-aqueous Phase Liquid (DNAPL) Migration Barrier (i.e., the upper Waterloo Barrier™ interlocking steel sheet piling and the proposed lower soil-cement barrier wall) Installation Procedures at the On-Site Area of the Rockaway Park Former Manufactured Gas Plant (MGP) Site (Site).

Field Change Request # 6 (FCR-06) dated February 25, 2010 was prepared to address the updated 120-foot DNAPL Migration Barrier (i.e., the Waterloo Barrier™ interlocking steel sheet piling) Installation Procedures. FCR-06 presented a phased approach for the installation of a continuous 120-foot deep DNAPL Migration Barrier, including the Phase 3 Composite 120-foot deep DNAPL Migration Barrier Wall approach, in accordance with the New York State Department of Environmental Conservation (NYSDEC) Record of Decision (ROD) and the NYSDEC approved 100 percent Remedial Design Report (RDR). NYSDEC approved FCR-06 on March 4, 2010. The National Grid Project Team commenced the phased installation approach in March 2009; which consisted of the following three DNAPL Migration Barrier Wall technologies and installation methodologies.

1. ***PHASE 1, 120-FOOT DEEP WATERLOO INTERLOCKING SHEETS WITH GROUTED JOINTS (2009 THROUGH MAY 2010)***: This phase considered the successful installation of the 120-foot deep Waterloo Barrier™ interlocking steel sheet piling and successful flushing and grouting of the interlocking joints in accordance with the RDR and Project Specifications (specifically, Section 02261, Waterloo Barrier™ System Steel Sheet Piling with Sealed Interlock System, refer to Attachment B). Phase 1 consisted of two alternative Waterloo Barrier™ interlocking steel sheeting installation methodologies, as summarized below:

    - ***March 2009 through May 2009 and October 2009***: Installation of Waterloo Barrier™ interlocking steel sheet piling by driving from east to west; where the male joint was the lead joint. ***Repeatable 2009 installations of the 120-foot deep interlocking steel sheet piling was observed not to be successful***;
    - ***Option Phase 1a***: Installation of Waterloo Barrier™ interlocking steel sheet piling by driving from west to east; where the female joint was the lead joint. ***Phase 1a was attempted in March 2010 and was also not successful***; and,
    - ***Option Phase 1b***: Pre-drill 24-inch diameter boreholes ("relief shafts") at the drive joints followed by the installation of the Waterloo Barrier™ interlocking steel sheet piling.

Phase 1b mobilization commenced in April 2010 and operations were performed in May 2010. Repeatable interlocking steel sheet pile installation operations were not observed and on May 27, 2010, Phase 1b Pre-Drill Activities and interlocking steel sheet pile installation operations were postponed.

2. ***PHASE 2, 120-FOOT DEEP WATERLOO INTERLOCKING SHEETS WITH GROUTED JOINTS PLUS JOINTS WITH AN EXTERNAL SEAL (2009 THROUGH AUGUST 2010***: This phase considered the successful installation of 65-foot deep Waterloo Barrier™ interlocking steel sheet piling. Primary flushing and grouting operations for the 65-foot deep Waterloo Barrier™ interlocking steel sheet piling was completed in July 2010 and five interlocking joints were observed to be noncompliant and will require an external joint sealant. As further discussed in the attached Work Plan, the external joint sealant will be incorporated into the construction of the Phase 3 Composite DNAPL Migration Barrier Wall.

3. ***PHASE 3, COMPOSITE 120-FOOT DEEP DNAPL MIGRATION BARRIER WALL:*** Since the 120 foot deep Waterloo Barrier™ interlocking steel sheet piling cannot be advanced to the remedial design depth of 120 feet bgs, a composite DNAPL Migration Barrier wall will be installed as follows:

    - Successful installation of the Waterloo™ Barrier interlocking steel sheet piling and successful flushing and grouting of the interlocking joints to a prescribed depth (e.g., 65 feet bgs); and then,
    - Soil-cement barrier wall constructed of overlapping jet grouted columns installed with a minimum five foot overlap of the bottom of the Waterloo™ barrier steel sheeting (e.g., top of soil cement barrier wall at 60 feet bgs and extend to the remedial design depth of 120 feet bgs).

The attached 2010 Waterloo Barrier Record of Construction Plan (refer to Attachment A) and the July 12, 2010 Table 1, 120-foot Deep DNAPL Migration Barrier Interlocking Steel Sheet Piling Quality Assurance Installation Summary Matrix (refer to Attachment B) present a summary of the remedial action construction progress for the 120–foot Deep DNAPL Migration Barrier and the approximately 65-foot deep Waterloo Barrier™ interlocking steel sheet piling.

2.0 REVISED REMEDIAL DESIGN APPROACH

A FCR-06a Phase 3 Work Plan (WP) for the proposed Phase 3, Composite 120-foot deep DNAPL Migration Barrier has been prepared and is included as Attachment C. The WP outlines the phased remedial design approach, construction procedures, and construction quality control and quality assurance (CQC/QA) procedures that are necessary to construct a continuous 120-foot deep Composite DNAPL Migration Barrier that has a maximum hydraulic conductivity (i.e., is not more permeable than) of 1×10^{-5} centimeters per second (cm/sec) in accordance with the NYSDEC approved remedial design and a soil-cement barrier wall with a minimum wall thickness of three feet. The WP also includes a Construction Quality Assurance Project Plan (CQAPP), Addendum # 2, which establishes the CQC/QA measures that are necessary to verify the construction of the soil-cement barrier wall.

3.0 SCHEDULE

The National Grid Project Team has proposed the following 2010 and 2011 remediation schedule for the installation of the Composite 120-foot deep DNAPL Migration Barrier.

- ***Step 1 (March 2010)***: Option Phase 1a was conducted in March 2010;

- ***Step 2 (April 2010 and May 2010):*** Option Phase 1b was conducted in April 2010 and May 2010;
- ***Step 3 (June 2010)***: Phase 2 – Step A commenced in June 2010 and was completed in July 2010;
- ***Step 4 (July 2010 and August 2010):*** Waterloo Barrier™ interlocking steel sheet piling certification report preparation and submission to National Grid Project Team;
- ***Step 5 (Fall 2010 and Winter 2011)***: Phase 2 – Step B (External Joint Sealant to be completed as part of the Phase 3 activities; and
- ***Step 6 (Fall 2010 and Winter 2011)***: Perform Phase 3, the installation of a Composite 120-foot deep DNAPL Migration Barrier after receipt of NYSDEC's approval of FCR-06a.
    - July 2010 NYSDEC Review and Approval of FCR-06a
    - July 2010 and August 2010 Specialty Jet Grouting Contractor Procurement
    - August 2010 Site Preparation for Jet Grouting Operations
    - September 2010 Specialty Jet Grouting Contractor Mobilization and Setup
    - Late September 2010 and Early October 2010 Six Pre-Production Columns and CQC/QA Testing Program
    - October 2010 through December 2010 Production Jet Grouting Operation
    - January 2011 through February 2011 Site Restoration

The National Grid Project Team plans to submit the Specialty Jet Grouting Contractor's Site Operations Plan, the Waste Management Contractor's Site Operations Plan, as well as the updated Site Specific Health and Safety Plan (SSHASP) in September 2010 prior to the start-up of the Phase 3 installation activities. As further discussed in the WP, the National Grid Project Team will prepare and submit the results of the Pre-Production Column Installations (i.e., CQC/QA Test Results, the Production Grout Mix, and Production Jet Grouting Parameters) prior to the start-up of the Phase 3 Production Column installation activities.

4.0 FCR-06a CONCLUSIONS

The remedial design intent of the RDR has been and will continue to be achieved with these expanded and revised 120-foot deep DNAPL Migration Barrier installation procedures (Phase 3). The goal of the National Grid Project Team is to install a continuous, 120-foot deep DNAPL Migration Barrier that has a maximum hydraulic conductivity of 1×10^{-5} cm/sec and complies with the RDR and the NYSDEC ROD.

The National Grid Project Team will notify NYSDEC of any emergency deviations from the prescribed DNAPL Migration Barrier Installation Procedures within the next business day of the event. If additional revised DNAPL Migration Barrier Installation Procedures are necessary, a written notice to the NYSDEC in the form of an FCR will be submitted a minimum of one week prior to the implementation of the revised "Installation Procedures".

In summary, PS&S respectfully request NYSDEC's approval of this FCR-06a and the Phase 3 installation of a 120-foot deep Composite DNAPL Migration Barrier.

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ATTACHMENT A

June 2010 and July 2010 On-Site Waterloo Barrier™ Record of Construction Plans

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ATTACHMENT B

July 12, 2010 Table 1, 120-foot Deep DNAPL Migration Barrier Interlocking Steel Sheet Piling Quality Assurance Installation Summary Matrix

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ATTACHMENT C

Composite 120-Foot Deep DNAPL Migration Barrier Work Plan

PHASE 3 COMPOSITE 120-FOOT DEEP DNAPL MIGRATION BARRIER WORK PLAN

For the:

Rockaway Park Former Manufactured Gas Plant Site
Rockaway Park, Queens County, New York
Site Number 2-41-029

Submitted by:

NATIONAL GRID
Hicksville, New York 11801

JULY 2010

Prepared by:

Paulus, Sokolowski and Sartor Engineering, PC
67B Mountain Boulevard Extension
Warren, Somerset County, New Jersey

Rockaway Park Former Manufactured Gas Plant Site
Rockaway Park, Queens County, New York
Phase 3 Composite 120-Foot Deep DNAPL Migration Barrier
Work Plan

TABLE OF CONTENTS

EXHIBITS

APPENDICES

EXECUTIVE SUMMARY

Paulus, Sokolowski and Sartor Engineering, PC (PS&S) has been retained by National Grid to prepare this Work Plan (WP) to document the phased engineering control installation approach to be implemented for the Composite 120-Foot deep Dense Non-Aqueous Phase Liquid (DNAPL) Migration Barrier at the Rockaway Park Former Manufactured Gas Plant (MGP) site located in Rockaway Park, Queens County, New York.

PS&S prepared Field Change Request #6 (FCR-06) on February 25, 2010 to update and expand the DNAPL Migration Barrier installation procedures with a phased approach for the installation of a continuous 120-foot deep DNAPL Migration Barrier in accordance with the New York State Department of Environmental Conservation (NYSDEC) Record of Decision (ROD) and the NYSDEC approved Remedial Design Report (RDR) dated November 2008. As part of FCR-06, PS&S presented an updated remedial installation approach (Phase 3) for a "composite" 120-foot deep DNAPL Migration Barrier composed of two parts: an upper Waterloo Barrier™ section overlapped with a lower soil-cement barrier wall. Field Change Request #6a (FCR-06a) presents these Phase 3 installation procedures and this Phase 3 WP was prepared to provide the expanded remedial design approach and construction methodologies. This WP package was developed to present in detail the remedial construction activities and construction quality control and assurance procedures proposed for the implementation of the Phase 3 (Composite 120-Foot deep DNAPL Migration Barrier) approach for the Rockaway Park site.

The current remedial design for the Site is identified in the approved 100-percent RDR, dated November 2008. The RDR includes the installation of a DNAPL Migration Barrier, aligned in an east-west direction, along the northern boundary of the On-Site Area. This DNAPL Migration Barrier, known as the On-Site DNAPL Barrier, will be composed of three sections: a 120-foot deep center section flanked to the east and west by two 50-foot deep sections. The DNAPL Migration Barrier was constructed using the Waterloo Barrier™ steel sheet pile system.

The Waterloo Barrier™ system consisted of a series of interlocked steel sheet piling with a sealable cavity within each interlock. In order to achieve the required depth of 120 feet bgs for the center section, two 60 foot long WEZ95 sheets were to be spliced together. After numerous attempts in 2009 and 2010, the installation of the 120-foot deep Waterloo Barrier™ was not successfully repeated. After the interlocking steel sheet piling was driven to an elevation that corresponds to a minimum of two feet below the proposed final grade, the interlocks were flushed and a proprietary low permeability grout was injected into the entire length of the interlock.

Currently, the On-Site DNAPL Migration Barrier is under construction at the Site. National Grid has retained Posillico Environmental, Inc. (Posillico), Farmingdale, New York as its prime remediation contractor. The two 50-foot deep sections have been installed, and the majority of the 120-foot section of the Waterloo Barrier™ was installed to a depth of approximately 65 feet. Complications that arose during this installation have led to the requirement for a revised remedial design approach for the DNAPL Migration Barrier.

In response to these difficulties encountered during installation of the interlocking steel sheet piles and to remain in compliance with the NYSDEC Record of Decision (ROD) dated October 2004, a revised remedial design approach was prepared for National Grid. A "Composite" 120-foot deep DNAPL migration barrier has been developed using the recent successful installation of a composite deep DNAPL Migration Barrier Wall, the Clifton MGP OU-1, Staten Island, New York as a model. This composite DNAPL migration barrier would contain two parts: the currently driven Waterloo Barrier^{TM}, as the upper section, joined to a lower soil-cement barrier wall created by triple fluid jet grouting techniques to form a single line of overlapping columns. As demonstrated by the Clifton Case Study, the soil-cement barrier wall could readily achieve an in-place overall permeability of 1×10^{-5} centimeters per second (cm/sec) or less after 28 days of in-situ curing.

The proposed soil-cement barrier wall will be installed at the Rockaway Park Former MGP Site, using a single row of jet grouted columns constructed by a triple fluid jet grouting method to form overlapping columns with a minimum wall thickness of three (3) feet. The constructed soil-cement barrier wall will be integral with the existing Waterloo Barrier^{TM} sealed steel sheet piling and will overlap the bottom of the Waterloo Barrier^{TM} interlocking sealed steel sheet piling by a minimum of five (5) feet or as necessary to demonstrate an integral composite barrier wall.

The selected Jet Grouting Contractor will be responsible for coordinating with the Prime Contractor regarding the conveyance, receipt and disposal of wastes generated by the jet grouting operations. The Jet Grouting Contractor will provide the necessary equipment and appliances so that wastes generated by the jet grouting operations can be conveyed to the on-site Waste Management Facility operated by the Waste Management Contractor.

The Jet Grouting Contractor will be solely responsible for the performance of construction quality control (QC) testing to confirm that the soil-cement barrier wall complies with the ROD, 100% RDR and National Grid's technical specification requirements. On behalf of National Grid, PS&S will provide on-site quality assurance (QA) services to observe the Jet Grout Contractor's compliance with the specifications and Contract Documents. PS&S will supplement the Contractor's QC Program with a field and laboratory inspection and testing program in accordance with the Construction Quality Assurance Project Plan (QAPP) Addendum #2 prepared for National Grid and dated June 2010.

1.0 INTRODUCTION

1.1 Project Overview

1.1.1 Site Location

The Rockaway Park Former MGP Site is located north and east of Rockaway Freeway, west of Beach 108th Street, and north and south of Beach Channel Drive in Rockaway Park, Queens County, New York. The Site encompasses an area of approximately 9.5 acres. An 8.9 acre area of the Site known as the On-Site Area is located south of Beach Channel Drive and includes remnant facilities of a former National Grid (National Grid) natural gas regulator station located in the southeastern portion of the Site. The 0.6 acre portion of the Site located to the north of Beach Channel Drive and to the south of Jamaica Bay is known as the Bulkhead Area and is owned by the City of New York.

1.1.2 Site History and Construction Progress

Operations at the Site began in the late 1870s and most of the facilities were demolished in 1958. In 1998, KeySpan Corporation acquired the Site through a merger of LILCO and the Brooklyn Union Gas Company. In 2007, National Grid acquired KeySpan Corporation.

National Grid and their prime remediation contractor, Posillico Environmental, Inc. (Posillico) mobilized to the Site and commenced remedial actions in accordance with the 100% RDR in December 2008. Waterloo Barrier™ interlocking steel sheet piling installations commenced at the On-Site Area in March 2009 and a general construction schedule is presented herein below.

- ***Step 1 (March 2009 through May 2009): Installation of the 50-feet deep "wing walls" and bottom 65-foot deep part of the 120-foot deep Waterloo Barrier™ interlocking steel sheet piling. Interlocking steel sheet piling was installed from east (Beach 108th Street) to west (Electric Substation) across the on-site area as shown on the Remedial Action Site Plan, Sheet C-04;***
- ***Step 2 (May 2009 and June 2009): Advancement of a limited geotechnical investigation (i.e., cone penetrometer test (CPT) process and three standard penetration test (SPT) borings to verify the subsurface geological conditions;***
- ***Step 3 (October 2009): Additional attempts to install the 120-foot deep Waterloo Barrier™ interlocking steel sheet piling were performed with limited success. The National Grid Project Team attempted different sheet pile installation techniques (i.e., several vibratory hammers, ABI Mobilram 18-22T Rig, 110-ton crane with swinging LCPS);***

- ***Step 4 (March 2010): FCR-06 Option Phase 1a was conducted in March 2010;***
- ***Step 5 (April 2010 and May 2010): FCR-06 Option Phase 1b was conducted in April 2010 and May 2010;***
- ***Step 6 (June 2010): FCR-06 Phase 2 – Step A commenced in June 2010 and was completed in July 2010; and,***
- ***Step 7 (July 2010 and August 2010): Waterloo Barrier^{TM} interlocking steel sheet piling certification report preparation and submission to National Grid Project Team.***

1.2 Remedial Design Objectives

The objectives for the remedial design approach include the following:

- Summarize the results of the pre-design activities performed in support of the remedial design;
- Present the draft remedial design for the implementation of the proposed remedial construction activities;
- Conceptually describe the proposed methods and procedures that will be used to implement the proposed remedial construction activities;
- Incorporate all of the design aspects into a set of biddable quality plans and Technical Specifications necessary to procure a remedial contractor who will implement the proposed remedial construction activities and assist in the development of the remedial design;
- Identify the project plans (i.e. Construction Quality Assurance Project Plan) that will be used during the remedial construction activities; and,
- Provide a schedule for the implementation of the activities associated with the proposed remedial construction.

1.3 Administrative History and Regulatory Governing Documents

1.3.1 October 2004 NYSDEC Record of Decision

The remedy to be implemented at the Site is detailed in a Record of Decision (ROD) entitled "Record of Decision, LILCO – Rockaway Park MGP Site, Rockaway Park, Queens County, New York, and Site Number 2-41-029" prepared by the New York State Department of Environmental Conservation (NYSDEC) and dated October 2004. The ROD was based on the public's input to the "Proposed Remedial Action Plan" prepared and presented by NYSDEC and dated August 2004. The selected remedy includes the following hydraulic engineering control remedial construction components:

- Installation of a dense non-aqueous phase liquid (DNAPL) migration barrier, aligned in an east-west direction, along the northern boundary of the On-Site Area. This barrier, known as the On-Site DNAPL Barrier, will be approximately 695 feet long and will extend to a depth of 120 feet

bgs in its central section and to 50 feet bgs on its eastern and western reaches. The technology to be utilized to install the DNAPL migration barrier will be the Waterloo Barrier™ steel sheet pile system; and,

- Installation of 31 passive DNAPL collection wells in the On-Site Area and within the Bulkhead Area, in areas with heavy concentrations of mobile DNAPL.

1.3.2 November 2008 200 Percent Remedial Design Report

In November 2009, National Grid issued a 100 % RDR for the Site. This RDR was prepared in accordance with the format set forth in the Remedial Design Work Plan (RDWP) approved by NYSDEC in December 2005.

1.3.3 April 2009 Field Change Requests, FCR-02 and FCR-02a

PS&S prepared Field Change Request# 2 (FCR-02) on April 17, 2009 and Field Change Request # 2a (FCR-02a) on April 24, 2009 to address the planned Waterloo Barrier™ Installation Procedures at the On-Site Area of the Rockaway Park Former MGP site. FCR-02 modified Posillico's procedures to install the remaining 120 foot long On-Site Area DNAPL Migration Barriers with a combined set-up consisting of the ABI Mobilram sheet pile rig and a cherry picker truck crane. FCR-02a was submitted to revise the Waterloo Barrier™ Installation Procedures to utilize a lattice boom crawler crane and a variable moment vibratory hammer for sheet pile installation instead of the ABI Mobilram and vibratory hammer.

1.3.4 October 2009 Revised Procedure for the Installation of the Interlocking Steel Sheets

Posillico updated the Waterloo Barrier™ installation procedures on October 2, 2009 to include a vibratory hammer (APE 200-6) hanging from a crane; similar to the test demonstration performed in February 2006.

1.3.5 February 2010 Field Change Request, FCR-06

PS&S prepared Field Change Request # 6 (FCR-06) on February 25, 2010 to present the DNAPL Migration Barrier updated installation procedures with a phased approach for the installation of a continuous 120-foot deep DNAPL Migration Barrier in accordance with the NYSDEC ROD and the NYSDEC approved RDR dated November 2008. The phased installation approach consists of the following three DNAPL Migration Barrier Wall technologies:

- Phase 1 consisted of a 120-foot deep Waterloo Interlocking sheets with grouted joints.

- Phase 2 consisted of 120-foot deep Waterloo Interlocking sheets with grouted joints plus joints with an external seal.
- Phase 3 proposed a composite DNAPL Migration Barrier Wall.

1.3.6 July 2010 Field Change Request, FCR-06a

PS&S has prepared an updated remedial design approach for a "composite" 120-foot deep DNAPL Migration Barrier composed of two parts: an upper Waterloo Barrier™ section overlapped with a lower soil-cement barrier wall.

1.4 WP Report Organization

This WP is organized in the following manner:

- Section 1.0 – INTRODUCTION: This section provides a brief description of the location of the Site, the historical operations performed on the Site, a summary of the approved RDR, and the remedial design objectives for the proposed remedial construction activities.

- Section 2.0 - REMEDIAL DESIGN: This section of the WP summarizes the design for the remedial construction activities.

- Section 3.0 – CONSTRUCTION: This section details the implementation of the remedial construction activities

- Section 4.0 – CONSTRUCTION QUALITY ASSURANCE PROJECT PROGRAM: This section references the Construction Quality Assurance Program to be utilized during the implementation of the proposed remedial construction activities.

- Section 5.0 – PROJECT SCHEDULE: This section presents a project milestone schedule.

- Section 6.0 – CONCLUSION: This section provides a summary of the proposed remedial design and construction activities in conjunction with the quality control and assurance procedures will satisfy the requirements of the approved RDR.

2.0 REMEDIAL DESIGN

2.1 Remedial Objectives

2.1.1 Current Remedial Design

The current remedial design for the Site is identified in the approved 100% RDR, dated November 2008. The RDR includes the installation of a DNAPL Migration Barrier, aligned in an east-west direction, along the northern boundary of the On-Site Area. This barrier, known as the On-Site DNAPL Barrier, will be approximately 695 feet long and was to be composed of three sections: a 120-foot deep center section flanked to the east and west by two 50 foot deep sections. The DNAPL Migration Barrier was to be constructed using the Waterloo Barrier™ steel sheet pile system.

The Waterloo Barrier™ system consists of a series of interlocked steel sheets with a sealable cavity within each interlock. After installation, the interlock is flushed and a proprietary low permeability grout is injected into the entire length of the interlock. For construction at the Site, WEZ95 steel sheeting is utilized. Additionally, both the top and bottom five feet of each steel sheet are reinforced with two 3/8-inch stiffener plates to improve driving mechanics. In order to achieve the required depth of 120 feet bgs for the center section, two 60 foot long WEZ95 sheets are spliced together. The top of the DNAPL migration barriers are driven to an elevation that corresponds to a minimum of two feet below the proposed final grade in order to allow for the installation of the Site-Wide Cap.

Currently, the On-Site DNAPL Barrier is under construction at the Site. National Grid has retained Posillico Environmental, Inc. (Posillico), Farmingdale, New York as its prime contractor. The 50-foot sections have been installed, however, in the 120-foot section, most of the Waterloo Barrier™ could not be driven below a depth of approximately 65 feet. Complications that arose during this installation have led to the need for a revised remedial approach for the DNAPL Migration Barrier.

2.1.2 Clifton Former MGP Site OU-1 Case Study

National Grid successfully completed the construction of a composite 130-foot deep DNAPL Migration Barrier in October 2009 at the Clifton Works Former MGP Site Operable Unit #1 (OU-1) located in Staten Island, Richmond County, New York. An initial demonstration of the soil-cement barrier overlapping jet grouting column installation technology at OU-1, using a double fluid system (water and grout), was performed by National Grid during the period of December 2004 through April 2005. Unavoidable surfacings (i.e., surface breakthroughs) of grout were created when double fluid grouting was utilized in the upper fill layer at OU-1. Subsequent to the issuance of National Grid's

findings with regard to the initial demonstration, National Grid retained a nationally recognized jet grouting consultant who formulated a new design approach for the installation of the subsurface barrier. This new design approach was presented to NYSDEC and included a combination of steel sheet piling and a soil-cement wall to form the required vertical subsurface DNAPL Migration Barrier. The steel sheeting was driven to depth of approximately 35 feet bgs, below the existing fill layer to mitigate the previously observed grout releases into the fill layer. A soil-cement barrier wall, using the super triple fluid technology (high speed water and grout cutting jets, with the water jet enshrouded within a cone of compressed air), was installed five to ten feet above the tip of the steel sheeting and was extended into an embedment stratum at an approximate depth of 130 feet bgs.

With the approval of NYSDEC, National Grid implemented the new design approach and separately contracted with Remedial Contractor to install the steel sheeting and with a Jet Grouting Contractor to complete the jet grouting. The entire soil-cement barrier wall was successfully completed and tested and demonstrated that compliance with the regulatory requirement of an in-place permeability of 1×10^{-5} cm/sec was achieved.

2.1.3 Composite Barrier Wall Solution

In response to recent difficulties encountered during installation of the interlocking steel sheet piles and to remain in compliance with the ROD, an expanded remedial design approach for a "composite" 120-foot deep DNAPL migration barrier has been developed using the Clifton Case Study as a model. This composite barrier would contain two parts: the currently driven Waterloo Barrier™, as the upper section, joined to a lower soil-cement barrier wall created by overlapping jet grouted columns constructed of cementitious materials. As demonstrated by the Clifton Case Study, the soil-cement barrier wall will readily achieve in-place permeabilities of less than 1×10^{-5} cm/sec.

The currently driven Waterloo Barrier™, installed to an average depth of approximately 65 feet bgs, would have its interlocking joints grouted. A record of construction survey drawing of the grouted Waterloo Barrier™ is currently being prepared to guide the installation of the soil-cement column wall and the few locations where Waterloo Barrier™ has been driven to depths below 65 feet bgs would be recorded. A progress as-built survey was prepared by Posillico and was included as Attachment A of FCR0-06a.

A continuous soil-cement DNAPL Migration Barrier wall, with a minimum wall thickness of three feet formed by overlapping jet grouted columns with a nominal diameter of six feet is proposed as the lower section of the 120-foot deep DNAPL Migration Barrier. The soil-cement barrier wall would be installed adjacent to the sealed steel sheeting of the Waterloo Barrier™. The top of the jet grouted column wall would overlap the sealed bottom of the Waterloo Barrier™ by a minimum of

five feet. The cementitious jet grouted column material would naturally bond with the existing Waterloo Barrier system. Since the joints of the Waterloo Barrier™ have been sealed with a proprietary grout, the result would be a continuous vertical barrier from two feet below the final grade surface to approximately 120 feet below the final grade surface.

2.2 Project Team

2.2.1 National Grid

National Grid has final responsibility for aspects of the implementation of the remedial actions. National Grid is responsible for communication with regulatory agencies, members of the surrounding community and the press. National Grid is also responsible for monitoring overall project schedule, milestones and completion. A National Grid representative, or their designated representative(s), will be on-site periodically during the performance of the remedial actions.

2.2.2 Construction Manager

ARCADIS US, Inc. (ARCADIS) represents National Grid as the Site Construction Manager (CM) to ensure the remedial construction activities are conducted in conformance with the project specific contract documents. In this role, ARCADIS manages site activities balancing the needs of National Grid and the various contractor(s) within the framework of the regulatory process. ARCADIS assists National Grid in its liaison with the NYSDEC, NYSDOH, and other project stakeholders, including adjacent property owners, other members of the community and city government officials. ARCADIS also works closely with the National Grid representative and the various contractors to manage cost control and sequencing of the project.

2.2.3 Engineer-of-Record

Paulus, Sokolowski and Sartor Engineering, PC (PS&S) will serve as the Engineer-of-Record for the Site. During the on-going construction, PS&S provides on-site day to day remedial construction quality assurance resident engineering services. PS&S's resident engineer and assistants conduct construction quality assurance inspections in order to review remedial construction activities for compliance with the NYSDEC-approved remedial and design documents for the Site. PS&S assists National Grid in its liaison with the NYSDEC, NYSDOH, and other project stakeholders, including adjacent property owners, other members of the community, and city government officials. PS&S works closely with the National Grid and ARCADIS representatives during their daily activities.

2.2.4 Contractors

2.2.4.1 Prime Contractor

National Grid has retained Posillico Environmental, Inc, Farmingdale, New York as its prime contractor for the Site remedial construction. Posillico has overall responsibility for the completion of the Site remedial construction in accordance with the remedial design approved by NYSDEC.

2.2.4.2 Jet Grouting Contractor

A Jet Grouting Contractor will be retained by the Prime Contractor. A soil-cement barrier wall will be constructed by the Jet Grouting Contractor; using triple fluid jet grouting technologies to form a single row of jet grouted overlapping columns, to form a continuous DNAPL Migration Barrier in accordance with the Technical Specifications. The Jet Grouting Contractor will also be responsible for coordinating with the Prime Contractor regarding the conveyance receipt and disposal of wastes generated by the jet grouting operations. The Jet Grouting Contractor will provide the necessary equipment and appliances so that jet grouting wastes can be conveyed to the on-site Waste Management Facility operated by the Prime Contractor.

2.2.4.3 Waste Management and Emergency Response Contractor

Posillico, the Prime Contractor, will carry out the Waste Management and Emergency Response (WM/ER) duties at the Site during the jet grouting operations. The Prime Contractor will be responsible for the implementation of an onsite Waste Management Facility which will receive, temporarily store, process, and ship to off-site disposal facilities waste generated during jet grouting operations. The Prime Contractor will also provide the necessary equipment and appliances and coordinate with the Jet Grouting Contractor to receive, recycle and dispose wastes. Lastly, the Prime Contractor will provide emergency response services during jet grouting as requested by National Grid.

2.2.4.4 Method of Contractor Selection

Jet Grouting Contractor: National Grid will complete the Jet Grouting Contractor procurement by first developing a list of qualified contractors and then by soliciting proposals from these qualified contractors. National Grid, ARCADIS, PS&S and Posillico will be participants in the Jet Grouting Contractor procurement process.

A list of potential contractors has been compiled. Each of the potential contractors has received a solicitation letter requesting the completion and return of an Expression of Interest Form to National Grid. A Pre-Bid

Information Meeting has also been held on June 23, 2010 to acquaint jet grouting contractors with the Site and specific requirements.

Pre-qualified contractors will receive a Request for Proposal (RFP). This RFP will formally solicit jet grouting services and request detailed information on the contractor's means and methods to complete the soil-cement barrier wall using triple fluid jet grouting technology at the Site and associated costs. In addition, the RFP response submittal must identify the contractor's prior work experience, proposed field crew and proposed drilling equipment and site-specific needs for work at the Site. Contractor responses to the RFP will be evaluated and the optimum contractor, considering means and methods, experience, schedule and price, will be chosen. Additional responses/data may also be requested and contractor interviews may also be held.

Waste Management and Emergency Response Contractor: Posillico, the Prime Contractor, will carry out the Waste Management and Emergency Response (WM/ER) duties at the Site during the jet grouting operations. National Grid will prepare an RFP including Price Quotation Form to obtain pricing and a defined scope of additional services from the Prime Contractor. The RFP will require that the Prime contractor demonstrate relevant experience in design operation and maintenance of a waste management facility. The Prime Contractor will be responsible to provide all labor, equipment, testing and materials required to manage the wastes during construction; manage the arrival and departure of transport vehicles; design, implement and operate a waste management facility for the jet grouting wastes; to provide and manage all containers for liquid and solid wastes; procure and operate a vapor management system for the waste management facility; manage the containers on-site during the implementation of the construction; sample, characterize, pre-condition, transport and dispose of all generated solid and liquid wastes at National Grid-approved and properly permitted, off-site disposal facilities. All wastes will be loaded / pumped into containers, provided by the Prime Contractor. The Prime Contractor will also prepare and submit all paperwork to document the off-site disposal. In addition, the Prime Contractor will provide Emergency Response services that may be required, as directed by National Grid, during the implementation of the jet grouting in support of the activities to be performed by the Jet Grouting Contractor.

2.3 Upper Waterloo Barrier® Interlocking Steel Sheet Piling

2.3.1 Mobilization

Mobilization/Site Preparation Activities for the Upper Waterloo Barrier® interlocking steel sheet piling included site preparation activities, construction of

temporary facilities and staging areas, location of utilities, removal of interior fencing, installation of soil erosion and sediment control measures, and construction of decontamination pads.

2.3.2 2009 and 2010 Installation Operations

The remedial design approach for a DNAPL Migration Barrier is based on the Rockaway Park 100-percent RDR dated November 2008 and the Waterloo Barrier™ System Steel Sheet Piling with Sealed Interlock System Rockaway Park Technical Specification, Section 02261. Installation of the 120-foot deep Waterloo Barrier™ interlocking steel sheet piling commenced in April 2009; where difficult driving conditions were observed and resulted in limited successful installations.

National Grid commenced a phased installation approach in March 2010 in an attempt to drive sheet piles to the 120-foot depth. The first approach consisted of the installation of Waterloo Barrier™ interlocking steel sheeting by driving from west to east; where the female joint would be the lead joint. Phase 1a was attempted in March 2010 and was not successful. Phase 1b consisted of pre-drilling 24-inch diameter boreholes ("relief shafts") at the drive joint followed by the installation of the Waterloo Barrier™ interlocking steel sheeting. Phase 1b mobilization commenced in April 2010 and operations were performed in May 2010. These operations were not successful.

2.3.3 Waterloo Barrier™ Construction QC/QA Program

National Grid's remediation contractor, Posillico retained the professional engineering services of C3 Environmental Limited (C3) to perform the quality control inspections during the installation of the Waterloo Barrier™ interlocking steel sheet piling. C3 inspected the installation in accordance with the RDR, dated November 2008 and the Project Specification, Section 02261. In addition, National Grid retained PS&S to provide quality assurance engineering services.

2.3.4 External Joint Sealant

The majority of the Waterloo Barrier™ interlocking steel sheeting in the area of the 120 –foot section of the DNAPL Migration Barrier Wall was successfully driven to approximate depth of 65 feet bgs and their respective interlocking joints were flushed and grouted to a bottom of steel depth of approximately 65 feet bgs. However, a total of five (5) interlocking joints could not be flushed and grouted to the required minimum depth. These five non-compliant interlocking joints, in accordance with the Technical Specifications (Section 02261 - Waterloo Barrier System Steel Sheet Piling with Sealed Interlock System), are listed below.

1. Sheet Pile/Joint Interlock #148: Interlocking Joint successfully flushed and grouted to 37-feet bgs; Noncompliant Interlocking Joint from 37-feet to 65-feet bgs.
2. Sheet Pile/Joint Interlock #149: Interlocking Joint successfully flushed and grouted to 50-feet bgs; Noncompliant Interlocking Joint from 50-feet to 65-feet bgs
3. Sheet Pile/Joint Interlock #160: Interlocking Joint successfully flushed and grouted to 50-feet below ground surface (bgs); Noncompliant Interlocking Joint from 50-feet to 65-feet bgs
4. Sheet Pile/Joint Interlock #161: Interlocking Joint successfully flushed and grouted to 53-feet below ground surface (bgs); Noncompliant Interlocking Joint from 53-feet to 65-feet bgs
5. Sheet Pile/Joint Interlock #162: Interlocking Joint successfully flushed and grouted to 30-feet below ground surface (bgs); Noncompliant Interlocking Joint from 30-feet to 65-feet bgs

National Grid will incorporate these five noncompliant joints into the Phase 3 remedial design approach as required to comply with the ROD and the 100% RDR. An external joint sealant will be installed in-board of the 120-foot deep DNAPL Migration Barrier to repair these five noncompliant joints. The external joint sealant would comprise of a soil-cement treatment to be installed by the selected Jet Grouting Contractor. For the above listed noncompliant joints, National Grid would require the Jet Grouting Contractor extend the top of the proposed jet grouted column(s) to overlap the bottom of the successfully flushed and grouted segments of these interlocking joints by a minimum of five (5) feet. The jet grouted column(s) will be constructed using triple fluid jet grouting techniques.

2.3.5 C3 Environmental Limited Final Installation Report and Certification

C3 Environmental Limited (C3) will issue a Final Report for the Waterloo Barrier® steel sheeting and grouted interlock system installation. The Final Report will also include a two-year warranty for the maximum bulk hydraulic conductivity of 1×10^{-5} cm/sec of the Waterloo Barrier®.

2.4 Lower Soil-Cement Barrier Wall

2.4.1 Overview

A Jet Grouting Contractor will install a soil-cement barrier wall (the lower section of the composite 120-foot DNAPL migration vertical barrier wall) using triple fluid jet grouting technology to provide a single row of overlapping jet grouted columns, to form a continuous soil-cement DNAPL Migration Barrier with a minimum wall thickness of three feet along the northern perimeter of the site in accordance with the NYSDEC approved 100% RDR. This low permeability soil-

cement barrier wall will be approximately 250 linear feet and continuous to a depth of 120 feet below grade surface.

The jet grouted columns will have a nominal diameter of six-feet. The overlapping jet grouted columns will form a soil-cement barrier wall with a minimum wall thickness of three feet. There will be a minimum of five-foot vertical overlap of jet grouted overlapping columns with the installed Waterloo Barrier® and grouted interlocks.

2.4.1.1 DNAPL Migration Barrier Wall Requirements

In-situ measurements will be performed by the Jet Grouting Contractor to demonstrate that the installed soil-cement barrier wall satisfies the maximum permeability requirement (i.e., not more permeable than) of 1.0×10^{-5} cm/sec after 28 days of curing and a minimum wall thickness of three (3) feet.

2.4.1.2 Hydrogeologic Information from Previous Studies

Groundwater levels observed during environmental investigations indicated that the groundwater levels ranged from approximately four and one half feet to eight feet bgs and may fluctuate due to seasonal variations in precipitation and tidal influences.

2.4.1.3 Soil-Cement Barrier Wall Design Parameters

The successful construction of an overlapping jet grouted column soil-cement barrier wall will be the jet grouting contractor's responsibility; where, the soil-cement barrier wall drilling and injection parameters will control the construction process. Therefore, the following phased design and construction program will be performed to sequentially select the necessary drilling and injection parameters required to successfully install the soil-cement barrier wall.

- Task 1 - Clifton Works OU-1 Production Parameters: The remedial design approach for the Rockaway Park soil-cement barrier wall will be based upon the successful installation of the soil-cement barrier wall for the Clifton Works OU-1 project.

- Task 2 - Bench Scale Compatibility Test: A bench scale compatibility pilot testing program will be performed to select the grout mix design for the proposed lower section soil-cement barrier wall. The testing data, key findings and recommendations for the grout mix design will be implemented in the soil-cement barrier wall.

- Task 3 - Pre-Production Parameters Study: The Jet Grouting Contractor will install six pre-production columns prior to the full production to assess and select the final jetting parameters required for the full

production work. All pre-production columns will be completed within the alignment of the soil-cement column wall.

- Task 4 - Production Parameters: Based on the Pre-Production Parameter Study, the drilling and injection parameters will be established for the soil-cement barrier wall installation phase to satisfy the performance requirements in the approved remedial design documents. Drilling parameters will include drill rod and bit sizes, maximum drilling depth, drilling method, drilling fluids, total borehole deviation at the termination depth, drilling rate, rotary speed, thrust on tool, rotary torque, drilling fluid pressure, and drilling specific energy. Injection operation parameters will include top/bottom elevation of jet grouted columns, grout, water/slurry and air pressures and flow rates, dwell time, lift step, revolutions per minute, grout density, total weight of dry materials injected, total volume of grout injected, size of water and grout jet nozzles before and after grouting.

2.4.2 Jet Grouted Column Layout

The layout of operations for the soil-cement barrier wall construction will be provided by the Jet Grouting Contractor and include drawings for grout batch mixing equipment, injection equipment, pumps, hoses, high pressure steel hard lines or other hose protection appliances, waste areas, and the location of jet grouting with respect to support equipment for the Site. The Jet Grouting Contractor will also provide the column layout plan including northing and easting locations for each proposed jet grouted column centers, inter axis spacing, estimated column diameter, primary/secondary/tertiary column identifications and span from the existing Waterloo Barrier^{TM} steel sheeting alignment. A generalized layout of the site is included as Exhibit B (Sheet C-04, Remedial Action Site Plan), and a generalized layout of the jet grouted columns is included as Exhibit C.

2.4.3 Base Grout Mix Design

The Jet Grouting Contractor will use a multi-component grout containing Attapulgite clay, Type II/III Portland cement and Grade 120 Granulated Blast Furnace Slag for use during the jet grouting operations. The Jet Grouting Contractor's Batch Mixing Plant will be capable of handling the multi-component grout and possibly other admixtures to uniformly blend a workable grout for use during the jet grouting injection. The grout mix design will likely consist of a two part dry blend wherein the components will be 50/50 to 70/30 percent weight of slag/cement and a clay slurry dosage of 4-6% by weight. Dry components will likely be combined with a nearby clean water source inside of a high shear colloidal mixer wherein the water to solids (i.e., slag, cement) ratio will be 0.7:1 to 1:1 by weight. The final grout mix design will be determined upon the

completion of the bench scale study (compatibility testing) and the pre-production columns field testing program.

For the Type II/III Portland cement, Grade 120 Granulated Blast Furnace Slag and the Attapulgite Clay, a product certification, signed by an authorized official on behalf of the manufacturer and attesting that the product meets the specified requirements, will be required from the Jet Grouting Contractor prior to any use of these materials for grout production.

2.4.4 Construction QC/QA Program

The Jet Grouting Contractor is responsible for construction quality control, field and laboratory testing and continuously preparing and maintaining project quality control records. Quality control records, routine testing procedures, observations, and measurements will be available for inspection by National Grid at any time. Analytical laboratory testing will be performed at laboratories certified under the NYSDOH Environmental Laboratory Accreditation Program (ELAP). On behalf of National Grid, PS&S will provide on-site quality assurance services and to determine the Jet Grout Contractor's compliance with the specifications and Contract Documents. PS&S will supplement the Contractor's QC Program with a field and laboratory inspection and testing program in accordance with the CQAPP Addendum #2 prepared for National Grid dated June 2010.

2.4.5 Waste Management

The Prime Contractor will be responsible to manage and pump wastes generated from the production of the soil-cement barrier wall construction work into containers within the Waste Management Facility designed and supplied by the Prime Contractor. Operations within the on-site waste management facility will be inspected daily by National Grid. Daily reports submitted by the Prime Contractor on the operations will be reviewed and analyzed. PS&S will receive and review the results of the waste characterization samples to determine the quality of the jet grouting cuttings. PS&S will also review waste disposal data, the physical character and disposal locations of the wastes being disposed.

2.4.6 Site Response Monitoring

During the remedial design construction activities to install the composite 120 – foot DNAPL Migration Barrier wall, the following Site Response Monitoring programs will continue to be in operation:

- Community Air Monitoring Program (CAMP), in conjunction with the air monitoring requirements of the Health and Safety Plan (HASP)
- Noise Monitoring (as necessary)
- Vibration Monitoring (as necessary)
- Odor Control and Vapor Management

Monitoring and surveillance equipment will be operated, maintained and calibrated in accordance with the manufacturer's instructions and the established quality assurance procedures. Equipment will be checked daily for proper operation. Field validation logs will be maintained on-site.

2.5 DNAPL Recovery Wells

In accordance with the approved 100% RDR, passive DNAPL Recovery Wells will be installed on each side of the On-Site Barrier and the upgradient side of the Bulkhead Area Barrier.

2.6 Site Restoration

In accordance with the approved 100% RDR, Site restoration activities will consist of Site grading and capping the Site as identified on the Remedial Design Drawings, re-establishing disturbed monitoring wells, re-establishing chain link fencing, and removing soil erosion and sediment control measures. The final Site grade will serve to direct on-site stormwater runoff to the central portion of the Site and allow for percolation into the subsurface.

2.7 Post-Remediation Activities

In accordance with the 100-percent RDR, Engineering and Institutional Controls will be implemented as part of remedial construction activities at the Site to protect human health and the environment from MGP-related constituents that will remain in the subsurface.

3.0 CONSTRUCTION

3.1 Pre-Mobilization and Submittals

3.1.1 Jet Grouting Contractor Site Operations Plan

The Jet Grouting Contractor will be required to prepare a Draft Site Operations Plan that demonstrates their knowledge of the project requirements. The Jet Grouting Technical Specification 02332, **Appendix D**, provides the requirements for this Plan.

The Draft Site Operations Plan will be submitted to National Grid for review. The Jet Grouting Contractor is also required to modify/amend the Draft Site Operations Plan, as per comments generated from the review. The Contractor is responsible for addressing all comments from National Grid and finalizing the Site Operations Plan. The finalized version of the Site Operations Plan will be submitted to the NYSDEC for review and approval. The Jet Grouting Contractor is also responsible for addressing all comments generated from the NYSDEC's or other regulatory agency review of the Site Operations Plan. The Site Operations Plan will include appropriate descriptions related to all aspects of the work including, but not limited to, the following:

- Proposed equipment and installation procedures
- Demonstration of remedial objectives
- A letter affirmatively accepting the HASP or a site-specific HASP Addendum prepared by the Contractor
- Work progression and initial project schedule
- Number of field operations personnel to be used on-site and their roles and responsibilities

The initial project schedule will be updated on a weekly basis, along with a two week projection of activities.

3.1.2 Prime Contractor's WM/ER Site Operations Plan

With their proposal to National Grid, the Prime Contractor will be required to prepare a Draft WM/ER Site Operations Plan that demonstrates knowledge of the project requirements. The WM/ER Site Operations Plan will be submitted to National Grid for review. The Draft WM/ER Site Operations Plan will include appropriate descriptions related to all aspects of the work including, but not limited to, the following:

- Proposed equipment and installation procedures
- Demonstration of contract objectives

- Management, staging, characterization and off-site transportation and disposal of remediation derived site wastes, including an estimate of the average number of trucks per day leaving the site, broken down by each month of construction
- Identification of field operations personnel to be used on-site and their roles and responsibilities

The Prime Contractor will also be responsible for preparing a Final version of WM/ER Site Operations Plan to be submitted to NYSDEC for review and approval. The Prime Contractor is responsible for addressing all comments generated both from internal review by National Grid and from the subsequent review of NYSDEC's or other regulatory agencies.

3.1.3 Site Specific Health and Safety Plan Addendums

The Jet Grouting Contractor will be required to review the Site-Specific Health and Safety Plan (HASP) dated May 2008, a copy of which will be provided upon the contract award. The Jet Grouting Contractor will either accept the HASP, in writing, or prepare as part of their Operations Plans, a Site-Specific HASP Addendum that meets the requirements of the HASP. The Site-Specific HASP Addendums will be reviewed by National Grid and will also be submitted to NYSDEC and the New York State Department of Health.

Level D personnel protective equipment (PPE) will be the basis for personnel protection with the Jet Grouting Contractor's Site-Specific HASP Addendums. The Jet Grouting Contractor will also be requested to provide contingency plans for PPE upgrades as warranted by Site conditions. The training and medical surveillance requirements outlined under the OSHA Hazardous Waste Operations Standard (29 CFR 1910.120) will be applied to the Site. These requirements include 40-hour training of site workers with an additional eight hours of training for supervisors. Individuals who have not received training within one year prior to entrance to the site will require eight-hour refresher training in accordance with OSHA requirements. All site workers are required to be part of a medical surveillance program through their employer. National grid will require that the Jet Grouting Contractor provide evidence of requisite training and medical surveillance for all relevant personnel.

3.2 Pre-Construction Activities

3.2.1 Working Platform

Prior to mobilization, the Prime Contractor will construct a Working Platform to provide a stable pad for the jet grouting drill rig(s) and equipment to be utilized to install the Soil-Cement Barrier Wall. The Working Platform will be constructed along the length of the installed Waterloo Barrier™ (approximately 65 feet bgs). The Working Platform will be constructed to the southern side of the Composite

120-foot deep DNAPL Migration Barrier. The proposed Working Platform will be constructed and operated on a part of the Site that has been remediated (refer to C-04). Specifically, the Tent Positions #9 and #10 Shallow Excavations and Backfill Operations will be completed prior to the mobilization and construction of the Working Platform. Adjacent to and south of the temporary steel sheeting, a six-inch layer of an interim asphalt cap will be constructed as a stable surface for the jet grouting equipment and will slope towards the spoils management trench (refer to Section 3.2.11 of this Phase 3 WP). The width of asphalt covered working platform will be between 15 feet and 18 feet.

The final design of the working platform will be completed by the Prime Contractor with input from the selected Jet Grouting Contractor and PS&S. The final drawings will be signed and stamped by a New York State licensed Professional Engineer. The completed design will be first reviewed by the National Grid Project Team and then submitted to NYSDEC for review and approval.

3.2.1.1 Spoils Management Trench

The waste management component of the Working Platform will consist of a spoils management trench. The trench width will be approximately five feet to eight feet. The final width will be controlled by the reach of drill rig to be utilized by the selected Jet Grouting Contractor. The existing Waterloo Barrier™ steel sheeting will comprise the northern face of the spoils management trench. Temporary excavation support steel sheets, presently on site, will be driven to approximately 25 feet bgs and will comprise the southern face of the spoils management trench. The temporary steel sheets will be driven by the Prime Contractor. This spoils management trench will effectively isolate the jet grouting operation return spoils from the remediated area of the Site. The trench depth will be up to six feet in depth corresponding to the observed groundwater, pending generated waste projections from the Jet Grouting Contractor.

The spoils management trench will be covered with plastic and plywood straddling the top areas of steel sheet walls weighed down by sand bags. The plastic and plywood cover will obstruct the view of the jet grouted column cuttings from the surface and will be used in conjunction with other odor/vapor management systems, to be provided by the Prime Contractor, to mitigate the potential for odors. Foaming on the spoils surface to control odors will be performed as necessary by the Prime Contractor.

This spoils management trench will contain a series of sump pumps (e.g. options include large trash pumps, etc.) to transfer the generated liquid wastes to the Waste Management Facility.

As part of the construction of the Working Platform, a splash barrier will be installed and maintained north of the Working Platform and spoils management

trench in an attempt to minimize jet grouted column waste materials coming into contact with the remediated site north of DNAPL Migration Barrier Wall alignment.

After the soil-cement Barrier Wall is constructed and the QC/QA program is completed, the waste material within the spoils management trench will be excavated to a depth of eight feet bgs and disposed off-site in accordance with the established RDR "Shallow Excavation Area" remedial activities.

3.2.1.2 Personnel Working Platform

Timber Mats and/or Scaffolding will be utilized as a personnel working platform. The personnel working platform will not rest directly on the steel sheets, but instead will have load bearing points on the fill and the asphalt adjacent to the top of steel sheets.

3.2.2 Utility Service Connections

The Jet Grouting Contractor will be responsible to obtain a permit from the City of New York to utilize an existing fire hydrant located on the northern side of Beach Channel Drive for fresh water supply. The Jet Grouting and Prime Contractors may use this hydrant for their operations. Both Contractors may also elect to use the existing on-site water service with the understanding that maintenance, i.e., freeze protection, and upgrade of the system and piping is the responsibility of the Contractors. Both Contractors will also provide for their own electric power needs, including phase, voltage and amperage and will procure and operate, if necessary, suitable size generators for this purpose.

Both Contractors will be fully responsible to notify and utilize the appropriate utility hotline location and mark-out services (New York Underground Facilities Protective Organization (UFPO)) and to locate, secure and protect all utilities. National Grid will cooperate with the Contractors to locate and mark-out all on-site utilities and to protect same, as necessary. The Contractors will be supplied with the results of a Subsurface Obstruction Survey performed by others. The Subsurface Obstruction Survey will detail underground utilities and other anomalies detected on the Site in relation to the alignment of the proposed vertical barrier containment wall and the proposed location for the Waste Management Facility.

Both Contractors will maintain the continuous operation of and protect from damage all poles, signs, services to buildings and residences, utilities in landscaped areas, utilities in the street, overhead utilities, utilities in right-of-ways, fuel pipes, gas pipes, water pipes, hydrants, sewers, drains, fiber-optic cables and electric, telephone, signal, and communication cables, whether or not they are shown on plans and figures.

3.2.3 Vibrating Wire Piezometer Installation

Prior to the soil-cement barrier wall construction, three vibrating wire piezometer clusters will be installed by National Grid along the alignment of the jet grouted vertical containment wall area. Each cluster shall contain three strings installed at approximately 55 feet, 85 feet and 115 feet below grade surface and the annulus backfilled with lean/relatively poor cement grout.

Before, during and after the soil-cement barrier wall construction, National Grid will monitor and collect data from these vibrating wire piezometer clusters. The retrieved data will relay subsurface pore water pressure and temperature generation. The data will be studied to determine the influences caused by the adjacent pre-drilling and injection grouting activities.

Appendix D, Jet Grouted Vertical Containment Wall Technical Specification 02332, contains details on the equipment installation.

3.3 Mobilization

3.3.1 Grout Plant

As part of their mobilization to the Site, the Jet Grouting Contractor will use a designated location within the On-Site Area, shown on **Exhibit B**, as the location of the Grout Batch Plant and High Pressure Pumps and Lines. Use of this area will allow the Contractor to maintain a clean support zone away from the active jet grouting and daily material handling of the jet grouting wastes.

The Grout Batch Plant will include mixing and batching equipment for the jet grouting silos for cement, clay and slag and high pressure pumps to produce the pressurized grout for injection. The design and operations of the Grout Plant will be proprietary to the selected Jet Grouting Contractor and will be described in detail within the Site Operations Plan (see Paragraph 3.1.1 herein). **Appendix D**, Jet Grouted Vertical Containment Wall Technical Specification 02332, provides further requirements for the Grout Plant.

Environmental controls will be required for the Grout Plant. The cement, clay and slag silos will be required to have dust collection systems to limit emissions of dust during loading/unloading activities as well as the jet grouting operations. Additionally, all pumps and motors will be required to be enclosed within a soundproof container, which will limit noise to the maximum extent possible.

3.3.2 Drilling Equipment

The Jet Grouting Contractor will provide drilling equipment to create boreholes that will facilitate the soil-cement barrier wall production. Details on the

equipment will be provided in their Jet Grouting Contractor's Site Operations Plan. This equipment will have the following minimum performance capabilities:

- Rod-handling capacity for drilling and jetting to depths of 140 feet bgs
- Ability to incorporate the drill rig and drilling stem into the Contractor's waste collection system
- Ability to operate within about 14" to 40" of the steel sheet pile wall
- Equipped with a real time data acquisition system to monitor and record the required drilling and injection parameters
- Capability of performing full rod rotational jet grouting at the required minimum revolutions per minute (rpm)

Further requirements on the Jet Grouting Contractors drilling equipment are contained in **Appendix D**, Jet Grouted Vertical Containment Wall Technical Specification 02332.

3.3.3 Waste Management Facility

3.3.3.1 Temporary Fabric Enclosure

The Prime Contractor will design, operate and maintain an on-site Waste Management Facility for the wastes created during jet grouting operations. The facility operations will be coordinated with the operations of the Jet Grouting Contractor and the Waste Management Facility will be ready to receive jet grouting waste materials on timely basis so as not to delay or impede jet grouting operations. Detailed requirements for this facility are included in **Appendix B**, Technical Specifications for Waste Management/Emergency Response, 02111.

A temporary fabric enclosure, currently located on-site and operated by the Prime Contractor on the Site, will serve as a waste management facility during the jet grouting operations. Drawings and technical specifications for this enclosure will also be made available to the Jet Grouting Contractor along with National Grid's preferred location for the waste management facility (refer to **Exhibit B**).

The Prime Contractor will need to design suitable modifications to this enclosure. All designs will need to be prepared and stamped by a New York State licensed Professional Engineer. Designs prepared by the Prime Contractor will be submitted to and reviewed by the National Grid Project Team, then submitted to NYSDEC. The Prime Contractor is also be required to obtain any required construction permits for the modifications and then to construct the approved modifications.

3.3.3.2 Vapor Management System Upgrades

The Waste Management Facility will be equipped with a vapor management system (VMS) capable of providing a minimum six air exchanges per hour for the

interior of the building while maintaining a negative air pressure within the facility. The VMS will be designed to process the recovered air from within the facility to remove contaminants to meet NYSDEC air emission standards and the requirements of the approved Site Specific HASP. The Prime Contractor will ensure that the type and quantity of carbon or other approved media used in the vapor management system(s) will meet the emission limits for benzene, toluene, ethylbenzene and xylene (BTEX). Processed air will be discharged to the atmosphere.

Stored jet grout waste is capable of generating large amounts of heat and humidity so that the Prime Contractor may need to consider an increase the air flow and/or to make other improvements to their VMS and Waste Management Facility to assure the proper function of their equipment and to prevent potential heat exhaustion of their staff, especially during summer and warm weather conditions.

3.3.3.3 Waste Collection and Conveyance System

The waste materials generated from jet grouting operations will be received from the Jet Grouting Contractor's drill inside the Waste Management Facility by pipes and/or hoses. The Prime Contractor will specify, provide and install suitable pipes/hoses for distributing the jet grout cuttings within the interior of the sprung structure. These pipes will operate without the use of valves. A volume totalizer will be connected to the output side of the Jet Grouting Contractor's waste transfer pipes which discharges inside the waste management facility. This totalizer will be attached to the outside of the waste transfer pipe and have an LCD screen for obtaining measurements in real-time.

Supernatant that is decanted from the hardened jet grout cutting wastes during temporary storage may be recycled and used by the Jet Grouting Contractor for rinsing operations during the jet grouting production.

3.3.3.4 Waste Holding Cells and Load-Out Area

Jet grouting wastes will be temporarily stored in holding cells, designed by the Prime Contractor, located within the Waste Management facility so that they harden. It is anticipated that a minimum of 24 hours temporary storage of jet grout wastes inside the Waste Management Facility will be required.

Hardened wastes will be removed by the Prime Contractor from the temporary storage and then loaded into dump trucks within a load-out area designed by the Prime Contractor. The Prime Contractor will contract with NYSDEC licensed waste haulers for the transportation of waste materials. All proposed haulers must have the necessary number of vehicles to accommodate project requirements without causing schedule delays.

The Prime Contractor will identify appropriate disposal facilities for approval by National Grid and these facilities will be selected from the list of disposal facilities that are currently approved by National Grid. No wastes will be transported to any facility that has not received National Grid approval.

The Prime Contractor will manage all disposal documentation including but not limited to all necessary manifests, bill-of-ladings, weight tickets, and Certificates of Destruction. At project completion, a summary report containing daily truck activity, tonnage removed by waste type, completed manifests, weight tickets and Certificates of Destruction will be prepared by the Prime Contractor for submission to National Grid and NYSDEC.

3.4 Jet Grouting Production Activities

3.4.1 Pre-Production Jet Grouted Columns

Six pre-production jet grouted columns will be installed within the alignment of the 120-foot DNAPL migration barrier wall prior to the full jet grouting production and evaluated to establish the soil-cement column production parameters. The pre-production columns must demonstrate compliance with the performance requirements specified in the Contract Documents and Technical Specifications prior to commencing full production grouting.

3.4.2 Jet Grouted Column Production Parameters

The jet grouted vertical containment wall columns production parameters will be determined upon completion of the bench scale testing and the pre-production columns field testing program. The jet grouting operations will then proceed within the parameters set forth for the following: jetting water pressure, jetting water flow rate, grout injection pressure, grout injection flow rate, compressed air pressure, injection rod lift step, injection dwell time, grout density, grout viscosity, slurry density, slurry viscosity, grout blend water to solids ratio, grout blend slag to cement ratio.

3.4.3 Field Verification Measurements

Field verification measurements and testing of the installation of the jet grouted columns will be conducted on the following components: drilling deviation, grout and water nozzle, fresh grout density, temperature, pH and viscosity, Attapulgite slurry density, temperature, pH and viscosity, fresh grout unconfined compressive strength, wet jet grouting cuttings unconfined compressive strength, sand content, temperature and pH, core recovery lengths and rock quality data.

3.4.4 QC/QA Program

A Quality Control and Quality Assurance (QC/QA) Program will include the field verification measurements, review of real-time data acquisition data during jet

grouting, review of grout batch plant tickets and quantities consumed, review of drilling deviation data, review of borehole trajectory sketches, a core drilling program, core hole camera inspection program, and a hydraulic water testing program. Reports of inspections or tests, including data reduction of raw data, organization, and presentation of graphs and plots wall are submitted to National Grid for review. Test methods used will be identified and recorded along with test results. Quality Control (QC) test results will be submitted within 24 hours of completion of tests. Daily recorded information wall include, but not be limited to, hard copy output and CD discs containing digital records from each jet grouting column and any bore hole surveys conducted during the shift.

The Construction Quality Assurance Project Plan Addendum # 2 and the Jet Grouting Contractor's Site Operation Plan will provide additional details on the QC/QA program to be implemented.

3.4.5 Jet Grouted Column Remediation Derived Waste

The remediation derived waste (RDW) resulting from jet grouted column(s) installation will include debris from construction of working platform, jet grout cuttings (i.e., native soil mixed with water and cement and possibly coal tar and/or NAPL), liquid wastes including water decanted from the jet grouting spoils as well as drilling mud, impacted groundwater, liquids generated from decontamination operations, spent personal protective equipment (PPE) including Tyvek® coveralls, plastic over boots and gloves, standard refuse (municipal) trash generated in support of the field operations.

The Jet Grouting Contractor will identify and provide the estimated daily waste flow rates to the Prime Contractor so that the Prime Contactor can manage the anticipated daily outputs and not interrupt the jet grouting operations.

3.4.6 Grout Excursion Response Program

The Jet Grouting Contractor will prepare and implement a cleanup and response plan for grout excursions that occur beyond the waste management areas during jet grouted column construction activities. The plan will include the approach to contain, excavate/pump and dispose of the jet grouting cuttings excursion off-site location.

3.5 Waste Management Facility

3.5.1 Operation Sequence

The Jet Grouting Contractor will provide the operation sequence for the installation of the soil-cement barrier wall so that the Prime Contractor can effectively coordinate their operations within the Waste Management Facility.

Additional details will be included in the Prime Contractor's WM/ER Site Operations Plan.

3.5.2 Wastewater Recycling and Reuse Program

Water decanted from the jet grouting wastes during temporary storage will be collected by the Prime Contractor in enclosed containers. The collected decant water will be pumped back to an enclosed tank located near the Jet Grouting Contractor's drill rig(s). This recycled water may be used by the Jet Grouting Contractor for rinsing and cleaning operations.

3.5.3 Off-Site Transportation and Disposal

The Prime Contractor will contract with NYSDEC licensed waste haulers for the transportation of waste materials. All proposed haulers must have the necessary number of vehicles to accommodate project requirements without causing schedule delays. The Prime Contractor will ensure that all transport vehicles are properly loaded and secured and do not exceed permitted weights. The WM/ER Contractor will also ensure that transport trucks are not queued along any public right-of-ways. All vehicles must be properly covered, secured, and decontaminated prior to leaving the site.

The Prime Contractor will manage all disposal documentation including but not limited to all necessary manifests, bill-of-ladings, weight tickets, and Certificates of Destruction. At project completion, a summary report containing daily truck activity, tonnage removed by waste type, completed manifests, weight tickets and Certificates of Destruction will be prepared by the Prime Contractor for submission to National Grid.

3.6 Decontamination

All Jet Grouting equipment will be decontaminated prior to leaving the site in accordance with the RDR and Field Change #3 (FCR-03).

3.7 Demobilization

The Jet Grouting Contractor will be demobilized in accordance with the RDR.

3.8 Site Restoration

Site restoration activities will be performed by the Prime Contractor and consist of site grading and capping the site as depicted on the Design Drawings included in the Contractor Documents and soil erosion and sediment control measures. The final site grade will serve to direct on-site stormwater runoff to the central portion of the Site and allow for percolation into the subsurface.

3.9 Monitoring Programs

3.9.1 Community Air Monitoring Program

Remedial construction activities will be performed so as to reduce risk of potential exposure of neighboring residents to MGP-related contaminants. The Community Air Monitoring Program will continue to be conducted as part of the remedial construction activities.

3.9.2 Noise and Vibration Monitoring Program

Remedial construction activities will be performed so as to limit the potential for adverse impacts due to noise and vibration. The Noise and Vibration monitoring programs will continue to be conducted as part of the remedial construction activities.

3.9.3 Vibrating Wire Piezometer Monitoring Program

Subsurface pore water pressure and temperature generation data will be collected from vibrating wire piezometer clusters before, during and after the soil-cement barrier wall construction. The data will be assessed to determine the influences caused by the pre-drilling and injection grouting activities.

4.0 CONSTRUCTION QUALITY CONTROL AND QUALITY ASSURANCE PROGRAM

4.1 Equipment Measurement and Flow Rate

The Jet Grouting Contractor's drill rig equipment will measure the water jet pressure and flow rate, grout pressure and flow rate, grout density, rotary speed, lifting rate, dwell time and lifting steps. For QA purposes, on-site observations as well as a daily, detailed review of the soil-cement barrier wall installation will be performed. PS&S will regularly measure and observe the Jet Grouting Contractor's equipment used for drilling and jet grouting. Information on the size of the grout and water nozzles was compiled along with the pressures and flow rates of the grout and water. In addition, the setup of the drilling and injection equipment on the working platform will be reviewed daily, including the required leveling and calibration of the inclinometers.

The injection energy and cement and slag consumption values will be observed for the soil-cement column installation. The Cement/Slag Consumption (Kg/m) and Total Injection Energy values, derived from the Jet Grouting Contractor's real time data acquisition program, will be plotted versus column installation depths below grade surface to illustrate the consistency of the production grouting parameters during the installation of each jet grouted column.

4.1.1 Survey and Location of Jet Grouted Column Injection Points

After completion of the soil-cement barrier wall, a Record of Construction Survey will be prepared to document the location and elevation of the center point of the core hole locations and jet grouted column injection points.

4.1.2 Daily Measurements and Reporting Requirements

The Jet Grouting Contractor's grout batch plant operations will be inspected daily, including a review of the Jet Grouting Contractor's computer reports on the operations of the grout batch plants. The following jet grouting operation reports will be submitted daily:

- Quality Control (QC) Daily Report
- Jet Grouted Column Reports (including time and date of beginning and completion of each grout column as well as interruptions to the jetting process and material supply)
- Drilling Reports
- Drilling Deviation Reports
- Grouting Reports (injection pressure of all fluids used, total grout quantity for each column, flow rates of all fluids used to construct each grout element, rates of rotation and withdrawal of jet rods for each column)

- Record of Construction "As-Built" Columns at plan view at six-foot depth intervals and profile view
- Grout Batching Reports (Grout mix data including proportions and unit weight density measurements)
- Total volume of spoils return during drilling and injection

4.2 Fresh Grout Sampling and Physical Testing Program

The uniformity of the grout mixture will be verified by physical field and laboratory testing. PS&S will acquire batch plant grout samples for physical testing at the mixing plant and split these samples with the Jet Grouting Contractor. These unit weight measurements will be taken at a minimum of one per 5,000 gallons of grout mixed and pumped. Three (3) sets of fresh grout cubes (three cubes in each set) for a total of nine (9) specimens will be taken for every 25,000 gallons of grout injected, to assure the quality of the grout blend.

4.2.1 Grout Cylinder and Grout Cube Laboratory Testing Services

The operations of the on-site waste management facility will be inspected multiple times during each day of operation. PS&S will review the waste disposal data provided including the physical character and disposal locations.

Jet Grouting cutting samples will be acquired from the on-site waste management facility to assess the quality of waste materials ejected (generated) during the jet grouting production in comparison to the material quality being injected during the soil-cement barrier wall construction.

PS&S will retain an independent testing laboratory to analyze and prepare reports on the batch plant samples. PS&S's contract with the independent laboratory will require pickup of the batch plant samples and rapid turnaround of the results to provide the most current data on the jet grout produced by the batch plants. Results of the batch plant samples will be reported to National Grid and Jet Grouting Contractor. PS&S will compare the results of its samples with those received from Jet Grouting Contractor.

4.3 Drilling and Injection Analysis

PS&S will review the drilling deviations of all boreholes for jet grouted columns and compare these deviations to the deviation criteria of 1.0 % at full depth of the jet grouted column. PS&S will provide real-time review of the drilling deviation data and provide an appropriate recommendation as to: if the borehole should be backfilled with grout and re-drilled at another time or if it can proceed with the grout injection. PS&S will review as-built jet grouted column figures prepared by the Jet Grouting Contractor and determine if the jet grouted columns will create the minimum three foot thick wall specified in the Contract Documents. PS&S will utilize the as-built figures provided by the Jet Grouting

Contractor, the PS&S graphic representations of the installed columns and a probability equation for an approximation of the wall thickness.

A continuing review of the calibration of Jet Grouting Contractor's slope inclinometer, used for determining drilling deviations, will be performed by PS&S. Observations of inadequate data will be reported to National Grid who will require resolution by the Jet Grouting Contractor.. Review will also include a determination as to the need and frequency of third party calibration checks of the Jet Grouting Contractor slope inclinometer during jet grouting operations

4.4 Borehole Deviation Measurement

Drilling deviation measurements will be performed using an instrument capable of biaxial measurements to determine the magnitude of all bore hole deviations. The biaxial instrument for measuring the drilling deviations of the jet grouted column borehole will fit inside the triple fluid jet rods or be attached to the bottom of the rods and fit along the entire length of the borehole being measured. Due to the presence of the steel sheet pile wall, magnetic measurements for the drill hole azimuth will not be allowed.

4.5 Core Exploratory Drilling Program and Camera Inspection

4.5.1 Core Hole Downhole Inspections

PS&S will inspect and analyze the core samples retrieved by Jet Grouting Contractor from the jet grouted columns. Inspections will be completed in accordance with Technical Specification 02332 attached to this WP as **Appendix D** of the National Grid's Rockaway contract documents. Cores will be logged as to depth and soil type. Observations of core recovery, core quality index (RQD), grout penetration and contact with soil horizons will be compiled and recorded. Specific observation of the jet grouted column's contact with other soil-cement treatment will be noted and documented. Photographic images of the cores will be acquired and compiled for further review. Cores will be stored in core boxes at a secure on-site area maintained by PS&S so that they can be retrieved and reviewed at later date, as required.

4.5.2 Core Hole Camera Inspections

Copies of core hole video tapes made by Jet Grouting Contractor will be received by PS&S. The videos will be independently reviewed and analyzed by PS&S. The videos will be used to identify column weeps, column cracks, the quality of soil-cement treatment and the soil horizons contacted by the jet grouted columns. Results of the core hole video reviews will be reported to National Grid.

4.6 In-Situ Hydraulic Conductivity Testing Program

Two types of in-situ water tests will be performed within the jet grouted column core holes:

- Stage 1 - Slug Removal/Recovery tests will be performed inside core holes drilled from 55 feet (the top of the jet grouted column) to an estimated a depth of 90 feet.

- Stage 2 - Constant Head Drawdown with Camera Monitoring tests will be performed inside of core holes drilled to 115 feet.

The in-situ permeability of the jet grouted columns will be evaluated by conducting water tests. The video survey of the open core holes cored into the jet grouted column will provide a means to assess the consistency of the soil-cement treatment in-situ. During the constant head pump test, a remotely controlled down-hole camera will be used to assess the open face of the borehole. The video footage resolves on the condition of the soil-cement treatment and to assess potential seepage from the casing seal. The combination of water testing with camera monitoring allows assessing the permeability and evaluates its consistency.

4.6.1 Two Stage Hydraulic Testing Program

4.6.1.1 Slug Removal / Recovery Tests

During the slug removal / recovery test the water level is rapidly dropped by at least 50 feet with high rate pumping and water levels are monitored during recovery. Volumes of water removed from the core hole and depth to water versus time of water level recovery will are to be recorded manually (meter readings). The slug removal / recovery test will be performed by the Jet Grouting Contractor or an experienced contractor that has drilled and conducted water tests in soil-cement or weak rock formations. These tests will be performed by the Jet Grouting Contractor under the observation of PS&S. One slug test will be performed for each of the two stages (Stage 1 and Stage 2).

4.6.1.2 Constant Head Pump Tests with Camera Monitoring

During the constant head pump tests with camera monitoring, the pump will be used to lower the water level in the core hole to the submersible pump set near the bottom of the core hole approximately 115 feet. With the water level lowered in the core hole to just above the pump setting, a remotely controlled camera will be inserted into the core hole and slowly lowered to inspect the interior quality and consistency of the core hole. During the camera monitoring (and after) the water level will be maintained by pumping to keep the water level depressed. Discharge volumes, water levels, and video footage will provide information on the soil-

cement under large and sustained hydraulic loading. These tests will be performed jointly by the Contractor and PS&S.

4.7 Soil-Cement Barrier Wall Record of Construction Drawing

A Record of Construction Drawing will be prepared by the Jet Grouting Contractor to identify the as-built and location and elevation of the overlapping jet grouted column centers, the core hole location and elevation centers and the minimum wall thickness for the soil-cement barrier wall at 6-foot depth intervals to a depth of 120 feet below grade surface. This drawing is required to be submitted to National Grid within two weeks after the Jet Grouting Contractor demobilizes from the Site.

5.0 PROJECT SCHEDULE

The installation of the proposed lower section soil-cement barrier wall at the Rockaway Park MGP Site is anticipated to begin with the mobilization of the Jet Grouting Contractor in September 2010 and completed with decontamination and demobilization of the Jet Grouting equipment and grout batch plant which is projected for January 2011. A detailed project schedule for the implementation of the Phase 3 remedial construction approach is shown below:

Remedial Task	Projected Dates
Remedial Design Submittals	July 2010
Regulatory Review/Approval	July 2010
Mix Design / Treatability Study	July to August 2010
Jet Grouting Contractor Procurement	July to August 2010
Pre-Construction Activities	July to September 2010
Jet Grouting Contractor Mobilization	September 2010
Pre-Production Columns and Field Testing Program	September to October 2010
Full Scale Production of Jet Grouted Columns	October 2010 to January 2011
Construction Quality Control/Quality Assurance Testing Program	September 2010 to January 2011
Decontamination / Demobilization of Jet Grouting Equipment	January 2011

As detailed above, National Grid has set an aggressive schedule for the implementation of the Phase 3 120-Foot DNAPL Migration Barrier Wall remedial construction. To support the proposed schedule, National Grid respectfully requests an expedited review and approval of this WP to minimize potential delays in the full production of the lower soil-cement barrier wall and the remaining components of the selected remedy detailed in the ROD.

6.0 CONCLUSIONS

The proposed composite 120-foot deep DNAPL Migration Barrier remedial design and construction activities presented in this Phase 3 WP are in accordance with the regulatory requirements identified in the ROD and are consistent with the 100-percent RDR dated November 2008. The goals and objectives for the remediation of Site established in the RDR and as described in the ROD will be achieved through the successful construction of the proposed composite 120-foot deep DNAPL Migration Barrier.

Human exposures to contaminants will be eliminated, to the extent practicable, through the installation of the composite barrier wall and the construction of a multi-component cap installed as per plan and approved changes.

Potential human exposures to remaining MGP-related contaminants through exposure to Site soils, surface water, and sediments will be eliminated, to the extent practicable, through the implementation of a future Site Management Plan and the adoption of an Environmental Easement to restrict future Site activities, maintaining the Site fenced and secure to restrict access, and by undertaking a long term monitoring program of on-site engineering controls, and Site groundwater to monitor the completed remedial construction.

The remedial design intent of the RDR has been and will continue to be achieved with these expanded and revised 120-foot deep DNAPL Migration Barrier installation procedures. The goal of the National Grid Project Team is to install a continuous, 120-foot deep DNAPL Migration Barrier that has a maximum hydraulic conductivity (i.e., is not more permeable than) of 1×10^{-5} cm/sec and complies with the RDR and the NYSDEC ROD.

The National Grid Project Team will notify NYSDEC of any emergency deviations from this Phase 3 WP and the prescribed DNAPL Migration Barrier Installation Procedures within the next business day of the event. If additional revised DNAPL Migration Barrier Installation Procedures are necessary, a written notice to the NYSDEC in the form of an FCR will be submitted a minimum of one week prior to the implementation of the revised “Installation Procedures”.

APPENDIX A

February 2010 Field Change Request, FCR-06

APPENDIX B

August 8, 2009 Geotechnical Investigation Location Plan, Boring Logs, and CPT Logs

APPENDIX C

Section 02111 – Waste Management and Emergency Response Technical Specification

SECTION 02111
WASTE MANAGEMENT & EMERGENCY RESPONSE

PART 1 - GENERAL

1.1 Related Documents

The Contract Documents and General Provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, also apply to this Specification.

1.2 Scope

The work covered by this Specification consists of furnishing all plant, supervision, labor, equipment, materials and performing all operations for waste management and emergency response, by a Waste Management and Emergency Response (WM/ER) Contractor to be retained for the Rockaway Park Former MGP Site (Site). The operations and activities of the WM/ER Contractor will be conducted in support of the construction of the jet grouted vertical barrier containment wall in accordance with the National Grid US (National Grid) Request for Proposal (RFP) and other applicable documents.

National Grid has retained Posillico Environmental, Inc, Farmingdale, New York Posillico) as its prime contractor for the Site remedial construction. The Prime Contractor will function as the WM/ER Contractor during the jet grouted vertical barrier containment wall construction. A separate Jet Grouting Contractor will also be retained and will serve as a subcontractor to Posillico. Wherever used in this document, the words, National Grid shall also include their designated Construction Manager (CM), ARCADIS-US and/or the Engineer of Record, Paulus, Sokolowski and Sartor Engineering PC (PS&SPC), for the Rockaway Park Former MGP Site.

A jet grouted vertical barrier containment wall will be constructed by National Grid's Jet Grouting Contractor at the Site, using a single row of jet grouted overlapping columns, using triple fluid jet grouting techniques to form a continuous soil-cement barrier wall with a minimum wall thickness of three (3) feet. The continuous 250-foot long subsurface soil-cement containment barrier will be installed from approximately 60-feet to 120-feet below ground surface (bgs) and overlap a minimum of five feet vertically with the existing upper DNAPL Migration Barrier (i.e., Waterloo Barrier® interlocking steel sheet piling). The lower soil-cement barrier wall and the upper Waterloo Barrier® would then form a continuous Composite 120-foot deep DNAPL Migration Barrier in accordance with the NYSDEC remedial design objectives.

The WM/ER Contractor shall be responsible for coordinating with the Jet Grouting Contractor regarding the receipt and disposal of wastes generated by the jet grouting operations. The WM/ER Contractor shall also provide the necessary equipment and appliances so that wastes generated by the Jet Grouting Contractor can be received at the on-site Waste Management Facility operated by the Waste Management Contractor. Lastly, the WM/ER Contractor shall provide emergency response services during jet grouting as requested by National Grid.

1.3 Definitions

Remedial Derived Waste (RDW): RDW is defined as waste materials generated from the planned jet grout column wall construction.

1.4 Submittals

The WM/ER Contractor is required to prepare and submit the items listed below for review and approval by National Grid. Six copies of each submittal shall be issued to the CM who will distribute copies to the appropriate responsible parties for their review and acceptance.

1. The WM/ER Contractor shall prepare a Draft Waste Management Site Operations Plan that demonstrates their knowledge of the project requirements. The Draft Waste Management Site Operations Plan will be submitted to National Grid for review. The WM/ER Contractor shall modify/amend the Draft Site Operations Plan, as per comments generated from the review. The WM/ER Contractor is responsible for addressing all comments from National Grid and finalizing the Waste Management Site Operations Plan. The finalized version of the Plan will be submitted to the NYSDEC. The WM/ER Contractor is responsible for addressing all comments generated from the NYSDEC's or other regulatory agency review of the Waste Management Site Operations Plan.

   The Waste Management Site Operations Plan shall include appropriate descriptions related to all aspects of the work including, but not limited to, the following:

   a. Qualifications of the WM/ER Field Manager and field team;
   b. Design drawings for the proposed retrofitting of an existing sprung structure currently located on the Rockaway Park Former MGP Site to serve as a Waste

Management Facility for jet grout wastes; said drawings to be signed and sealed by a Professional Engineer in the State of New York;

c. Specific details on how the jet grout waste materials will be handled, managed, containerized, staged, characterized, transported and disposed off-site at a permitted National Grid-approved disposal facility;
d. Description of all equipment, supplies, materials and methods to be utilized in the Waste Management Facility construction and operations and maintenance;
e. Design details, including drawings, catalog cut sheets and specifications, for the exhaust/vapor management system to be utilized for the existing sprung structure.
f. Proposed methods to collect, control and containerize jet grout spoils, supernatant, drilling fluids, clean grout, excavated soils and debris and wash water;
g. An operations narrative,
h. The design and construction details of the waste containers to be utilized during the Waste Management Facility operations; and
i. Proposed detailed construction schedule.

2. The WM/ER Contractor shall provide a description of the work completed each day and other pertinent information necessary to completely detail the daily activities. The description shall include estimated percentages of work tasks completed; hours spent on standby time and/or on emergency response time and other pertinent information and observations such as grout escapes, ground heave or other unusual behavior as well as the measures employed to correct such instances.

3. The WM/ER Contractor shall identify the names and addresses of the selected disposal facility sites chosen from the National Grid approved list. Copies of waste characterization data for the disposal of waste materials and bills of lading and/or manifests for disposal sites shall be submitted by the WM/ER Contractor on a monthly basis.

4. For approval by National Grid, the WM/ER Contractor shall submit the names of the proposed waste transporters and their NYSDEC registration numbers and insurance certificates. No waste materials shall be transported by waste transporters that are not approved by National Grid.

5. The WM/ER Contractor shall submit evidence that their Field Manager and supporting personnel are experienced in the management, characterization and off-site disposal of RDW, the coordination and management of large waste trucking operations, and emergency response activities. The submittal shall contain a detailed

listing of completed WM, T&D and ER projects including, but not limited to, client name, client reference contact (name and telephone number), project location, dates, and a brief summary of the project.

6. The WM/ER Contractor shall submit copies of waste profiles and analytical data for waste sampling activities. Waste profiles shall be reviewed and approved by National Grid.

7. After completion of the work, copies of all final disposal documentation (i.e., manifests, Bills of Lading, weight tickets and Certificates of Destruction). Copies of these documents shall be available for inspection at the site by National Grid.

8. For any disposal facility not currently approved for use by National Grid, the WM/ER Contractor shall bear the burden to prove that the facility is adequate and sufficient for National Grid's needs. The WM/ER Contractor shall provide a copy of the facility's audit package for review and approval by National Grid. Disposal facility approvals by the National Grid Project Team will require a minimum one month review and approval process.

9. The WM/ER Contractor shall submit details on the proposed on-site truck weigh scale and its operations and maintenance plan.

1.5 Remediation Derived Wastes

The types of waste to be expected include, but are not limited to, the following:

- Waste concrete and debris from construction of working platform
- Jet grout cuttings (i.e., native soil mixed with water and cement and possibly coal tar and/or NAPL)
- Liquid wastes including water decanted from the jet grouting spoils as well as drilling mud
- Impacted groundwater
- Liquids generated from decontamination operations
- Spent personal protective equipment (PPE) including Tyvek® coveralls, plastic over boots and gloves.
- Standard refuse (municipal) trash generated in support of the field operations

1.6 Off-Site Disposal Facilities

The WM/ER Contractor shall identify appropriate disposal facilities for approval by National Grid and these facilities must be selected from the list of disposal facilities that are currently approved by National Grid. No wastes shall be transported to any facility that has not received National Grid approval.

For each proposed disposal facility, the WM/ER Contractor shall identify the facility's locations, capacity, type of wastes permitted to receive and their treatment/destruction or disposal method. In addition, the WM/ER Contractor shall provide copies of each proposed facility's current Federal or State permits. Please note that jet grout cuttings must be disposed at a low temperature thermal desorption facility and landfill disposal is not acceptable.

The following disposal facilities are included on the current National Grid list:

- Casie Protank, Vineland, NJ
- Clean Earth of Delaware, New Castle, DE
- Clean Earth of Philadelphia, Philadelphia, PA
- Clean Earth of Southeast Pennsylvania, Morrisville, PA
- Bayshore Soil Management, Keasbey, NJ
- ESMI of New York, Fort Edward, NY
- DuPont, Deepwater, NJ (hazardous liquids)
- Clean Waters of New York, Staten Island, NY (non-hazardous liquids)

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 Responsibilities

The WM/ER Contractor is responsible to provide all labor, equipment, testing and materials, including but not limited to: waste containers, to manage, characterize, transport and dispose of all solid and liquid wastes generated from the implementation of the jet grouting at permitted, off-site disposal facilities. **The WM/ER Contractor is placed on notice that the timely disposal and removal of jet grout wastes are of a critical nature to the jet grouting process and that the jet grouting waste handling and removal shall not cause delays.**

The WM/ER Contractor will be responsible for the following tasks as part of the management, storage, characterization and off-site disposal of the remediation derived wastes (RDW):

- On-site management of the remediation derived wastes (RDW).
- Operate and maintain the Waste Management Facility on a daily basis, as to not impede the progress of the work by the jet grouting contractor and other subcontractors working on-site.
- Provide all labor, equipment materials, transportation, disposal charges, testing and any other activities necessary to dispose jet grout cuttings, including any preconditioning of the waste necessary to assure acceptance by the disposal facility.
- Monitor the curing of the jet grouting waste cuttings.
- Decant supernatant (i.e. free liquids from the storage containers of jet grout wastes) to separate containers and then disposing these liquids at a permitted off-site disposal facility, approved by National Grid.
- Manage the arrival and departure of transport vehicles to ensure no conflicts with the work.
- Characterize the RDW in accordance with the requirements of the selected off-site disposal facilities.
- Prepare all paperwork (i.e., manifests, Bills of Lading, etc.) to document the off-site disposal of the RDW, with required signature of National Grid on all documents transmitted to the disposal facilities.
- Transport the RDW to properly permitted off-site disposal facilities, pre-approved by National Grid, in a manner consistent with all applicable Federal, State and Local regulatory requirements.
- Provide completely executed copies all manifests, Bills of Lading, weigh tickets, Certificates of Destruction and all other documentation regarding the off-site disposal of the RDW.
- Furnish a completion letter report including all of the above provisions for inclusion into the project file.

3.2 Waste Management

1. All wastes generated from the implementation of the jet grouting operations shall be managed by the WM/ER Contractor.

2. The WM/ER Contractor will ensure that a suitable volume of storage for RDW is available at all times so as not to impede the progress of the work. The WM/ER Contractor will select the proper type and size of containers for each type of waste.

3. Roll-off units used to containerize contaminated material shall be watertight. A cover shall be placed over the units to prevent precipitation from contacting the stored material. The units shall be placed in locations approved by National Grid. Liquid which collects inside the roll-off units shall be removed and managed in accordance with this Specification.

4. Liquid collected from the implementation of the jet grouting operations, other containers or generated from decontamination operations shall be containerized in approved tanks or barrels.

3.3 Waste Characterization

Waste characterization sampling for generated and staged materials shall be collected by the WM/ER Contractor. The WM/ER Contractor will characterize all RDW according to the selected disposal facility requirements. The WM/ER Contractor will arrange for testing of the samples at an off-site NYSDOH ELAP approved laboratory. The WM/ER Contractor will then prepare waste profiles for proposed off-site disposal facilities, confirm acceptance of waste types and forms with the disposal facilities and advise National Grid as to any restrictions imposed by disposal facility operating hours.

In addition, the WM/ER Contractor will precondition the jet grout waste and other components of the RDW to be transported off-site, as necessary, to meet the acceptance criteria of the selected disposal facility. For any waste materials rejected by the selected disposal facility, it shall be the responsibility of the WM/ER Contractor to amend the rejected materials in order to meet disposal facility requirements and then return the amended materials to the disposal facility at no additional cost to National Grid.

3.4 Transportation and Disposal

The WM/ER Contractor shall contract with NYSDEC licensed waste haulers for the transportation of waste materials. All proposed haulers must have the necessary number of vehicles to accommodate project requirements without causing schedule delays. The WM/ER Contractor will ensure that all transport vehicles are properly loaded and secured in accordance with the 100% RDR and do not exceed permitted weights. The WM/ER Contractor will also ensure that transport trucks are not queued along any public right-of-ways. All vehicles must be properly covered, secured, and decontaminated prior to leaving the site.

3.5 Disposal Documentation

The Contractor shall manage all disposal documentation including but not limited to all necessary manifests, bill-of-ladings, weight tickets, and Certificates of Destruction. At project completion, a summary report containing daily truck activity, tonnage removed by waste type, completed manifests, weight tickets and Certificates of Destruction will be prepared by the Contractor for submission to National Grid.

3.6 Waste Management Facility

3.6.1 Design and Construction

A sprung structure, currently located on the Site, will be made available to the WM/ER Contractor for service as a waste management facility during the jet grouting operations. Drawings and technical specifications for this sprung structure will also be made available to the WM/ER Contractor along with National Grid's preferred location for the waste management facility.

The WM/ER Contractor will need to design suitable modifications to this sprung structure. In addition, the WM/ER Contractor will need to complete design services for any interior temporary waste storage containers and associated waste loading facilities. All designs shall be signed and stamped by a New York State licensed Professional Engineer. The WM/ER Contractor is required to obtain any required construction permits for the modifications and then to construct the approved modifications.

The WM/ER Contractor shall specify, provide and install suitable pipes/hoses for distributing the jet grout cuttings within the interior of the sprung structure. These pipes must be designed to operate without the use of valves. A volume totalizer will be connected to the output side of the Jet Grouting Contractor's waste transfer pipes which discharges inside the waste management facility. This totalizer shall be attached to the outside of the waste transfer pipe and have an LCD screen for obtaining manual measurements.

3.6.2 Operations

The WM/ER Contractor shall provide staff, equipment and materials to operate and maintain the Waste Management Facility. The facility operations shall be coordinated with the operations of the Jet Grout Contractor and the Waste Management Facility shall be ready to receive jet grout waste materials on timely basis so as not to delay or impede jet grouting operations. The WM/ER Contractor should also assess the need to conduct

operations during periods when jet grouting is not being performed (i.e. such as to comply with disposal site requirements or to perform facility maintenance) and then to conduct appropriate operations during non-jet grouting periods.

The waste materials generated from jet grouting operations will be received from the Jet Grout Contractor's drill inside the Waste Management Facility by pipes and/or hoses; temporarily stored so that they harden; removed by WM/ER staff and equipment from the temporary storage into trucks hired by the WM/ER Contractor and then disposed by the waste hauler hired by the WM/ER Contractor. The WM/ER contractor should plan for a minimum of 24 hours temporary storage of jet grout wastes inside the Waste Management Facility.

The water that is decanted from the jet grout wastes during temporary storage shall be collected by the WM/ER Contractor in enclosed containers. The collected decant water shall be pumped back to an enclosed tank located near the Jet Grouting Contractor's drill. This recycled water will be used by the Jet Grouting Contractor for drilling, washing and cleaning operations.

3.7 Vapor Management System

The Waste Management Facility will be equipped with a vapor management system (VMS) capable of providing a minimum six air exchanges per hour for the interior of the building while maintaining a negative air pressure within the facility. The VMS will be designed to process (utilizing carbon absorbers or other approved method) the recovered air from within the facility to remove contaminants to meet NYSDEC air emission standards and the requirements of the approved Site Specific HASP. The WM/ER Contractor will ensure that the type and quantity of carbon or other approved media used in the vapor management system(s) will meet the emission limits for benzene, toluene, ethylbenzene and xylene (BTEX). Processed air will be discharged to the atmosphere.

It is noted that stored jet grout waste is capable of generating large amounts of heat and humidity. The WM/ER Contractor should consider the need to increase the air flow and/or to make other improvements to their VMS and Waste Management Facility to assure the proper function of their equipment and to prevent potential heat exhaustion of their staff, especially during summer and warm weather conditions.

The WM/ER Contractor shall continuously monitor the emissions from the VMS utilizing a Photo Ionization Detector (PID). If the PID readings exceed 10 ppm or greater above background, then a detector tube for BTEX will be utilized to sample the VMS exhaust to determine BTEX concentrations. The calculated concentration of BTEX will be compared to the NYSDEC Guidelines for Control of Toxic Air Contaminants.

The VMS must also be equipped with, at a minimum, the following (or as approved by National Grid):

- An adequately sized air handler system that will provide a minimum of six air exchanges per hour
- Flexible air ducts
- Particulate filters
- Granular activated carbon (GAC) box absorbers or other approved air treatment systems
- Measures to exclude vehicle and equipment exhaust from the air handler system
- Early warning GAC change-out determination devices
- Pressure gauges
- Air sampling ports
- Sound barriers/exhaust attenuators
- Continuous effluent monitoring

The WM/ER Contractor shall be prepared to change-out the carbon vessel based on effluent monitoring readings as well as carbon saturation indications (i.e., reading from saturation indicators, pressure loss, etc.). The WM/ER Contractor will be responsible for the characterization and off-site disposal of spent carbon as well as condensate removed from the activated carbon canister.

3.8 Temporary Working Platform

Prior to mobilization, the WM/ER Contractor will construct a working platform to ensure the stability of the jet grouting drill rig(s) and equipment to be utilized to install the jet grouted column vertical containment wall. The working platform will be constructed along the length of the installed Waterloo Barrier® (approximately 65 feet bgs). The working Platform will be constructed to the southern side of the Composite 120-foot deep DNAPL Migration Barrier, consisting of compacted common fill layers to sub-grade. A compacted 18” CAP Material will overlay the common fill and then a six-inch layer of asphalt cover. The width of asphalt covered working platform will be between15 to 18 ft.

The final design of the working platform will be completed by the WM/ER Contractor with input from selected Jet Grouting Contractor and PS&S. The final drawings will be signed and stamped by a New York State licensed Professional Engineer. The completed design will be first reviewed by PS&S, as Engineer-of Record and then after PS&S review, submitted to NYSDEC for review and approval.

3.8.1 Spoils Management Trench

The waste management component of the working platform will consist of a spoils management trench. The trench width will be 5 to 8 feet. The final width will be dictated by the reach of drill rig to be utilized by the selected jet grouting contractor. The existing Waterloo Barrier® steel sheeting will comprise the northern face of the spoils management trench. Temporary excavation support steel sheets, presently on site, to be driven up to 25 feet bgs will comprise the southern face of the spoils management trench. The temporary steel sheets will be driven by the WM/ER Contractor. This spoils management trench will effectively isolate the jet grouting operation return spoils from the remediated clean fill. The trench depth will be up to 8 feet or the depth to groundwater, pending generated waste projections from the jet grouting contractor.

The spoils management trench will be covered with plastic and plywood straddling the top areas of steel sheet walls weighed down by sand bags. The plastic and plywood cover will obstruct the view of the jet grout cuttings from the surface and will be used in conjunction with other odor/vapor management systems, to be provided by the WM/ER Contractor, to mitigate the potential for odors. Foaming on the spoils surface to control odors will be performed as necessary by the WM/ER Contractor.

This spoils management trench will contain a series of sump pumps (e.g. options include large trash pumps, Goldwin, etc.) to transfer the generated liquid wastes to the Waste Management Facility.

As part of the construction of the working platform, pieces of Waterloo Barrier® sheet piles or other suitable impervious sheet materials will be used to fabricate extensions to the installed Waterloo Barrier®. The purpose of these extensions is to provide an 18 inch high splash barrier

3.8.2 Personnel Working Platform

The WM/ER Contractor will provide Timber Mats and/or Scaffolding to be utilized as a personnel working platform by the Jet Grouting Contractor. The personnel working platform will not rest directly on the steel sheets, but instead will have load bearing points on the fill and the asphalt adjacent to the top of steel sheets.

3.9 Emergency Response

The WM/ER Contractor will perform Emergency Response (ER) services, as directed by National Grid, in the case of an environmental spill, release or other type of incident on or offsite. The WM/ER Contractor will maintain a ready status, 24-hours per day and seven days per week, to respond to potential environmental incidents resulting from the implementation of the remedial actions The emergency response activities may involve containment and/or cleanup of releases or spills of petroleum products or hazardous materials and ensuring all waste containers are properly sealed to mitigate exposure or release of vapors to workers, public or environment. The WM/ER Contractor will have available all spill control, containment and cleanup equipment and trained personnel necessary to respond to an environmental incident.

It will be at the discretion of National Grid to set in motion the ER crew. The WM/ER Contractor shall be solely responsible for all costs associated with the clean-up of any spillage caused by the Contractor's own actions. Said clean-up must be performed in accordance with all applicable federal, state and local regulations, and will be subject to the approval of National Grid. For the purpose of this specification, a Major Incident is defined as an incident that is reportable under Federal, State and/or Local regulations as authorized by National Grid. A Minor Incident is defined as an incident that is not reportable under Federal, State and/or Local regulations and can be contained and remediated with relative ease and should not cause a major disruption to the jet grout column wall construction activities as authorized by National Grid.

3.10 Field Manager

The WM/ER Contractor must provide a Field Manager to interact with the National Grid and the Jet Grouting Contractor to ensure the proper number, type and container sizes are available at a given time as to not interfere with the jet grout production. The WM/ER Field Manager will provide on-site management, staging of jet grout waste containers and oversight during facility operations, handling, loading and transportation activities.

3.11 Odor and Dust Suppression

The WM/ER Contractor will perform all waste management activities in a manner to limit the potential for fugitive odor and dust emissions. Odor and dust suppression measures shall be readily available and utilized, if necessary, during the work. Odor control measures will consist of Rusmar® Foam, Biosolve®, Hydroseal or an approved equivalent. Dust control will consist of water spraying or approved equivalent. The need to utilize odor or dust suppression measures will be in accordance with the HASP and/or field direction received from National Grid.

3.12 Work Area Access

The WM/ER Contractor will interact with National Grid to arrange access to the work areas and to designate areas for staging of transport and delivery trucks, waste management areas, equipment/container storage, contaminated waste storage and other operations as needed in support of waste management and emergency response during jet grouting operations. The WM/ER Contractor is notified as to the high sensitivity of this project and the need to properly manage work access to ensure that operations of adjacent businesses and occupants of adjacent residential properties are not adversely impacted.

3.13 Physical Features

The WM/ER Contractor shall be fully responsible for the protection of all buildings, railroad lines, monitoring wells, structures, landscaped areas, trees, walls, roadways, driveways, sidewalks, curbs, and pavements during the performance of any work that may adversely impact these features. Suitable precautions shall be utilized to protect these features and any damage caused by the WM/ER Contractor shall be repaired or replaced to pre-existing conditions in a prompt manner, as directed, and at no cost to National Grid.

3.14 Office Trailers

The WM/ER Contractor shall maintain the office trailers existing on Site to be utilized during the implementation of the proposed jet grouting construction activities. The WM/ER shall maintain the existing office trailer for National Grid, the NYSDEC, PS&SPC, the Air Monitoring Contractor (ENSR) and Site Security. The WM/ER Contractor will continue to provide the following temporary utilities to support the office trailers as required during the jet grouting operations: electricity, telephone service, water supply, and sanitary facilities.

3.15 Site Security

The WM/ER Contractor will provide security at the Site 24-hours per day and seven days per week. During Site working hours, a WM/ER Contractor employee will be assigned to the main entrance gate to control access to the Site. The employee will be equipped with a two-way radio with phone service to ensure constant contact with Site personnel. All Site workers, subcontractors and Site visitors will be required to sign a daily log. A list of persons authorized for Site entry will be maintained at the site entrance. The

WM/ER Contractor will maintain a stock of temporary fencing and spare locks on the site in the case that it is needed as additional security fencing for localized security measures. The perimeter of the Site will be secured and locked during non-working hours. Perimeter security checks will be performed hourly and conditions will be logged.

3.16 Decontamination Area

During the implementation of the jet grouting construction activities, the Site will be divided into three primary zones: the exclusion zone (EZ), the contamination reduction zone (CRZ), and the support zone (CSZ). These locations will be identified in the field during the implementation of the soil-cement barrier wall construction. The decontamination area will be within the CRZ and will include the personnel decontamination area and the equipment decontamination pads. Equipment and personnel decontamination will also take place inside the waste management facility. All heavy machinery, trucks, equipment and personnel entering the waste management facility will be subject to decontamination procedures in accordance with the approved 100% RDR.

END OF SECTION 02111

APPENDIX D

Section 02332 – Jet Grouted Vertical Containment Wall Technical Specification

SECTION 02332
JET GROUTED VERTICAL CONTAINMENT WALL

PART 1 GENERAL

1.1 References Standards

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN PETROLEUM INSTITUTE (API) STANDARD SPECIFICATIONS

API SPEC 13A Specification for Drilling-Fluid Materials

API SPEC 13B Standard Procedure for Testing Drilling Fluids

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C39/ C39M Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

ASTM C 109/C 109M Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)

ASTM C 143 Slump of Hydraulic Cement Concrete

ASTM C 150 Standard Specification for Portland Cement

ASTM C 494 Standard Specifications for Chemical Admixtures for Concrete

ASTM C 989 Standard Specification for Slag Cement for Use in Concrete and Mortars

ASTM D 698 Test Method for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

ASTM D 3740 Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used In Engineering Design and Construction

ASTM D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D 2113 Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation

ASTM D 2487 Test Method for Classification of Soils for Engineering Purposes

ASTM D 4832 Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

ASTM D 5084 Standard Test Methods for Measurements of Permeability of Saturated Porous Materials Using a Flexible Wall Permeameter

ASTM E 329 Practice for Use in the Evaluation of Testing and Inspection Agencies as Used in Construction

ASTM D 5783 Standard Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geo-environmental Exploration and the Installation of Subsurface Water-Quality Monitoring Device

1.2 Scope

The work covered by this Specification consists of furnishing all plant, supervision, labor, equipment, materials and performing all operations, by a Contractor to be retained for the Rockaway Park Former MGP Site, Rockaway Park, New York, in connection with the construction of the jet grouted vertical barrier containment wall in accordance with the National Grid US (National Grid) Request for Proposal (RFP) and other applicable documents.

National Grid has retained Posillico Environmental, Inc, Farmingdale, New York as its prime contractor for remedial construction. The Jet Grouting Contractor to be retained through this specification and other procurement documents will serve as a subcontractor to Posillico. Wherever used in this document, the words, National Grid shall also include their designated Construction Manager, ARCADIS and/or Engineer of Record, Paulus, Sokolowski and Sartor Engineering PC, for the Rockaway Park Former MGP Site.

A jet grouted vertical containment wall shall be constructed by the Jet Grouting Contractor at the Rockaway Park Former MGP Site, Rockaway Park, New York, using a single row of overlapping jet grouted columns constructed using a triple fluid jet grouting method, resulting in a continuous barrier with a minimum wall thickness of three (3) feet and a permeability of no greater than 1 x 10^{-5} cm/sec after 28 days of curing. In the event

that the triple fluid jet grouting method encounters uncontrolled release of compressed air or induces collapse or hydro-fracture of loose fine sands at depth, then a modified triple fluid jet grouting method (high speed water without the use of compressed air) will be available for use as an alternative jet grouting method. Furthermore, the modified triple fluid method will have the capabilities (equipment and material handling) to inject a high speed drilling mud or high speed water. The capabilities of both the standard and modified triple fluid methods will be demonstrated during the pre-production testing program prior to full jet grouting production.

The constructed jet grouted column wall must be made integral with the existing Waterloo Barrier® sealed steel sheeting that was installed at the Site. The quality of the contact with the steel sheets will be verified by coring close to the jet grouted column(s) and Waterloo Barrier® contact. The constructed jet grouted column wall must overlap the bottom of the Waterloo Barrier® sealed steel sheeting by a minimum of five (5) feet above the lowest level of grout seal in the inter-lock of the Waterloo Barrier®, or as necessary to demonstrate an integral composite barrier wall. The Jet Grouting Contractor shall be responsible for coordinating with a separate Waste Management Contractor regarding the receipt and disposal of wastes generated by the jet grouting operations and the Jet Grouting Contractor shall provide the necessary equipment and appliances so that wastes generated by the Jet Grouting Contractor can be received at the on-site Waste Management Facility operated by the Waste Management Contractor.

For each jet grout drill hole, a drilling deviation measurement over the entire length of the drill hole shall be performed and data reduced prior to starting the injection phase of the jet grouting. Drilling deviations shall also be performed on each core hole and any rotary exploratory hole. The Jet Grouting Contractor shall be responsible for managing the stored mix water during jet grouting. Grout batch mixing and/or injection shall not occur when the mix water temperature is below 50 degrees Fahrenheit so as not to impair the hardening of the grout mixture.

1.3 Geotechnical Site Conditions

1.3.1 Explorations

Subsurface explorations of the Rockaway Park MGP Site have been performed by National Grid and a copy of the logs of these explorations and CPT records are being provided to potential contractors. The CPT explorations were performed after the installation of the Waterloo Barrier® sealed steel sheeting. Several of the boring logs in the vicinity of the proposed soil-cement barrier wall indicate that from approximately 50 to 100 feet below grade surface (bgs), there exist thick layers of loose fine sand beneath the water table. These loose fine sands are susceptible to hydro-fracturing during drilling, jetting and injection.

Exploratory drilling conditions are further discussed in the 100% Remedial Design Report dated November 2008 and a copy of this document is being made available to potential contractors. The groundwater levels indicated on the logs of explorations are at the time of exploratory drilling and will vary depending on the time of year and conditions in the adjacent Jamaica Bay.

The deep groundwater conditions at the site vary from brackish to salty and have varying levels of MGP waste contamination over the depths of the proposed soil-cement barrier wall. A groundwater exploration was performed at the Site in 2002. Results of this exploration are discussed in the Final Remedial Investigation Report prepared for National Grid and dated January 30, 2004.

1.3.2 Contractor's Responsibility

It is the Jet Grouting Contractor's responsibility to become acquainted and satisfied as to the character, quality, and quantity of surface and subsurface materials by inspecting the sites and by evaluating information derived from available exploratory work and the explorations that are required as part of this contract. As part of the pre-production activities to be performed for the jet grouted vertical containment wall construction, a soil boring will be performed by National Grid in the vicinity of the soil-cement barrier wall alignment. Soil samples to depths of approximately 130 feet will be obtained for examination. The results of this soil boring program shall be used by the Jet Grouting Contractor as part of the assessment for selecting the jetting parameters to be employed during the trial field.

The Jet Grouting Contractor will be supplied with an as-built survey of the Waterloo Barrier® sealed steel sheeting that was installed at the Site. The survey notes the locations and top elevations of the steel sheeting that was identified during the survey. The Jet Grouting Contractor will also be given the driven length of each steel sheet pile and the top and bottom elevation of the grouted joint interlocks. The Jet Grouting Contractor will also be supplied with the results of a recent Subsurface Utility/Obstruction Survey that was performed at the Site. The survey notes the locations of utilities and subsurface anomalies that were located during the survey. However, this survey does not relieve the Jet Grouting Contractor of his responsibility to locate existing utilities through excavation, probing or other suitable methods prior to jet grouting. The Jet Grouting Contractor should also note that various subsurface structures and obstructions may exist on the Site and difficult drilling may be encountered.

1.3.3 Modifications to the Jet Grouted Vertical Barrier Containment Wall Depth

National Grid may at any time, prior to or during construction, require a change in the depth of the jet grouted vertical barrier containment wall. The objective of the jet grouted containment wall is to prevent further migration of non-aqueous phase liquids (NAPL) beyond the Site boundaries. The effectiveness and optimization of the vertical barrier containment wall may require increasing or decreasing the depth of the containment wall. The Jet Grouting Contractor shall utilize equipment that is capable of jet grouting, coring, and performing rotary exploratory drilling to depths up to 43 meters (140 feet) below grade surface (bgs).

1.4 Definitions

The terms used in this Specification are defined as follows:

1.4.1 Drilling Deviation Measurements

Drilling deviation measurements are performed for every jet grouted column drill hole, coring and rotary exploratory hole using an instrument capable of biaxial deviation measurements to determine the magnitude and azimuth of all down-the-hole deviations. The Jet Grouting Contractor shall select a biaxial instrument for measuring the drilling deviations of the drill rods which shall be able to fit inside the triple fluid jetting rods, and be capable of measuring the rod deviation over the entire length of the drill hole to a final depth of approximately 120 feet. The contractor shall demonstrate that they can control the azimuth of their selected probe, as determined by a field comparison with a standard inclinometer. The contractor shall install a conventional inclinometer cased hole to a depth of approximately 120 feet, and use a standard calibrated inclinometer probe from Slope Inclinometer to define the deviation of the inclinometer casing. This will be considered as the gold standard of comparison for evaluating the contractors selected probe. The specific procedures for performing the inclinometer tests and acceptability of the contractors probe in terms of accuracy and repeatability of measurements are covered under **Paragraph 3.1.6** of this specification.

The biaxial inclinometer will also be used for locating all core holes and any rotary exploratory bore holes along the entire length of the hole being measured.

Due to the presence of the steel sheet pile wall, magnetic measurements for the drill hole deviation shall not be used (for example: magnetometers and TIGOR-type devices).

1.4.2 Jet Grouting Contractor

The Jet Grouting Contractor is responsible for the installation of the jet grouted column wall portion of the vertical barrier containment wall. The Jet Grouting Contractor will work with ARCADIS and National Grid to designate areas for vehicle entry, staging of materials and equipment, parking, establishment of site layout, office trailers and support equipment and other site operations.

1.4.2.1 Jet Grouting Contractor Qualifications

The Jet Grouting Contractor shall submit for evaluation two (2) projects of similar scope and complexity as to that considered for Rockaway Former MGP site. Comparable projects are consider to be those in the past 5 years, in which a jet grouted soil-cement barrier wall has been installed to at least 100 feet in depth, and has a total minimum surface area of 50,000 sq.ft. The Contractor shall submit evidence that they currently have used in-rod inclinometer probes and have a data base of drilling deviation data which proves that they have the capability of accurately measuring the position of the jet grout columns over a depth of at least 100 feet. They shall submit as-built drawings of the final barrier wall from the two projects, along with field data (ex. pumping tests), which proves that they can form soil-cement with a hydraulic conductivity of 1 X 10^{-05} cm/sec (or lower).

Case histories in which the jet grouting contractor has performed jet grouting in submerged, loose fine sand would be considered more favorably when evaluating the past experiences of the contractor.

Since waste management is a critical part of this project, the Contractor shall submit as part of their offer, details from the two required case histories how they controlled the jet grouting cuttings, (pumps, T-preventers, etc), volume of waste generated in relationship to the volume of fluid injected, methods of excavation and disposal and treatment of the solid waste, along with the volume of supernatant and methods used to reduce the alkaline of the liquid waste.

1.4.3 Jet Grouting

Jet grouting, as defined in this specification, shall consist of a triple fluid system, in which the jetting rods are designed to inject three different fluids through nozzles which inject; high velocity water shrouded within a cone of compressed air, with the third fluid being high velocity grout through jets. This process excavates soil and MGP contaminates using air and water jet(s) and grout injection using a jet located below the point where the water jet is located. The grout jet shall be approximately 1 meter (3 feet) below the water jet. The triple fluid jetting rod is slowly rotated and incrementally lifted

at a constant incremental speed and distance to achieve thorough mixing of in-situ soils with grout. The grouted soil shall form a homogeneous cylindrical treatment of soil-cement to form a barrier of inter-connected jet grouted columns. This triple fluid jet grouting process will be used to form a single line of full cylindrical overlapping jet grouted columns with a minimum continuous wall thickness of three (3) feet. The triple fluid jet grouting shall also allow for a minimum five (5) foot overlap with the bottom of the Waterloo Barrier® grouted interlock steel sheeting.

Due to the soil conditions at the site, (submerged, loose fine sand at depth), the compressed air may pose problems for the jet grouting. For example, uncontrolled compressed air releases away from the injection hole, or collapse or fracturing of the fine sand which causes a reduced column size or poorly mixed soil-cement treatment. These are considered unacceptable events for this MGP site, and must be prevented by modification of the drilling and jet grouting process. The Contractor shall also have available the equipment for a modified triple fluid jetting system. The modified triple system shall not use compressed air, but shall be able to inject high speed water or high speed drilling mud (i.e water and clay with or without additives) through the upper jet on the injection monitor. The actual fluid injected will depend upon the ground response to form a three foot thick soil-cement barrier wall. The lowest grout jet shall be the same as in a conventional triple fluid system.

1.4.4 Jet Grouting Specialist

The Jet Grouting Contractor shall have a Jet Grouting Specialist with at least five years of continuous experience in the last seven years in triple fluid jet grouting on projects of similar scope and magnitude. This individual shall be on site for the entire project and shall be in technical control of the project. The Jet Grouting Specialist shall be knowledgeable in all aspects of jet grouting including, but not limited to:

(1) Selection of drilling methods and drilling mud to minimize formation fracturing;
(2) Operation and maintenance of jet grouting pumps and drills and other support equipment such as air compressors, drilling deviation equipment and borehole cameras;
(3) A thorough knowledge of how to batch multi-component grouts containing, clay, cement and slag for use during jet grouting;
(4) Preparation of submittals, and project progress reports and final documentation for certifying the as-built locations of the final soil-cement barrier wall; and
(5) Quality assurance/quality control (QA/QC) testing required for the jet grouted vertical containment wall construction.

1.4.5 Single line of Overlapping Jet Grouted Columns

A series of overlapping nearly cylindrical jet grouted columns of grout mixed with in-situ soil to form uniformly mixed soil-cement barrier wall. The intent of the single line of jet grouted columns is to form a continuous barrier containment wall (i.e. single row of columns to form a barrier) which satisfies all the technical requirements of this specification.

1.4.6 Jet Grouting Operator

The Jet Grouting Contractor shall have an individual with at least five years experience in the past seven years in the operation and maintenance of jet grouting drills, rod assemblies, grouting plants, and high pressure pumping equipment required to perform the jet grouting process specified for this project.

1.4.7 Borehole Camera

The bore hole camera is a closed circuit television (CCTV) video camera and shall be used in conjunction with cored boreholes or rotary exploratory holes in the jet grouted containment wall, The bore hole camera shall be capable of fitting inside of all holes drilled through a single jet grouted column and/or overlapped columns. The camera shall also be capable of viewing the sidewalls of all holes along the entire length of the hole and be able to operate in either a dry borehole or in a water-filled borehole.

1.4.8 Borehole Camera Specialist

A Borehole Camera Specialist is an individual with at least three years experience in the past five years in the operation and maintenance of borehole cameras and field-operated video recording equipment.

1.4.9 Jet Grouted Vertical Barrier Containment Wall

The jet grouted soil-cement barrier wall is a vertical DNAPL migration barrier consisting of a primary line of jet grouted columns constructed by using the triple fluid jet grouting techniques. The approximate lineal extent is shown on Jet Grouted Column Plan and the approximate vertical extent is shown on Jet Grouted Column Profile Plan.

1.4.10 Working Platform

The working platform will be constructed by the Prime Contractor under contract with National Grid along the alignment of the lower soil-cement barrier wall over the existing surface grade. This platform will form the surface for which the jet grouted vertical

containment wall is constructed by the Jet Grouting Contractor's drilling equipment. The working surface shall be designed to support the static and dynamic loading of the drilling equipment. The working surface shall also be constructed to allow for sufficient containment and management of the jet grout cuttings during the drilling and injection phase.

1.4.11 Top of Jet Grouted Vertical Barrier Containment Wall

The top of the jet grouted vertical barrier wall will generally correspond to approximately 60 feet bgs. Waterloo Barrier® sealed steel sheeting has been generally constructed to a depth of approximately 65 feet bgs. At locations where two to three pairs of Waterloo Barrier® have been driven to approximately 110 feet to 115 feet bgs, the depths of the jet grouted columns will need to be modified in order to minimize potential shadowing impacts. The soil-cement portion of the wall will overlap the lowest extent of the sheet piles with sealed interlocks by a minimum of 5 feet or as necessary to make a water tight seal with the existing Waterloo Barrier® steel sheet pile wall. The approximate vertical extent of each sealed (grouted) interlock is shown in profile on the Profile Plan to be provided to the Contractor.

1.4.12 Rotary Exploratory Drilling

Rotary exploratory drilling (such as tri-cone Tungsten carbide roller bit) into the primary line of jet grout treatment shall be selected by the Jet Grouting Contractor to produce a minimum 102-millimeter (4-inch) diameter bore hole using only water as the drilling fluid. The bore hole shall be able to accommodate the bore hole camera required in this specification.

1.4.13 Triple Fluid Jetting Monitor

The triple fluid jetting monitor is the rod appliance which holds the water, air, and cement jets. For the modified triple fluid system, the monitor shall be able to inject a pressurized fluid without the use of compressed air

1.4.14 Jet Grouting Cuttings

Jet grouting cuttings are a pumpable fluid mixture of contaminated soil, treatment agent, volatile organic compounds and liquids (water, NAPL's) which are ejected from the point of injection during the jet grouting process.

1.4.15 Jet Grouting Waste Products

Jet Grouting Waste Products are materials which are generated during the triple fluid jet grouting process. These waste products include: jet grouting cuttings, wash water, unused grout and any other liquids and debris generated to support the jet grouting process.

1.4.16 Soil-Cement

Soil-Cement is formed in-situ utilizing the triple fluid jet grouting process. This material (soil-cement) is the primary component which makes up the jet grouted overlapping column vertical containment wall. The soil-cement formed by the jet grouting process will produce a uniform mixture of in-situ soil with grout injected using the triple jet grouting process. The mechanical properties of the soil-cement treatment shall be that it is core-able within 14 days of curing in-situ and have a hydraulic permeability of 1×10^{-05} cm/sec (or lower) after 28 days of curing in-situ.

1.4.17 Waste Management/Emergency Response Contractor

The Prime Contractor, under contractor with National Grid, will serve as the Waste Management/Emergency Response (WM/ER) Contractor during the jet grouted vertical containment wall construction. The WM/ER Contractor will be responsible to provide waste management, transportation and disposal and emergency response services for all wastes generated during the construction of the jet grouted containment wall and supplemental construction activities. In addition, this firm will construct and operate an on-site waste management facility for the receipt of the jet grout wastes produced by the Jet Grouting Contractor.

1.4.18 Community Air Monitoring Plan

As required by the New York State Department of Environmental Conservation, National Grid has implemented a Community Air Monitoring Plan (CAMP) for construction activities at the Site. The CAMP is operated in conjunction with the Site Specific Health and Safety Plan (HASP) and:

1. Establishes background levels of target compounds in ambient air prior to initiation of remedy;
2. Monitor and document perimeter ambient air levels of target compounds during the implementation of the remedy;
3. Provides an early warning system to prevent elevated off-site exposures by responding aggressively to exceedances of short-term action levels, to ensure that longer-term exposures at the perimeter are at or below levels determined by health regulatory agencies to be acceptable risks;

4. Evaluates ongoing effectiveness of, and need for additional vapor and/or dust suppression controls and/or alteration of work activities, to reduce airborne compounds to below acceptable risk levels; and,
5. Uses real-time perimeter monitoring results in conjunction with confirmatory air sampling.

1.5 Submittals

National Grid approval is required for all submittals. Submittals shall be sent to National Grid at least 14 calendar days prior to commencement of any mobilization of jet grouting equipment for production work except where noted otherwise in this specification. The Jet Grouting Contractor's schedule for submittals shall be included on the Master Schedule required by **Paragraph 1.6**, SCHEDULE herein.

1.5.1 Jet Grouting Contractor Qualifications

The Jet Grouting Contractor shall submit documentation for the evaluation of two (2) projects of similar scope and complexity as to that considered for this MGP site. Comparable projects are consider to be those in the past 5 years, in which a jet grouted barrier wall has been installed to at least 100 feet in depth, and has a total minimum surface area of 50,000 square feet. The Contractor shall submit evidence that they currently have used in-rod inclinometer probes and have a data base of drilling deviation data which proves that they have the capability of accurately measuring the position of the jet grouted columns over a depth of at least 100 feet. They shall submit as-built drawings of the final barrier wall from the two projects, along with field data (ex. pumping tests), which proves that they can form soil-cement with a hydraulic conductivity of 1 X 10^{-05} cm/sec (or lower).

1.5.2 Jet Grouting Equipment

Data on all equipment to be used in the construction of the jet grouted vertical barrier containment wall shall be submitted as well as the equipment to be used for Construction Quality Control testing to be performed in the field and/or laboratory. Project case history data shall be presented to show that the proposed equipment is capable of performing the full scale production work.

1.5.2.1 Jet Grouting Mixing Plant

The Grout Batch Mixing Plant shall be capable of handling multi-component grouts in which Portland Cement, Granulated Blast Furnace Slag, Attapulgite Clay and other admixtures are uniformly blended to form a workable grout for use during the jet grouting injection.

1.5.2 Instruments for Drilling Deviation Measurements

Data on all instruments to be used for drilling deviation measurements shall be submitted, including manufacturer's operating manual. An instrument capable of biaxial deviation measurements to determine the magnitude and azimuth of all hole deviations. The biaxial instrument shall be able to fit inside the triple fluid jetting rods for down-the-hole measurements. In particular, the Jet Grouting Contractor shall provide details concerning the operation and data reduction of the instruments used for measuring drilling deviations for the triple fluid jet rods. The Jet Grouting Contractor shall provide a methodology for updating and checking their calibrated slope inclinometer and the proposed drilling deviation instrument. The Jet Grouting Contractor shall submit graphs comparing the calibrated inclinometer to the proposed instrument for in-rod measurements.

1.5.3 Control and Handling of Jet Grouting Waste

The Jet Grouting Contractor shall submit a site-specific waste management plan for control and handling of all jet grouting waste from the injection point. The Jet Grouting Contractor shall provide waste generation estimates calculated from their own Project Case History database. A copy of this data shall be submitted to National Grid and the WM/ER Contractor for their information. The Jet Grouting Contractor shall show the location and volume capacity of waste management system components. Data on and use of diverters and any service pumps to control the movement of the jet grouting cuttings shall be submitted. Methods of pumping jet grouting waste from the Jet Grouting Contractor's waste management system to the proposed on-site Waste Management Facility to be operated by the WM/ER Contractor (Prime Contractor) shall be included. The Jet Grouting Contractor shall specifically address how solid and liquid waste will be handled.

1.5.4 Vibrating Wire Piezometers

The Jet Grouting Contractor will perform three borings and then install three clusters of multi-level vibrating wire piezometers (VWPs); where each multi-level VWP cluster will include three (3) Geokon Model 4500 standard VWP instruments for a total of nine (9) VWP instruments. The typical installation will include three vibrating wire piezometers, a Geokon Model 8025 data logger, proprietary Geokon software, marine 12 volt batteries and a water tight valve box install flush at the ground surface. Readout devices will be provided by the Jet Grouting Contractor. The Jet Grouting Contractor provide an installation drawing of the vibrating wire piezometers and then a record of construction drawing of the Geokon Model 4500 standard vibrating wire piezometer installations as submittals to the National Grid Project Team.

1.5.5 Casing Installation

The Jet Grouting Contractor shall submit a plan for the installation of steel casing for the Quality Control/Quality Assurance Testing Program. The casing installation shall be continuous from the working platform to the top of the proposed jet grouted columns and/or overlapping columns. This plan shall indicate the methodology for casing installation including the means of providing a watertight seal between the casing and borehole drilled for the casing installation as required for the in-situ hydraulic conductivity testing.

1.5.6 In-Situ Water Testing

The Jet Grouting Contractor shall submit data on equipment and procedures used for conducting water pump tests inside of coreholes, including those in which a remotely operated camera is simultaneously inserted into borehole for observing the quality of the in-situ soil-cement. Flow rate and water level data from pump tests will be used to analyze in-situ permeability. The video footage from the camera monitoring will be used (along with other data) to assess the quality of the soil-cement within the jet grout treatment. Data on equipment shall include the type of drilling / coring to create the test borehole, submersible pump, data and sketches to shown that how the pump and camera fit into the test borehole, all gages for pressure and flow rate, and data reduction methods and analyses. The Submittal for borehole camera is discussed in **Paragraph 1.5.13.**

The equipment shall be able to perform the following test procedure.

1) Submersible pump shall be capable of working inside of all coreholes, tri-cone drill holes and any other borehole drilled into the jet grouted columns;

2) Submersible pump shall be capable of operating at depths of up to 120 feet, with a pump rate sufficient to drawdown the water level inside of the corehole to a minimum depth of 100 feet (30.5 meters);

3) Submersible pump shall be capable of pumping coal tar contaminated water from the core hole or any rotary exploratory holes to the Waste Management Facility;

4) Once the water pump rate is established, the pump shall remain in the borehole and a borehole camera survey shall be immediately conducted over the full length of the open borehole; and

5) It may be necessary to keep the borehole open for up to two weeks to obtain the hydraulic conductivity measurement data required to reject or accept the jet grouted column under examination.

1.5.7 Equipment and Procedures for Rotary Exploratory Drilling

Jet Grouting Contractor shall submit data on equipment and procedures to be used for performing the rotary exploratory drilling.

1.5.8 Equipment and Procedures to Obtain Samples

Jet Grouting Contractor shall submit data on equipment and procedures to obtain cutting samples and cored samples. Cored samples of containment wall (hardened soil-cement) shall be a minimum 101 mm (4 inch) in diameter (or other size as approved by National Grid). The corehole sample locations and time of coring cured soil-cement will be determined by National Grid.

The coring technique selected by the Jet Grouting Contractor shall be capable of obtaining continuous samples of the jet grouted column.

1.5.9 High Pressure Operating Safety Manual

The Jet Grouting Contractor is responsible for the safety of its personnel and equipment. The Jet Grouting Contractor will establish safety protocols and provide safety training to all personnel on-site as related to operating and working within the vicinity of high pressure pumps, lines, valves, etc. At a minimum, the safety manual will contain names, telephone numbers and the manufacturer's certificates related to safe operating pressures for all lines, valves, connections, blow-off valves and any other items which operate under high pressure (above 7 MPa; 1000 psi). The manual will contain pump pressure characteristics used for the project, including: pressure-flow-transmission setting curves for high pressure pump, and piston size. Manual will have the name, phone number, and location of Jet Grouting Contractor- appointed high pressure safety officer. Each member of jet grouting crew will sign the safety manual after receiving appropriate instruction. The safety manual shall be submitted at least 21 calendar days prior to commencement of any mobilization of jet grouting equipment for the production work. Any safety infractions and or incidences, no matter the severity, shall be kept as a log entry in the safety manual. A copy of the current manual shall be available on site for review by National Grid.

The Jet Grouting Contractor shall establish a high pressure pumping safety corridor from the grout batch plant to their drill. The purpose of this corridor is to prevent any

personnel from accidentally walking across the high pressure hoses used to transmit any of the fluids or compressed air used for jet grouting.

The Jet Grouting Contractor shall submit sketches and manufacturers operating manual on safety valves to control maximum pressure in jet grouting line.

The Jet Grouting Contractor shall submit details of how operators at the drill rig will keep in constant communication with the high pressure pump operator. The Contractor will have a communication system which will not solely rely upon hand held devices and has a high level of assurance that high pressure pumping can be stopped quickly (i.e. 10 seconds or less).

1.5.10 Air Quality and Uncontrolled Releases of Jet Grouting Cuttings Action Plans

There are two issues related to the action response values for the Rockaway Park Former MGP project: 1). Air quality CAMP alarms due to VOC and/or dust releases and 2) Uncontrolled releases of jet grouting cuttings or compressed air beyond the injection hole.

The Jet Grouting Contractor shall submit for review, within five calendar days after the Notice to Proceed, generalized plans of action to be implemented in the event any CAMP alarms or uncontrolled releases of jet grouting cuttings occur. The generalized plans of action shall include positive measures by the Jet Grouting Contractor to do any or all of the following that is or are applicable:

1. Stop jet grouting immediately
2. Submit plan to proceed forward with jet grouting operations for approval by National Grid

1.5.11 Layout of Jet Grouting Equipment

The Jet Grouting Contractor shall provide a submittal for the layout of its jet grouting equipment. The layout of operations for the jet grout vertical barrier containment wall construction shall include, but not be limited to, drawings for grout mixing equipment, injection equipment, pumps, hoses, high pressure steel hard lines or other hose protection appliances, high pressure safety corridor, waste areas, and the location of jet grouting with respect to support equipment for the Site.

1.5.12 Jet Grouting Batch Plant Capabilities

The Jet Grouting Contractor shall provide a submittal that demonstrates the capability of uniformly mixing dry blend materials (Portland Cement, Granulated Blast Furnace Slag and/or Attapulgite Clay) in sufficient quantities with water to produce a stable uniformly mixed multi-component grout for performing jet grouting. The Jet Grouting Contractor shall show that their grout plant is capable of performing the batching and blending for a multi-component grout in accordance with the selected mix design. For Bidding Purposes, Silos and metering system shall be demonstrated to have the capability of blending a two part dry blend wherein the components will be 50% / 50% to 70% / 30%, weight of granulated blast furnace slag Grade 120 to Type II/III Portland Cement by weight. Individual components can be added to high shear mixer separately such that the correct required proportions are accurately placed into the high shear mixer. Dry components shall be combined with a clean water source inside of a high shear colloidal mixer wherein the water to solids ratio (i.e slag, cement, clay) will be 0.7:1 to 1:1 by weight. The Jet Grouting Contractor shall demonstrate that their equipment is capable of metering liquid activators, Attapulgite clay or additives to the slag-cement slurry prior to pumping into the batch agitator. The metering of the additive will be accurate so that the weight/volume of the liquid can be accurately metered at a dose rate of about 4% to 6% of the solids in the slurry. The additives shall not be directly added to the colloidal mixer or agitator tank, but must be accurately metered in the piping between the high colloidal mixer and agitator.

1.5.13 Borehole Camera

As part of the submittals, the Jet Grouting Contractor shall provide detail drawings for the borehole camera for use inside the boreholes as specified and all rotary exploratory holes. Manufacturer's data specification sheets shall be included in the submittal for review, in particular capabilities of the encoder to stamp video tapes in real time. Three copies of video tapes for all borehole camera surveys shall be submitted to National Grid within 24 hours of performing the survey.

1.5.14 Schedule and Sequence of Operations

The Jet Grouting Contractor will submit a general work sequence and schedule that includes, but is not limited to, the following tasks:

1) Mobilization and site preparation

2) Coordination of work associated with:
   Mobilize to Site
   Soil-Cement Barrier Wall + QC Testing

Site Restoration
Decontamination/Demobilization

Any pre-production work associated with the above activities, jet grouted column layout and installation sequence, waste and site restoration shall also be included in the project schedule.

1.5.15 Quality Control Testing and Reports

Reports of inspections or field and laboratory testing, including data reduction of raw data, organization, and presentation of graphs and plots shall be submitted to National Grid for review. Test methods used shall be identified and recorded along with test results. Quality control (QC) test results shall be submitted within 24 hours of completion of tests. Daily recorded information shall include, but not be limited to, hard copy output and CD discs containing digital records from each jet grouted column and any bore hole surveys conducted during the shift. Digital records shall contain:

1. Summary page containing:

   a) Basic project information, date, length, jet grouted column and/or core hole identification.

   b) Data on drilling operations including start and end time, drill rod and bit sizes, maximum depth, drilling method, any fluids, total hole deviation at the hole bottom.

   c) Grouting operations start and end time: top/bottom elevation of jet grouted columns, average drilling and injection parameters, total weight of dry materials injected, total air pressure and volume of jetting water, total volume of grout injected, size of air, water and grout jet nozzles.

   d) Any observations during drilling and injection, other pertinent observations such as grout escapes, ground heave, conformance to response values, or other unusual behavior.

2. Digital file for input into Microsoft Excel Spreadsheet containing the following data scanned continuously:

   a) During drilling: clock time, depth, drilling rate, rotary speed, thrust on tool, rotary torque, drilling fluid pressure, specific energy.

b) During jet grouting: clock time, depth, incremental lift speed, air pressure and flow rate, water pressure and flow rate, grout density, pressure and flow rate, revolutions per minute (rpm), dwell time and lift step.

3. Hard copy and digital file of all bore hole drilling deviation surveys. Digital file for input into Microsoft Excel spreadsheet shall contain: general project and borehole information, surveyed ground location of injection hole, depth of survey, deviation in transverse and longitudinal directions and total hole deviation.

Other records submitted shall include: test samples taken from grout cubes, wet samples of soil-cement, core samples, water pressure tests, copies of video taken by borehole camera, permeability calculations, and any other information from construction of jet grouted containment wall.

1.5.16 Factory Calibrations on Instruments Used for Control of Jet Grouting

A factory calibration shall be done on all instruments used for control of the jet grouting. Certification shall indicate that the test equipment used for this purpose is calibrated and maintained in accordance with the test equipment manufacturer's calibration requirements and are traceable to the National Institute of Standards and Technology. Calibration certificates (obtained for each instrument within one month of start of project) shall be maintained on-site for the duration of the project for the following instruments:

1) Drilling Instruments:

a.	RPM's (N)	rev/sec
b.	Torque transducer (T)	Kilo-Newton-meter
c.	Thrust on drill rods (F)	Kilo-Newton
d.	Drilling speed (R)	m/sec

As part of the QA/QC program, the above drilling parameters will be used to calculate the specific energy (E) versus depth as:

$$E = F/A + 2 \times \pi \times N \times T / (A \times R) + \text{water hammer energy}$$

Where as "A" is the cross sectional area (m^2) of the bore hole, and "π" equals 3.14. The value of specific energy, "E" (kJ/m3), will be plotted versus the drilling parameters on the same graph for ease of visualization and submitted to National Grid for review.

2) Jet Grouting Instruments:
   a) water or Attapulgite slurry: pressure, flow rate and density (slurry only)
   b) air: pressure and flow rate
   c) grout: pressure, flow rate and density

d) depth: depth indicator

The Contractor shall not rely on fluid mechanics calculations for the purposes of recording the flow rates of any fluid injected. Electro-mechanical flow meters must be used as the transducer to measure the flow rates.

As part of their submittal process, the Contractor shall submit physical samples of their proposed air-water-grout jets for nozzle size measurements and verification. At the request of National Grid, air-water-grout jets shall be available for measurements and verification for the duration of the jet grouted vertical containment wall construction.

3) Factory Calibration on Bore hole Surveying Instruments

a. Factory calibration certificates (within one month of start of project) for all bore hole surveying instruments.

1.5.17 Treatment Agent Certification

The Jet Grouting Contractor will use either a 50/50 or 70/30 by weight dry blend of Grade 120 Granulated Blast Furnace Slag and Type II/III Portland Cement and with a clean water source to mix a water to solids ratio of 0.7:1 or 1:1. Attapulgite Clay slurry will be added to the fresh grout and/or used for jetting during the grout injection phase of production. For this treatment agent, the Contractor shall provide the following information:

a. For Type II or III Portland cement, a statement signed by an authorized official to certify on behalf of the manufacturer of the cement attesting that the product meets the specified requirements. The statement must be dated after the award of the contract, must state the Jet Grouting Contractor's name and address, must name the project and location and must list the specific requirements which are being certified.

b. For Grade 120 Blast Furnace Slag, a statement signed by an authorized official to certify on behalf of the manufacturer of the slag attesting that the product meets the specified requirements. The statement must be dated after the award of the contract, must state the Jet Grouting Contractor's name and address, must name the project and location and must list the specific requirements which are being certified.

c. For Attapulgite Clay, a statement signed by an authorized official to certify on behalf of the manufacturer of the cement attesting that the product meets the specified requirements. The statement must be dated after the award of the contract, must state the Jet Grouting Contractor's name and address, must name the project and location and must list the specific requirements which are being certified.

1.5.18 Jet Grouting Samples

Jet grouting samples consisting of cored samples, wet cutting samples, and fresh grout samples taken by the Jet Grout Contractor which have not yet been tested shall be archived and stored on-site in a moist environment for future testing.

1.5.19 Surveying Plan for Jet Grouted Vertical Containment Wall

The surveying plan for locating the center of each jet grouted column injection point drill hole, the alignment of the vertical barrier containment wall alignment and wall elevations and relating them to the contract drawings shall be established by the Jet Grouting Contractor and submitted to National Grid for review and approval. The locating system shall be able to relocate the drill hole center within 25 millimeters (1-inch) of the location initially used to perform the injection. The submittal shall be stamped by a Professional Land Surveyor registered in the State of New York.

1.5.20 Jet Grouted Wall Construction

The Jet Grouting Contractor shall submit the layout and detailed jetting procedures for the jet grouted containment wall construction, drilling methods, drilling deviation. measuring techniques, jetting parameters to be used (all nozzle sizes, pump pressures, flow rates, rod rotation, dwell time, lift step, lift speed, inter-axis spacing, estimated column size), Type II/III Portland Cement, Grade 120 Granulated Blast Furnace Slag and Attapulgite Clay grout formulations, and any other information needed to construct the single line of the jet grouted vertical containment wall.

1.5.21 Final Construction Report

A Final Construction Report compiling all data gathered, including but not limited to, column locations in plan view at six-foot depth intervals and in profile (elevation view), drilling and injection reports, bore hole surveys, water pressure test data, all laboratory data, a record of construction plan and elevation view of the containment wall, as continuously maintained by the Jet Grouting Contractor shall be submitted. A draft copy shall be provided to the National Grid Project Team for review and comment. The Jet Grouting Contractor shall respond to the National Grid comments and shall create a Final Construction Report. Five copies of the Final Construction Report shall be submitted by the Jet Grouting Contractor to National Grid within one month of demobilizing from the site. The Final Construction Report will be submitted by National Grid to NYSDEC as

part of the overall Final Engineering Report (FER) within three months of the remediation project completion.

1.6 Project Schedule

The Jet Grouting Contractor shall prepare and submit a project schedule in Microsoft Project Planner. The project schedule shall reflect milestone dates such as site preparation work, mobilization of jet grouting equipment, pre-production, testing program, start of full scale jet grouting production work, completion of full scale jet grouting production and site demobilization.

An initial project schedule shall be submitted with the Jet Grouting Contractor's bid. Updated project schedules shall be prepared and submitted to National Grid with the Jet Grouting Contractor's monthly invoices. The Jet Grouting Contractor shall identify any delays or if a delay in the primary activities is anticipated and indicate how they will adjust resources to maintain milestones required for project completion.

The Jet Grouting Contractor is alerted that jet grouted column production operations may only be conducted during weekdays between the hours of 7:00 am to 6:00 pm. No night or weekend jet grouted column production work shall be performed and night or weekend non-production work may only be performed with the prior permission of National Grid.

PART 2 PRODUCTS

2.1 Materials

The Jet Grouting Contractor shall maintain at the job site a sufficient quantity of raw materials and other supplies such that the work can proceed uninterrupted by material shortages. The grout to be used shall be suitable for the project.

2.2 Treatment Agents

The Jet Grouting Contractor will use Type II or Type III Portland Cement, Grade 120 Granulated Blast Furnace Slag and Attapulgite Clay as the Treatment Agents for this remedial construction work. Table 1 presents a list of the preferred material suppliers for the construction of the soil-cement barrier wall.

Table 1 – Preferred Material Supplier List National Grid – Rockaway Park Former MGP Site Jet Grouting Contractor RFQ and WSAR # 15 Phase 3 120-Foot Deep DNAPL Migration Barrier Installation		
Construction Material	**Preferred Construction Material Supplier**	**Preferred Construction Material Supplier Contact Information**
Grade 120 Blast Furnace Slag	La Farge North America	Mr. Frank Lore 5160 Main Street Whitehall, PA 18052 201-437-2576, Extension 25 Frank.Lore@LaFarge-NA.com
Type III Portland Cement	La Farge North America	Mr. Frank Lore 5160 Main Street Whitehall, PA 18052 201-437-2576, Extension 25 Frank.Lore@LaFarge-NA.com
Attapulgite Clay	BASF USA	Mr. Michael Ford BASF Corporation 100 Campus Drive Florham Park, NJ 07932 973-245-7119 Michael.Ford@basf.com

The requirements for each product follow below.

2.2.1 Portland Cement

The cement shall be free flowing and not contain lumps which would clog the jets. The Cement shall be a Type II or Type III Portland Cement as per ASTM C 150. A written mil certification specifying cement quality shall be provided by the cement manufacturer and submitted to National Grid for approval. Samples of the Portland cement, along with vendors and source suppliers, will be provided as a submittal to National Grid.

2.2.2 Granulated Blast Furnace Slag

The Grade 120 Granulated Blast Furnace Slag shall be free flowing and not contain lumps which would clog the jets. The slag shall satisfy the all requirements established by the various vendors and comply with ASTM C 989-06. A written mil certification specifying slag quality shall be provided by the slag manufacturer and submitted to

National Grid for approval. Samples of the blast furnace slag, along with vendors and source suppliers, will be provided as a submittal to National Grid.

2.2.3 Attapulgite Clay

The Attapulgite Clay, used in the industry as a salt water gel, shall be free flowing and not contain lumps which would clog the jets. The Attapulgite clay mineral shall satisfy all requirements established by the various vendors and comply with API SPEC 13A/B. A written mil certification specifying quality shall be provided by the Attapulgite manufacturer and submitted to National Grid for approval. Samples of the Attapulgite Clay, along with vendors and source suppliers, will be provided as a submittal to National Grid.

2.3 Admixtures

Admixtures may be used in the grout mix provided that they are shown necessary to satisfy coreability, permeability or other technical performance requirements. The use of admixtures must be approved by National Grid prior to use. If the Jet Grouting Contractor proposes the use of an admixture, the Jet Grouting Contractor shall submit a written statement to National Grid identifying any admixture(s), its effect on the grout mix, its long-term stability, its effect on the environment, and its health and safety impacts through manufacturer's MSDS.

2.4 Water

A New York City fire hydrant is located along the northern side of Beach Channel Drive and has been previously utilized as a water source for other operations. The Jet Grouting Contractor will be furnished with data on the available volume and pressure of the hydrant by National Grid and the Jet Grouting Contractor will need to determine if this source is suitable for their operations. If the hydrant water temperature is such that it impairs grout hardening, the Contractor shall adjust the water temperature to enable hardening of the grout and/or modify the grout mixture to encourage hardening of the grout. The Jet Grouting Contractor shall be solely responsible to supply any and all equipment, trucking, and piping required for transporting water from the hydrant to the Site. The Jet Grouting Contractor is also responsible for obtaining all required permits for use of the hydrant.

2.5 Material Storage Facilities

The Jet Grouting Contractor shall provide all necessary materials, equipment and personnel to store the cement, slag and any proposed admixtures under conditions as to

prevent moisture or contaminants from mixing with the materials prior to use in the grout mix.

2.6 Submersible Borehole Camera

The borehole camera shall meet the following requirements:

1. The camera and all attached appliances shall fit within any corehole and/or rotary exploratory hole used on the project. The camera shall be able to easily pass through the entire length of all holes. It should be noted that a submersible pump, power supply cable and discharge piping will be positioned in the corehole during the camera run and the camera must also be able to traverse the corehole with this in-place equipment. The selected pumping equipment shall eliminate any electromagnetic influence.

2. The camera must be capable of operating to a maximum depth of 43 meters (140 feet) of water (60 psi water pressure).

3. The camera shall be capable of pan/tilt and 360 degree rotation in a horizontal plane when suspended vertically inside the bore hole. An alternative pan/tilt and 360 degrees rotation of the camera field of view plan can be submitted and utilized. This alternative is subject to approval by National Grid.

4. The video camera and monitor shall be color and high resolution. The monitor shall be a minimum size of twelve (12) inches for real time viewing.

5. A Video Cassette Recorder (VCR) shall be provided with borehole camera and be used to instantaneously record images captured by the borehole camera. This VCR shall at least be a four (4) head unit with S-VHS input and toggle and freeze frame display capabilities. S-VHS format tapes must be converted to DVD. DVD recorders are also acceptable as an alternate to a VCR.

6. The camera must be capable of operating inside any hole for a minimum of four (4) hours of continuous operation without fogging or condensation and should be able to operate in wet or dry conditions. The camera shall be able to operate at a temperature of at least 65 degrees Celsius (150 degrees Fahrenheit).

7. The camera shall have a minimum variable lighting of 20 lux @ 1 meter and prevent any glinting (reflective light) problems with viewing the side walls of any bore hole

8. The camera shall be self-focusing or remotely controlled manually.

9. A controller and encoder shall be provided and will project onto the color monitor and stamp videotape with the following information in real time: hole or location identification, clock time (resolution to 1/30 second or better) and location (depth and orientation).

10. All camera functions including focus, iris, camera orientation and lighting intensity shall be controllable from the surface, either manually or automatically.

11. The color image shall be compliant with National Television System Committee format and have a scan rate of at least 620 lines at 50 HZ, and a resolution of at least 320 lines TV.

12. Camera shall be lowered and raised using an electrically powered winching system, with depth encoder and LCD depth display integrated into the winching system.

13. Deflocculating of suspended particles or flushing with clean water of the core hole water may be required to allow adequate water clarity for viewing. The camera may also be wrapped in a clear clean water filled plastic bag to allow for adequate viewing.

14. For boreholes formed by coring or rotary exploratory drilling, the compass orientation (N-S-E-W) of the field of view shall be estimated for each elevation in which a camera survey is conducted. The compass orientation shall be recorded versus time and depth. Camera frame shall have an option for attaching a magnetic compass for manually viewing the compass orientation of the image.

PART 3 EXECUTION

3.1 Equipment

3.1.1 General

The Jet Grouting Contractor shall furnish all necessary plant and equipment for the jet grouted containment wall construction, including the preparation for and completion of all drilling deviation measurements and all equipment required to implement the construction quality assurance and quality control testing. All equipment used for drilling bore holes, measuring drilling deviation, lowering, raising and rotating the jet rods, mixing grout, supplying pressurized grout, air and water to jets and jet rods used to construct the jet grout columns shall have proven performance records for use in jet grouting work. The Jet Grouting Contractor shall obtain and store, at the job site, spare parts and backup equipment to maintain jet grouting equipment in satisfactory operating

condition to prevent loss of time due to mechanical breakdown or equipment failure. Any special equipment required for blending of a 70/30 or 50/50 dry blend of Type II or III Portland Cement and Granulated Grade 120 Blast Furnace Slag shall also be included. The Jet Grouting Contractor should also note that various subsurface structures and obstructions may exist on the Site and difficult drilling may be encountered.

3.1.2 Jet Grout Drilling Equipment

Jet grout drilling equipment shall be of the type and capacity suitable for drilling in submerged loose fine sand materials at the Site at depths greater than 60 feet and capable of installing the required borehole sizes to the required depths. Jet grout drilling equipment shall be suitable for drilling the jet rods to the depths required, then raising and rotating the jet rods to the depths and at the rates required for containment wall construction. The bore hole shall be stable and have sufficient annular space between the jet grout drill rods and the side walls of the drill hole to be able to maintain a constant flush of cuttings to the surface. Drilling technique shall be able to achieve a maximum target drilling deviation of 1 % or less. The equipment shall be capable of drilling and jet grouting to depths up to 43 meters (140 feet).

The jet grouting drill shall have an integrated data acquisition system which during drilling will continuously monitor the following:

a. Clock Time
b. Drilling Speed (meters per second)
c. Thrust on Drill Rods (Kilo-Newton)
d. Torque (Kilo-Newton-meter)
e. Drill Rod RPM's (revolutions per minute, or indicate sweep angle)
f. Drilling Fluid Pressure (Mega-Pascal)
g. Drilling Specific Energy (kJ/m3)

3.1.3 Triple Fluid Jet Rods

The triple fluid jet rods shall have the capacity to be drilled through and then be used to convey, water, grout and/or Attapulgite slurry, air, grout pressures and flow rates required to produce jet grout columns in the work site soil types identified in the contract documents, and of the size and depth indicated in the specifications and drawings.

Additionally, the triple fluid jet rods shall have the capacity to accommodate a biaxial instrument for measuring the drilling deviations of the triple fluid jet rods. The instrument shall be able to fit inside the triple fluid jet rods or be attached to the bottom of the rods.

3.1.4 Grout Mixing and Injection Equipment

Grout mixers, holding tanks, water tanks and pumps shall be of sufficient capacity and design to ensure an adequate supply of homogeneous grout and water delivered at the required pressure to the jet rods for a full 8 hour work shift to produce grout columns of the required quality and dimensions.

Since the current concept for the jet grouting work is to utilize either a 50/50 or 70/30 dry blend of Grade 120 Granulated blast furnace slag and Type II/III Portland cement , the Jet Grouting Contractor's grout mixing plant shall have the capability of being utilized as a batch plant to mix up the cement and slag and uniformly blend them with water to form a stable grout for jet grouting. The grout mixing plant shall also have the capability of uniformly blending Attapulgite clay with water to form a stable slurry for jet grouting.

The grout batching plant shall be equipped with a paper tape output device(s), as a minimum, to measure and monitor the batching in real time. The Jet Grouting Contractor will provide National Grid with copies of all batching records at the end of each work day.

The grout mixing equipment shall have a controlled weighing system for assuring that the dry and wet constituents of the grout are properly proportioned. The grout mixer/agitator will allow easy access for QA/QC personnel to obtain fresh samples of grout.

The grout batching plant shall have a mud balance, API Marsh funnel and FANN Viscometer for manually checking the rheology of the grout, Attapulgite slurry and/or the drill and jet grout cuttings

The Jet Grouting Contractor shall mobilize the necessary equipment to provide for a pumping capacity of up to 500 bars of water/slurry and grout pressure. If the Jet Grouting Contractor believes that they require increased pumping capacity to satisfy the technical requirements of the jet grouted vertical containment wall, then they should mobilize the additional equipment which they deem is more appropriate.

The jet grout drill shall contain a data acquisition system and appropriate instrumentation to continuously acquire the following jet grouting parameters:

1. Clock Time
2. Air Pressure and Flow Rate
3. Water/Slurry Pressure, Flow Rate and Density (Attapulgite slurry only)
4. Grout Pressure, Flow Rate, and Density
5. Depth below ground surface and incremental lift step and speed
6. Dwell Time

7. Drill Rod rpms

During jet grouting, an LCD (Liquid Crystal Display) or paper strip recorder will be available for inspection by National Grid so that the jetting parameters can be verified in real-time and checked manually.

Once a jet grouted column has been completed, the Jet Grouting Contractor will submit a hard copy of the output along with a digital record of the drilling, drilling fluid quantities, all borehole deviation measurements and jetting parameters as part of their Daily Record.

3.1.5 Equipment Weight, Speed, and Width

The Jet Grouting Contractor shall select drilling/jetting equipment weight which can be supported by the design of the working platform.

3.1.6 Drilling Deviation Measurements

Upon completion of the borehole drilling to the design depth and without removing the drill stem to the surface, the borehole deviation shall be measured in-situ. The alignment of each jet grout column borehole shall be measured using a biaxial inclinometer probe lowered directly through the inner tube of the drill stem rods to a minimum depth of 120 feet bgs. A minimum duration of ten minutes shall elapse prior to beginning the deviation measurements to allow for the inclinometer line to lax (slacken) and for the probe temperature to stabilize at depth (temper) within the inner drill stem tube. The inclination readings shall then be taken on the way up at intervals of two feet. The drill rod stem and deviation measurement equipment shall prevent the probe from being in contact with impacted groundwater during the borehole deviation measurement.

The inclinometer probe shall be geared with two inclinometric cells or units that allow for the simultaneous reading of angular inclination from verticality in two perpendicular directions (X and Y). The cells are to be designed to measure angular inclination with an accuracy of ±0.01° within an angular range of ±3.00°.

3.1.6.1 Inclinometer Calibration

An initial factory calibration shall be completed on the inclinometer(s) in accordance with the manufacturer's requirements. The calibration certificates shall be submitted to National Grid for review and approval. The certificates shall be renewed as required.

Field calibrations of the inclinometers shall be performed on a daily basis prior to the borehole deviation measurements. This procedure shall utilize a graduated instrument capable of precisely applying angles of inclination to the inclinometer probe. The

calibration verification shall be conducted for both the x and y direction axis. The field calibration data shall be logged by the Jet Grout Contractor for submittal to National Grid.

3.1.6.2 Data Reduction Program

The angular inclination measurements shall be recorded and stored by a real-time data acquisition system at the drill rig and then processed by the Jet Grout Contractor using a data reduction computer program prior to the grout injection.

The proposed data reduction program shall be able to interpret the global reference system (northing and easting coordinates) values by using the raw angular inclination measurements at the various depths.

3.1.6.3 Deviation Measurement Comparison Studies

The Jet Grouting Contractor shall insert a standard PVC slotted inclinometer casing in one of the Pre-Production Quality Assurance Core Holes for the purpose of conducting a inclinometer measurement comparison study. The Contractor shall retain the services of an independent contractor to perform the inclinometer measurements within the open core hole to a depth of approximately 120 feet bgs to support this comparison study. The independent contractor shall use a slope inclinometer (with wheels) to measure deviation in traverse and longitudinal directions. Prepared graphics shall be submitted to National Grid for comparison to the inclinometer measurements performed by Jet Grouting Contractor and their proposed deviation measurement instrument.

The Jet Grouting Contractor shall also demonstrate precision and repeatability using their proposed biaxial inclinometer probe during the Pre-Production phase. A minimum of five down-the-hole inclinometer measurements shall be performed in the same pre-drilled borehole to support this comparison study. The raw data deviation in traverse and longitudinal directions, summary plots and reports by the Jet Grouting Contractor shall be submitted to National Grid for analysis and approval.

3.1.7 Tarp

The Jet Grouting Contractor will maintain the ability to utilize an impermeable tarp tub waste control system in the event that odors and vapor emissions cannot be controlled with other engineering practices (i.e., odor/emission suppressing foam, polyethylene sheeting, etc.). The Contractor shall maintain the tarp on-site, at all times, as not to delay the progress of the drilling and jet grouting activities. The tarp shall be constructed so as not to interfere with the waste handling system.

The Jet Grouting Contractor will provide a tarp with clear fabric/plastic in order to allow the operator to be able to view the operation of the waste handling system. The tarp shall be replaceable in the case that jet grouting materials are splashed onto the curtain and obstructs the view of the operator during the jet grouting operations.

Prior to mobilization and as part of the Jet Grouting Contractor's Operations Plan, the Jet Grouting Contractor will submit a shop drawing detailing the proposed construction of the tarp to National Grid for review and approval. The tarp shall not be deployed to the Site prior to approval of the shop drawing by National Grid. Once approved and constructed, the Contractor shall mobilize the tarp to the Site and maintain it on-site throughout the duration of the project.

The Jet Grout Contractor shall procure and operate a vapor management system (VMS), as necessary, including the exhaust and air treatment system, to be used in conjunction with the tarp. A shop drawing for the VMS shall be submitted to National Grid for approval prior to its use. The VMS shall be stored on site for use as needed and required.

3.2 Jet Grouting

3.2.1 Site Preparation

The Jet Grouting Contractor will be provided with an as-built survey drawing that indicates the location, the top elevation and the bottom elevation of each grouted joint interlock of the Waterloo Barrier® sealed steel sheet piling that has been driven along the alignment of the proposed jet grouted columns. Both a PDF copy and a CAD file of this as-built survey will be provided for the Jet Grouting Contractor's use.

The Jet Grouting Contractor will also be provided with a survey drawing showing the results of a Subsurface Utility/Obstruction Survey performed at the Site. However, the results of this survey do not relieve the Jet Grout Contractor from verifying the presence/absence of utilities on the Site. If deemed necessary, the Jet Grout Contractor shall locate utilities by pre-trenching and potholing prior to any jet grouting operations being performed in the vicinity.

The Prime Contractor, under contract with National Grid will provide and construct a temporary working platform along the alignment of the jet grouted vertical barrier containment wall to be used by the Jet Grouting Contractor in order to implement the jet grouting operations. This working platform will provide the means for directing generated jet grout wastes to the on-site Waste Management Facility. In no case shall the jet grout cuttings be allowed to flow off-site.

3.2.2 Surveys and Markers

The Jet Grouting Contractor shall provide, install, replace and maintain all layout and necessary construction staking to locate the centerline of the soil-cement barrier wall within the allowable range of jet grout containment wall installation shown on the contract drawings. Surveyor's caps, appropriately identified to include survey control number, elevation, and name of the surveying company, and elevations and mounted on a minimum 10.2-centimeter (4-inch) diameter, 0.6-meter (2-foot) long steel pipe, driven into the ground, shall be provided at each end of the containment wall and at 7.6 meters (25 feet) maximum intervals between the ends. A tabulated list containing survey control numbers, grid coordinates, and elevations shall be submitted National Grid within five (5) working days prior to the start of any construction. The coordinates and elevations shall have units consistent with the contract drawings. The caps shall be surveyed to establish initial elevation and final elevation to an accuracy of plus or minus 3 centimeters (0.1-foot) and these stakes shall be protected from damage or movement throughout the work. Survey construction control staking shall be performed by a New York State licensed professional surveyor and all survey data shall be stamped by the licensed surveyor. In addition, the working platform used by the Jet Grout Contractor shall contain surveying reference points for monitoring.

The center point for each proposed jet grouted column drill hole shall be surveyed and marked in a manner that will allow relocation of the hole if the area is obscured by jet grout cuttings, mud, etc. The Jet Grout Contractor shall provide, install, replace and maintain all layout and necessary construction staking to locate within 25 millimeters (1 inch) the center of any drill holes used during the construction of the jet grout containment wall.

Upon completion of the jet grout containment wall construction, permanent metal marker stakes shall be installed to indicate the location of each end of the containment wall. The survey station information shall be indicated on the permanent metal markers and the location of these permanent markers shall be recorded on a CAD drawing submitted to National Grid.

3.2.3 Drilling and Jet Grouting Sequence

The Jet Grout Contractor shall select equipment and drilling techniques to assure a stable drill hole. Drilling technique shall be able to achieve a maximum total drilling deviation of one (1) percent or less. Drilling deviation measurements shall be taken for every jet grouting drill hole, core hole and any rotary exploratory hole with readings taken at every 0.6 meter (2 feet) depth increment. The last reading shall be taken at the bottom of the bore hole approximately 120 feet below grade surface.

The drilling and grout injection sequence shall be such that an adequate distance is left between the freshly installed jet grouted columns and any new injection. A minimum of approximately 48 hours shall elapse between injecting triple fluid jet grout next to an installed column. Furthermore, the closest spacing shall be at least three inter-axis spacings or approximately 4.5 meters (15 feet) (whichever is greater) prior to the 48 hour time elapse. The spacing between columns shall be measured from center of installed jet grouted column to center of proposed injection.

3.2.3.1 Horizontal and Vertical Alignment Tolerances

The maximum horizontal deviation of the as-installed center of any soil-cement element at the ground surface shall not exceed 25 millimeters (1-inch) from the layout center coordinate, shown on the Jet Grouting Contractor's submittal. The vertical alignment of the drill hole shall not deviate in any direction more than 1 percent from vertical. At the direction of National Grid, any soil-cement element which exceeds the allowable horizontal alignment tolerances shall be supplemented with one or more adjacent or overlapping elements, at no additional cost to National Grid.

Once drilling is completed to final depth, the Jet Grouting Contractor shall measure the drilling deviations for each hole prior to injection. The instrument to measure drilling deviations shall be a biaxial inclinometer which has been approved by National Grid. Periodically, National Grid may require the Jet Grouting Contractor to re-calibrate the inclinometer for accuracy, and compare the in-rod instrument to a calibrated slope inclinometer.

3.2.3.2 Jet Grouting Stage

A critical element for jet grouting is an assurance of a continuous flush of cuttings to the surface. When jet grouting is first initiated (for example after rod breaks), the cement jet and water jets will be activated to the pressure, flow rate, grout density and rod rpm's as prescribed in the Jet Grouting Contractor's submittal. The Jet Grouting Contractor will not lift the jetting rods until a steady flush of cuttings is observed at the surface. Thereafter, jet grouting will be conducted following the prescribed jetting parameters submitted by the Jet Grouting Contractor.

In the event that the above procedure cannot effectively produce a continuous flush of cuttings to the surface, then the Jet Grouting Contractor shall submit for review an alternative drilling and jet grouting procedure. Plastic casing lined holes (i.e. PVC), which can be cut by the high speed jet will not be allowed.

If incipient or actual blowouts through the surface of the Site occur during jet grouting, all jet grouting activities shall immediately stop and the Jet Grouting Contractor shall

notify National Grid. Jet grouting activities shall not resume until approval from National Grid is given.

3.2.4 Variation in Triple Fluid Jet Grouting

If the Jet Grouting Contractor's selected drilling and triple fluid injection parameters, including the use of compressed air, cause surface blowouts or movements which consistently exceed a total lateral or vertical displacement of 25 mm (1 inch) as measured by various monitoring points, then variations in the triple fluid jet grouting method must be made and may include the reduction of pressures and /or elimination of the use of compressed air. The Jet Grouting Contractor shall submit a plan for the required variations for approval by National Grid.

3.2.5 Triple Fluid Jet Grouting Work

Triple fluid jet grout injection, rotation, and extraction rates shall be sufficient to produce grout columns meeting the depth, diameter and performance requirements specified in **Paragraph 3.3**. Any jet grout hole or columns lost or damaged as the result of mechanical failure of equipment, inadequacy of grout, air, or water supplies, or improper drilling or injection procedures shall be backfilled with cement grout and identically replaced by another corresponding jet grout column, or partial column, drilled and injected by the Jet Grout Contractor at no additional cost to National Grid.

3.2.6 Pre-Production Columns

Six pre-production jet grouted columns will be installed within the alignment of the 120-foot deep DNAPL Migration Barrier wall prior to the full jet grouting production. Each of these columns will be evaluated to establish the soil-cement barrier wall production parameters including: jetting water pressure, jetting water flow rate, grout injection pressure, grout injection flow rate, compressed air pressure, injection rod lift step, injection dwell time, grout density, grout viscosity, slurry density, slurry viscosity, grout blend water to solids ratio, grout blend slag to cement ratio. The initial setting of jetting parameters will be based on the experience and recommendations of the Jet Grouting Contractor as described in their Operations Plan. The initial grout mixture will be provided by the National Grid Project Team to the selected Jet Grouting Contractor prior to the start of the pre-production column installations. The initial grout mixture is currently being evaluated as part of an on-going grout compatibility study.

Each of the pre-production columns must demonstrate compliance with the performance requirements specified in the Contract Documents and Technical Specifications prior to commencing full production grouting. If the pre-production columns are determined to be non-compliant, the Jet Grouting Contractor must take corrective actions (i.e., repair

column installations) in order to construct a compliant, continuous 120-foot deep soil-cement barrier wall.

National Grid will select up to three locations in the pre-production column area for quality assurance coring as described in **Paragraph 3.3** herein, for borehole camera inspection as described in **Paragraph 3.3.1** herein and for in-situ hydraulic conductivity testing following the procedure specified herein at **Paragraph 3.6.6,** "In-Situ Water Testing". To support the pre-production columns evaluation, the Jet Grouting Contractor shall complete an initial inclinometer calibration as described in **Paragraph 3.1.6.1**, provide and install steel casing from the ground surface into the top of the jet grouted column (see **Paragraph 3.6.2** herein) and complete drilling deviation measurements of the coreholes as described in **Paragraph 3.1.6** herein.

During a period of approximately 20 days after the completion of the six pre-production columns, National Grid will work with the Jet Grouting Contractor to complete an evaluation of the pre-production columns to determine if acceptable soil-cement treatment has been installed. The National Grid Project Team will also evaluate the nominal diameter of the columns and the jetting parameters to be used for production jet grouting operations. The Jet Grouting Contractor's field crew will be placed on standby for a period of up to 20 days during this pre-production columns evaluation.

3.3 Performance Requirements for Jet Grout Containment Wall

The performance requirements will be measured using corehole data only (to assure least disturbance to the soil-cement), in which the jet grout containment wall shall satisfy the following two major design criteria:

1) A maximum hydraulic conductivity of 1.0 X 10^{-05} centimeters per second with a cure time of at least 28 days

2) Soil-Cement shall be uniformly mixed so that a continuous barrier is formed with a minimum 3 foot thick wall along the entire surface of the barrier. Continuity of soil-cement treatment shall be determined by obtaining continuous cores allowed a cure time of at least 14 days after injection. The minimum sample size extracted from in-situ soil-cement treatment shall be at least 4 inches in diameter or as approved by National Grid.

The primary means of determining the in-situ hydraulic conductivity shall be by water testing conducted on core holes drilled into the columns. Locations for water testing will be determined by National Grid from column production data, grout cuttings inspections, coring inspections and drilling deviation measurements.

3.3.1 Wall Continuity for Jet Grouting

The jet grout containment wall shall have the following minimum properties:

1. Minimum total wall thickness shall be 0.91 meters (3 feet) for the entire depth of the jet grout containment wall.

    a. The Jet Grout Contractor shall submit weekly as-built drawings consisting of the actual position of the jet grout columns, with plan view layouts starting at the surface and thereafter at 5-meter depth increments with the last plan view being the bottom of the wall. The minimum thickness of 3 feet shall be superimposed on each plan view along with the trajectory of the drilling deviation of the jet grout hole. Digitized data shall be submitted on magnetic media for a personal computer (PC) in Autocad format (latest version) along with a hard copy output. The digitized data shall differentiate between primary, secondary, tertiary injection patterns for the primary line of jet grouting. The exact format of the digitized data shall be coordinated with National Grid.

    b. The Jet Grouting Contractor shall submit weekly tabulated values of effective column diameter (D), inter-axis spacing (I) at working surface, maximum total drilling deviations (e), and depth (z, at 5-meter intervals) for each jet grout column installed. Tabulations shall have a column of (D-I)/e values for each depth increment. Digitized data shall be submitted on magnetic media for a PC in Microsoft Excel format along with a hard copy output. The exact format of the digitized data shall be coordinated with the National Grid.

2. The thickness of the containment wall shall be evaluated using soil-cement data from the cores recovered, which shall adhere to the following criteria:

    a. Soil-cement cores shall be retrieved from the entire jet grout column, starting from the top and continuing to the approximately five feet above the bottom of the jet grout column.

    b. If the core recovery is less than 50% of a core run, for soil-cement cured at least 14 days, the Jet Grouting Contractor shall evaluate the reasons for the insufficient core recovery and submit a jet grouting plan to repair the defects in the line of treatment. The Jet Grouting Contractor shall perform additional coring to determine the lateral extent of the defects in the jet grout containment wall. The depth and extent of repair shall be approved

by National Grid. As soon as practicable, the Jet Grouting Contractor shall develop and implement preventive measures to preclude the need for corrective measures. The additional coring and repair shall be performed at no cost to National Grid.

c. For all core holes, a borehole camera survey shall be performed in which a submersible pump has been used to draw-down the water level to a target value of 100 feet (30.5 meters). The camera survey shall be performed over the entire depth of hole with particular attention paid to core runs with less than 90% recovery. After the borehole camera survey is reviewed along with all other data, National Grid shall determine the need for repair of the jet grout treatment. If the data reveals physical defects, for example: pervious zones, cave-ins, voids, areas of untreated soil or inclusions within the in-situ soil-cement treatment, then the treatment shall be repaired at least five feet above and below the interval of the core where the barrier was non-compliant. The Jet Grouting Contractor shall perform additional coring to determine the lateral extent of the defects in the jet grout containment wall. The Jet Grouting Contractor shall submit a jet grouting plan to repair the defects in the treatment. The type of repair, depth and extent of repair shall be approved by the National Grid. As soon as practicable, the Jet Grouting Contractor shall develop and implement preventive measures to preclude the need for corrective measures. The additional coring and repair, and verification of the wall continuity shall be performed at no additional cost to National Grid.

3. For any rotary exploratory hole, drilling deviations and borehole camera surveys shall be taken over the entire length of the bore hole.

4. The Jet Grouting Contractor shall submit, weekly, three copies of the video tape (or DVD) for each borehole camera survey along with as-built drawings consisting of the actual trajectory of each core hole or rotary exploratory hole superimposed on the jet grout containment wall plan view layout at the working surface. The effective zone of treatment and minimum total wall thickness shall be superimposed on the plan view. The Jet Grouting Contractor shall indicate the core depths which satisfy **Paragraph 3.6.3**. All digitized data shall be submitted on magnetic media for a PC in Autocad format along with a hard copy output. The exact format of the digitized data shall be coordinated with National Grid.

5. All soil-cement retrieved from core runs shall be well mixed cemented soil without any visible air vesicles or untreated soil inclusions. The surface of the core runs shall resist a knife scratch (approximate depth of 1/16-inch) using moderate pressure on the knife.

6. The Jet Grouting Contractor shall have a maximum of 6 pre-production columns to assess and select the jetting parameters required for the full production work. All pre-production columns shall be completed within the alignment of the jet grout column wall. National Grid will be responsible for any repairs to these six columns. Thereafter, all repairs to the jet grout wall shall be at the expense of the Jet Grout Contractor.

7. Once the Jet Grouting Contractor has demonstrated that their jetting parameters produce a compliant material, then the hydraulic horsepower for the water and cement pumps along with the kilograms of cement injected per linear meter shall be 90% (or greater than) the value selected by the Jet Grouting Contractor. Once these limits have been established, they shall be maintained and verified using the data acquired by the data acquisition system.

8. After all of the QA/QC evaluations have been performed, the Jet Grouting Contractor shall tremie backfill starting at the bottom of the corehole or rotary exploratory drill hole using low pressure cement grout specified in **Paragraph 2.2**. It should be anticipated that all coreholes through the barrier wall will be kept open for at least 2 weeks (and potentially longer as required) so that National Grid can perform its own QA testing.

3.3.2 Hydraulic Conductivity

National Grid will examine all of the jet grouting and drilling deviation records and, in conjunction with the Jet Grouting Contractor, determine the location for hydraulic conductivity testing of the jet grout containment wall.

The in-situ hydraulic conductivity testing shall follow the procedure specified herein at **Paragraph 3.6.6,** "In-Situ Water Testing". As a guide for scheduling, the water testing shall be performed after a minimum of 28 days curing. The calculated in-situ hydraulic conductivity shall not be greater than $1x10^{-5}$ cm/s for any individual production column after 28 days of curing in-situ.

3.3.3 Response Values CAMP Air Quality and Displacement Responses

If at anytime during the jet grout containment wall construction, the Air Quality CAMP monitors are triggered above their action levels, then the Jet Grouting Contractor will comply with the directions of National Grid and all jet grouting may be required to cease as per the NYSDEC-approved CAMP Plan. The Jet Grout Contractor will secure their equipment and a meeting will be held within one hour to develop a plan of action to proceed forward.

If at anytime during the jet grout containment wall construction any displacement measurement equals or is greater than 25 millimeters (1 inch), as measured by surface deformation points installed on the Jet Grouting Contractor's working platform, then the jet grouting will have exceeded the displacement response value. The jet grout column under production will be completed. The Jet Grouting Contractor shall then submit a plan to National grid for proceeding with construction of the next columns in a manner that minimizes surface and lateral movements to below 25 millimeters (1 inch). The Jet Grouting Contractor shall continuously observe the area of construction for evidence of distress and take appropriate measures to preserve the integrity of the production area at all times.

3.4 Cleanup and Site Restoration

The Jet Grouting Contractor shall continually clean up jet grout wastes, debris and leftover materials resulting from the jet grout containment wall construction. Prior to demobilizing, the Contractor shall clear all debris which may have accumulated in the execution of the work.

All excavations caused by the Jet Grouting Contractor during the jet grouting activities shall be properly backfilled with certified "clean" materials obtained from a New York State Department of Transportation-approved source. All backfill materials delivered to the Site will be accompanied by a clean fill certification from the source stating the following:

1. The source of the backfill is from a NYSDOT-approved source;
2. The backfill materials are mined from a virgin source not subject to previous industrial or manufacturing activities; and,
3. The materials are free of contaminants and hazardous constituents.

The backfill material shall be placed in a maximum loose lift thickness of 0.3 meters or (12 inches) and compacted to at least 90 percent of ASTM D 698. A minimum of three in-place field density tests and a laboratory compaction test representative of the material being compacted in accordance with ASTM D 698 shall be performed. Tests shall be taken near the start, middle and end of placement.

3.5 Waste Management

The Jet Grouting Contractor will be responsible to coordinate with the Prime Contractor and effectively manage all wastes generated from the production of the jet grouted columns. Temporary storage, handling and load out of the jet grouting solid and liquid

wastes will take place primarily within the on-site Waste Management Facility provided and operated by the Prime Contractor.

3.6 Quality Control

The Jet Grouting Contractor shall be responsible for continuously preparing and maintaining project quality control records. Observations, measurements, and tests described in these specifications shall be performed for quality control. All quality control records, routine testing procedures, observations, and measurements shall be available for inspection by National Grid at any time.

A storage area with moisture and temperature control environment meeting the requirements of the specifications shall be provided by the Jet Grouting Contractor for temporary storage of fresh grout, grout cuttings and core exploratory drilling samples. For long term storage of samples, the samples shall be transported to a laboratory having the environmental conditions meeting the specification requirements.

3.6.1 Jet Grout Sampling

3.6.1.1 Fresh Cement Grout Cubes

The uniformity of the grout mixture shall be verified by unit weight (density) measurements of the mixed grout by mud balance, taken at the mixing plant. This is to provide a manual check of the Jet Grouting Contractor's data acquisition for the fresh grout. These manual measurements shall be taken at a minimum of one per 19,000 liters (5,000 gallons) of grout mixed and pumped. Three (3) sets of grout cubes (three cubes in each set) for a total of nine (9) specimens will be taken for every 95 cubic meters (25,000 gallons) jet grout column formed, to assure the quality of the cement and water. The preparation and storage, of the grout cubes shall be in accordance with ASTM C 109.

3.6.2 Casing Installation

Steel casing shall be installed to support coring of the jet grout columns which will be subjected to in-situ water testing. This casing shall extend from the injection point in the top of the working platform to the top of the column and form a watertight seal between the casing and borehole drilled for the casing installation. Casing shall not be installed until after the jet grout column has set for a period of at least 14 days. One of the following methods may used to install the casing:

1. A borehole is advanced from the working pad to the top of the column and a socket in the top of the column for the casing is created. The borehole is reamed, as necessary, to fit the casing. The casing with a casing shoe and carbide teeth is

installed into the casing borehole and into a socket created in the top of the column and spun-in tight with the drill rig. The interior of the casing and annulus is then filled with lean grout. The grout as allowed to harden within the casing and annulus. The grout in the casing is reamed out into the top of the column. Coring and in-situ testing is performed.

2. A borehole is advanced from the working pad to the top of the column and a socket in the top of the column for the casing is created. The borehole is reamed, as necessary, to fit the casing. Most of the borehole is filled with grout. The casing is then inserted and spun into the hole up to the top of casing. The grout is allowed to harden in the casing and annulus. The grout in the casing is then reamed out to the top of the column. Coring and in-situ testing is performed.

3. A borehole is advanced from the working pad to the top of the column and a socket in the top of the column for the casing is created. The borehole is reamed, as necessary, to fit the casing. The casing is installed into the borehole and the casing annulus is tremie grouted in the borehole (similar to the water well method). Coring and in-situ testing is performed.

4. The procedures as proposed by the Jet Grouting Contractor and approved by National Grid.

3.6.2.1 Casing Seal Test

All steel casings installed for in-situ hydraulic conductivity water testing shall be tested by the Jet Grouting Contractor for the presence of leaks prior to testing or camera inspection. National Grid shall receive 24 hours prior notification of these tests so that they can observe the leak testing.

3.6.3 Core Drilling and Cored Samples

During the coring operation, information shall be obtained about the characteristics of the jet grout containment wall that may or may not be apparent from the core recovered from the hole. Observations of the drilling action must be made and reported to present as complete a picture as possible regarding the consistency of the containment wall. When coring, the Jet Grouting Contractor's Quality Control Representative should note the amount of water return as compared to the amount being injected through the drill rods. Careful observation of the changes in the drill water return can indicate a potential defective zone. While the drill rod is rotating, the drill action and rate of penetration shall be noted and recorded. Changes in drilling rate can be related to changes in wall composition and provide complimentary data in areas of poor core recovery. Basic information to be included on each coring log should include: size and type of core bit

and barrel used; bit changes; depth; length; and time for each run; and amount of core actually recovered.

The coring will advanced into the column in two stages: approximately 60 to 90 feet bgs and 90 to 115 feet bgs. These coring stages are necessary to facilitate the in-situ water testing program described in **Paragraph 3.6.6.**

All core samples shall be a minimum of 4 inch diameter or as approved by National Grid. The core drilling technique shall be capable of keeping drilling deviations to a value of 1 percent or less. It is preferred that the coring of the jet grout columns be performed by the Jet Grouting Contractor using equipment and procedures that minimize drilling deviations and that is capable of obtaining undisturbed core samples. The Jet Grouting Contractor may employ the services of a Subcontractor for coring, however, that firm's credentials, experience and proposed equipment must be submitted for approval by National Grid prior to the Subcontractor's mobilization to the Site. In that the core recovery for the jet grout material is unique and the information from coring is critical to the verification of containment wall continuity, submitted data on equipment and procedures requires National Grid approval.

The Jet Grouting Contractor shall provide core boxes for the storage of cores. All core boxes shall be constructed of at least ½ inch (0.5 inch) thick plywood with wooden covers having hinges attached to the body of the box. The samples in the wooden core boxes shall be wrapped in heavy plastic and taped closed to assure no release of odors during storage. The core boxes shall be stored in a laboratory moisture room having constant temperature, saturated environment until tested or until otherwise directed by National Grid.

All holes shall be measured for deviations once all of the samples have been extracted from the boring. The location and scheduling of coring shall be coordinated with National Grid. Approximately 10 percent of the jet grouted vertical containment wall columns are estimated to be cored as part of the quality control/quality assurance testing program for the project.

3.6.4 Rotary Exploratory Holes

Rotary exploratory drilling (such as tri-cone Tungsten carbide roller bit) may be selected by National Grid or the Contractor to produce a minimum 102 millimeter (4-inch) diameter bore hole. The decision to use other rotary techniques will be at the direction of National Grid.

3.6.5 Jet Grout Compressive Strength Testing

3.6.5.1 Fresh Cement Grout

Three (3) grout cubes will have unconfined compressive strength test (ASTM C 109) performed on samples cured after three (3), seven (7), and twenty-eight (28) days, except samples shall be formed using molds conforming to ASTM C 109.

3.6.6 In-Situ Water Testing Program

The purpose of performing the in-situ water permeability test is to assess compliance of the soil-cement to satisfy the barrier wall performance, (**Paragraph 3.3**). Two types of in-situ water tests will be performed on the coreholes during Stage 1 and Stage 2: a Slug Removal / Recovery Test and a Constant Head Drawdown with Camera Monitoring.

The in-situ permeability of the soil cement columns will be evaluated by conducting water tests. The video survey on open holes cored into the soil-cement columns will provide a means to assess the consistency of the soil-cement in-situ. During the constant head pump test, a borehole camera will be used to assess the open face of the corehole. The video footage resolves on the condition of the soil-cement and to assess potential seepage from the casing seal. The combination of water testing with borehole camera monitoring allows assessing the permeability and evaluates its consistency.

The water tests shall be conducted within two stages (Stage 1 and Stage 2) on the core holes drilled advanced into the soil cement columns at two stages. Stage 1 water tests and borehole camera monitoring will be performed on the corehole interval from the bottom of the casing to a depth of 90 feet. Stage 2 water tests and borehole camera monitoring will be performed on the corehole interval from the depth of 90 feet to a depth of 115 feet. A discussion of the testing follows below.

3.6.6.1 Slug Removal / Recovery Tests

During the slug removal / recovery test the water level is rapidly dropped by at least 50 ft with high rate pumping and water levels are monitored during recovery. Volumes of water removed from the core hole and depth to water versus time of water level recovery will are to be recorded manually (meter readings). The slug removal / recovery test will be performed by the Jet Grouting Contractor or an experienced subcontractor to the Jet Grout Contractor that has drilled and conducted water tests in soil-cement or weak rock formations. These tests will be performed solely by the Jet Grouting Contractor under oversight by National Grid. One slug test will be performed for each of the two stages (Stage 1 and Stage 2).

3.6.6.2 Constant Head Pump Tests with Camera Monitoring

During the constant head pump tests with borehole camera monitoring, the pump will be used to lower the water level in the corehole to the submersible pump set near the bottom of the core hole (90 feet for Stage 1 and 115 feet for Stage 2). With the water level lowered in the corehole to just above the pump setting, the borehole camera will be inserted into the corehole and slowly lowered to inspect the interior quality and consistency of the corehole. During the borehole camera monitoring (and after) the water level will be maintained by pumping to keep the water level depressed. Discharge volumes, water levels, and video footage will provide information on the soil-cement under large and sustained hydraulic loading. These tests will be performed jointly by the Jet Grouting Contractor and National Grid.

Water levels will be recorded throughout pumping (drawdown) and natural recovery using equipment with automated data logging and manual methods as a back-up. Cumulative volume will be recorded periodically using an automated volume totalizer.

National Grid will retain an independent expert to analyze the data. The water level data from the slug / recovery and constant head pump tests will be used with finite element analyses to estimate the in-situ permeability of the soil cement. Discharge volumes recorded periodically during the constant head phase of the camera monitoring tests will be analyzed statistically to assess variability in well recharge under sustained hydraulic stress.

3.6.7 Packer Testing

The Jet Grouting Contractor shall be able to perform packer testing in either the casing or borehole/ core hole advanced into the soil-cement column. The Jet Grout Contractor shall provide an inflatable packer system capable of expanding and conforming to the casing or borehole/core hole and holding up to 150 feet of water head. The inflatable portion of the packer shall be 4 to 5 feet in length and chemically compatible with corrosive conditions of the grout and MGP material. The packer shall be equipped with 150 feet of steel security cable (3/16 to 1/4 inch) on a reel to manually lower and suspend the packer in the casing or borehole/core hole. The packer shall be equipped with an air line to inflate and deflate the packer system. The Jet Grouting Contractor shall provide compressed bottled air (Size 300) with a regulator and bleed valve to inflate and deflate the packer system.

3.6.7.1 By-Pass Packer Testing

In the event that the casing seal in the top of the soil-cement column is leaking or a section or the soil-cement column needs to be hydraulically assessed, the Jet Grout

Contractor shall be able to perform packer testing. To assess a casing leak test, the packer is to be lowered into the core hole and set approximately 5 feet below the bottom of the casing using the suspension cable. The packer is to be inflated using the bottled compressed air according to the manufacturer's instructions. The depth of the packer is to be verified using a weighted tape. The submersible pump with discharge tubing and electric power supply are to be positioned and set in the casing or core hole. A slug test is to be performed on the water within the casing. The slug test will be performed in similar fashion as described in **Paragraph 3.6.6**. During the slug test, the water in the casing is rapidly pumped down to the depth setting of the pump. Depth to water level measurements will be obtained during the pump down and recovery at predetermined intervals using both manual and automated methods. The data is to be provided to the Engineer for evaluation of permeability and to determine approximate leakage. After the test is completed, the pumping equipment and water level measuring equipment can be removed from the casing or core hole. The packer can then be deflated and removed from the casing or core hole.

3.6.8 Installation of Vibrating Wire Piezometers

Prior to the soil-cement barrier wall construction, three vibrating wire piezometer clusters will be installed by National Grid along the alignment of the jet grouted vertical containment wall area. Each cluster shall contain three Geokon Model 4500HD instrument and three Geokon Model 8025 data loggers installed at approximately 55 feet, 85 feet and 115 feet below grade surface and subsequently backfill with lean/relatively poor cement grout.

Before, during and after the soil-cement barrier wall construction, National Grid will monitor and collect data from these vibrating wire piezometer clusters. The retrieved data will relay subsurface pore water pressure and temperature generation. The data will be studied to determine the influences caused by the adjacent pre-drilling and injection grouting activities in the containment zone.

Essentially, the monitoring may provide early warning and detection to minimize the potential migration off-site of impacted source materials during the production grouting.

Monitoring of the vibrating wire piezometer clusters will also help National Grid demonstrate that the pressure spikes and increases in the soil and aquifer temperature observed during pre-drilling and/or injection returned to baseline conditions the following column(s) production.

3.6.9 Containment Wall Measurements

The depth interval of each column shall be continuously measured and recorded. The wall and overlap distance shall be continuously measured, and recorded. The information shall be submitted daily to National Grid.

3.7 Records

Records shall be maintained by the Jet Grouting Contractor for all testing, measurements, and inspections performed to ascertain that the jet grout containment wall construction meets the specifications. Required reports, records, and documentation shall be furnished to the National Grid daily. The Jet Grouting Contractor's required records are outlined below.

3.7.1 As-Built Plan and Elevation of Jet Grout Containment Wall

An as-built plan and elevation view of the vertical containment wall shall be continuously maintained by the Jet Grouting Contractor. The final version of these profiles shall be delivered to National Grid prior to demobilization from the Site. The as-built jet grout column locations and other information specified in **Paragraph 3.3.1** shall be submitted to National Grid on a weekly basis.

3.7.2 Results

The results of all construction quality control testing required in these specifications shall be furnished by the Jet Grouting Contractor. The Jet Grouting Contractor shall furnish records of all observations, measurements, and tests performed, identified with the location and time of testing. These records shall be furnished no later than 24 hours after the tests, measurements, and/or observations were made. All test results used for QC purposes shall be maintained in an electronic data base system compatible with Microsoft Excel or AutoCad as per the appropriate parts of this Specification. Specification values shall be shown with the test results and shall be updated and provided weekly. Upon completion of the project, an electronic copy shall be submitted.

3.7.3 Construction Log

The Jet Grouting Contractor shall continuously maintain a construction log of daily activities which shall include delays encountered during construction, causes of delays, locations of affected areas, and extent of delays. The log shall also record unusual conditions or problems encountered, and the dispositions made. The construction log shall be submitted daily to National Grid.

3.8 Quality Assurance

National Grid will inspect the work for quality assurance purposes as well as to ensure compliance with the specifications and Contract Documents in accordance with the Construction Quality Assurance Project Plan Addendum #2 prepared for National Grid dated June 2010. This inspection and/or testing will in no way relieve the Jet Grout Contractor of the responsibility of performing tests necessary to meet the construction requirements. All testing procedures being conducted by the Jet Grouting Contractor shall be available for inspection by National Grid at any time.

END OF SECTION 02332

APPENDIX E

Construction Quality Assurance Project Plan Addendum #2

CONSTRUCTION QUALITY ASSURANCE PROJECT PLAN ADDENDUM #2

for

A COMPOSITE 120-FOOT DEEP DNAPL MIGRATION BARRIER

For:

Rockaway Park
Former Manufactured Gas Plant (MGP) Site
Rockaway Park, Queens County, New York
Site Number 2-41-029

Prepared for:

NATIONAL GRID

175 East Old Country Road
Hicksville, New York 11801

JUNE 2010

Prepared by:

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TABLE OF CONTENTS

APPENDICES

TABLES

FIGURES

1.0 INTRODUCTION

National Grid, as owner of the Rockaway Park Former Manufactured Gas Plant (MGP) site located in Queens County, New York, is required to install a continuous 120-foot below grade surface (bgs) deep Dense Non Aqueous Phased Liquid (DNAPL) Migration Barrier along a 250 linear feet portion of the northern perimeter of the MGP site. The current remedial installation approach involved the installation of a Waterloo Barrier ® interlocking steel sheet piling system to a depth of 120 feet bgs. Due to complications that arose during the effort to drive the steel sheeting to a depth of 120 feet bgs, National Grid was required to develop an alternative remedial installation approach (Phase 3) for the deep DNAPL Migration Barrier.

The Phase 3 remedial installation approach for the deep DNAPL Migration Barrier will consist of a Composite 120-foot deep DNAPL Migration Barrier. The upper section of the composite barrier wall consists of the existing Waterloo Barrier ® interlocking steel sheeting that has been successfully installed to a general depth of 65 feet bgs. The lower section of the composite barrier wall will consist of a continuous soil-cement barrier wall with a minimum wall thickness of three feet to a depth of 120 feet bgs. The soil-cement barrier wall will be installed using triple fluid jet grouting techniques to form a single row of overlapping jet grouted columns. The soil-cement barrier wall will demonstrate a maximum hydraulic conductivity of 1×10^{-5} centimeters per second (cm/sec) after 28 days of in-situ curing. The soil-cement barrier wall would overlap the existing Waterloo Barrier ® interlocking steel sheeting by a minimum of five feet.

National Grid will retain the services of a specialty Jet Grouting Contractor to install the lower soil-cement portion of the 120-foot deep DNAPL Migration barrier in accordance with the New York State Department of Environmental Conservation (NYSDEC) Record of Decision (ROD) and the NYSDEC approved Remedial Design Report (RDR) dated November 2008 (refer to attached National Grid Rockaway Park Former MGP Site Remedial Action Site Plan Design Drawing C-04).

This Construction Quality Assurance Project Plan (CQAPP) Addendum #2 identifies the procedures to be used for the implementation of a construction quality assurance program during the installation of the lower soil-cement portion of a continuous 120-foot deep DNAPL migration barrier. The CQAPP presents the organization, objectives, and construction quality control/ quality assurance (CQC/QA) procedures to be implemented to install a continuous 120-foot deep DNAPL migration barrier at the site. This CQAPP provides descriptions of protocols to be utilized for field sampling, sample handling and storage, laboratory analysis, record keeping and data evaluation and management to demonstrate that the remedial construction activities will be performed pursuant to the 100% RDR and the Contract Documents.

An initial CQAPP was previously prepared for PS&S quality assurance activities during remedial construction at the Rockaway Park site. A CQAPP Addendum #1 was prepared in March 2010 to address the Phase 1 and Phase 2 Waterloo Barrier ® interlocking steel sheeting installation procedures. This document serves as an Addendum to the previous CQAPP prepared by Paulus, Sokolowski, and Sartor Engineering, PC (PS&S) and formalizes the additional quality

assurance procedures to be implemented during the installation of a Phase 3 Composite 120-foot deep DNAPL Migration Barrier phase of the remedial construction at the Rockaway Park site.

1.1 Project Team

A project team has been assembled by National Grid (owner) for the Rockaway Park site. The Project Team is described below:

1.1.1 National Grid

National Grid has final responsibility for all aspects of the implementation of the remedial actions. National Grid is responsible for all communication with regulatory agencies, members of the surrounding community and the press. National Grid is also responsible for monitoring overall project schedule, milestones and completion. A National Grid representative, or their designated representative(s), will be on-site periodically during the performance of the remedial actions.

1.1.2 Construction Manager

ARCADIS US, Inc. (ARCADIS) represents National Grid as the site construction manager (CM) to ensure the remedial construction activities are conducted in conformance with the project specific contract documents.

ARCADIS manages site activities balancing the needs of National Grid and the various contractor(s) within the framework of the regulatory process. ARCADIS assists National Grid in its liaison with the NYSDEC, New York State Department of Health (NYSDOH), and other project stakeholders, including adjacent property owners, other members of the community, and city government officials. ARCADIS also works closely with the National Grid representative and the various contractors to manage cost control and sequencing of the project.

1.1.3 Engineer-of-Record

PS&S serves as the Engineer of Record for the Rockaway Park site. During construction, PS&S provides on-site day to day remedial construction quality assurance resident engineering services. PS&S's Resident Engineer and field staff conduct construction quality assurance inspections in order to review remedial construction activities for compliance with the NYSDEC-approved remedial and design documents for the Site. PS&S assists National Grid in its liaison with the NYSDEC, NYSDOH, and other project stakeholders, including adjacent property owners, other members of the community, and city government officials. PS&S works closely with the National Grid and ARCADIS representatives during their daily activities.

1.2 Contractors

1.2.1 Prime Contractor

National Grid has retained Posillico Environmental, Inc, Farmingdale, New York (Posillico) as its prime contractor for the Site remedial construction. Posillico has overall responsibility for the completion of the Site remedial construction in accordance with the remedial design approved by NYSDEC.

1.2.2 Jet Grouting Specialty Contractor

A Jet Grouting Specialty Contractor will be retained by the Prime Contractor. A jet grouted vertical containment wall will be constructed by the Jet Grouting Contractor, using a single row of jet grouted overlapping columns, to form a continuous soil-cement barrier with a minimum wall thickness of three feet using triple fluid jet grouting techniques. The Jet Grouting Contractor will provide the necessary equipment and appliances so that generated wastes can be received at the on-site Waste Management Facility operated by the Prime Contractor.

1.2.3 Waste Management and Emergency Response Contractor

The Prime Contractor (Posillico) will function as the Waste Management and Emergency Response (WM/ER) Contractor during the jet grouting operations. The Prime Contractor will implement the waste management and emergency response as required and will operate and maintain the onsite Waste Management Facility. The Prime Contractor will mobilize the necessary equipment and personnel required to effectively receive, temporarily store, process and ship to off-site disposal facilities waste generated during jet grouting operations. The Prime Contractor will provide the necessary equipment and appliances and coordinates with the Jet Grouting Specialty Contractor to receive, recycle and dispose wastes. The Prime Contractor provides the emergency response services during jet grouting operations as requested by National Grid.

2.0 COMPOSITE DNAPL MIGRATION BARRIER WALL

A composite deep DNAPL Migration Barrier wall comprising of Waterloo Barrier® interlocking steel sheeting in the upper section and a soil-cement barrier wall (jet grouted in-place) in the lower section will be installed to the remedial design depth of 120 feet bgs. This approach includes the following components:

2.1 Composite 120-foot deep DNAPL Migration Barrier

The National Grid Project Team proposes a composite 120-foot deep DNAPL Migration Barrier. This composite DNAPL Migration Barrier will consist of the following two sections (upper and lower) to develop a continuous, 120-foot deep DNAPL Migration Barrier:

1. **Upper Section from 0 feet to 65 feet bgs**: Waterloo Barrier® interlocking steel sheet piling. Waterloo Barrier® has been installed to a general tip depth of approximately 65 feet bgs. The interlocking joints of the Waterloo Barrier® system have been successfully flushed and grouted on average to the sheet pile tip depth. Five interlocking joints have been observed to be non compliant with respect to the technical specifications and will require an external joint sealant; and,

2. **Lower Section from 60 feet bgs to 120 feet bgs**: A soil-cement barrier wall consisting of overlapping jet grouted columns installed by triple fluid jet grouting methods. The soil-cement barrier wall will overlap the existing Waterloo Barrier® interlocking steel sheet piling by a minimum of five feet, have a maximum hydraulic conductivity (i.e., is not more permeable than) of 1×10^{-5} centimeters per second (cm/sec) and will have a minimum wall thickness of three feet to a depth of 120 feet bgs.

Field Change Request (FCR-06a) presents the Phase 3 composite deep DNAPL Migration Barrier Wall and the planned soil-cement barrier wall specifications, composite barrier wall installation procedures and CQC/QA procedures. This CQAPP Addendum #2 addresses the specific CQC/QA procedures and engineering certification requirements.

2.2 Bench Scale Compatibility Test

A bench scale compatibility testing program will be performed by National Grid and PS&S to select the grout mix design for the proposed lower section soil-cement vertical containment wall. PS&S will review the laboratory testing data, summarize the key findings and provide recommendations on the grout mix design to implement for the soil-cement barrier wall construction.

2.3 Jet Grouting Parameters Field Testing Program

Jet grouting construction quality control/quality assurance (CQC/QA) will start with the installation of six pre-production jet grouted columns to examine/verify that the initially selected jet grouting parameters are sufficient to satisfy the performance requirements in the approved remedial design and Contract documents. Initial jet grouting parameters will be established once the jet grouted column(s) demonstrate compliance. The Jet Grouting Contractor will then be required to consistently apply those established jet grouting parameters without deviation for the duration of the full production jet grouting.

During the installation, the following parameters will be measured and recorded:

- Basic project information, installation date and time, column length, borehole/column identification.

- Drilling operations including start and end time, drill rod and bit sizes, maximum drilling depth, drilling method, drilling fluids, total borehole deviation at the termination depth. During drilling: clock time, depth, drilling rate, rotary speed, thrust on tool, rotary torque, drilling fluid pressure, specific energy.

- Injection operations start and end time: top/bottom elevation of columns, average grout, water, and air pressures and flow rates, injection parameters, total weight of dry materials injected, total volume of grout injected, size of water and grout jet nozzles before and after grouting. During jet grouting: clock time, depth, incremental lift speed, water pressure and flow rate, grout density/pressure/flow rate and revolutions per minute (rpm).

- Any observations during drilling and injection activities, other pertinent observations such as grout escapes, ground heave, or other unusual behavior.

Off-site laboratory testing will be performed as part of the CQC/QA on the fresh grout and the jet grouting spoils return by both the Jet Grouting Contractor and PS&S. The fresh grout and jet grouting spoils will be tested for unconfined compressive strength (UCS) strength after 4, 7, 14, and 28 days of curing during the initial pre-production column field testing program. Testing will continue during production column installation and will be compared to those results obtained during the initial pre-production column field testing program to monitor for consistency within a tolerance.

3.0 QUALITY CONTROL PROCEDURES

The Jet Grouting Contractor will implement a Construction Quality Control Plan (CQCP) for the jet grouted vertical containment wall installation. The CQCP will include the continuous real time data logging and recording of all drilling and injection parameters, borehole deviation measurements, grout plant operations data, manual measurements, field testing data and the production of detailed graphic reports relating to each jet grouted column installed. The CQCP will also provide for the frequency and measurement of the deviations of the drilled boreholes for the jet grouted columns, field and laboratory testing of the grout, inspection and physical testing of core samples of installed jet grouted columns, the coring of the centers and overlaps of completed jet grouted columns, video inspection of the core holes and slug tests in the core holes to determine permeabilities.

The Jet Grouting Contractor CQCP will include details for the following construction quality control procedures:

- **Jet Grouting Construction,** which describes the general quality control procedures to be applied by the Jet Grouting Contractor to ensure, verify and document the quality of the jet grouting.
- **Coring Exploratory Drilling,** which provides a specific procedure for the performance of the coring exploratory drilling of the in-situ jet grouted columns.
- **Borehole Camera Inspection,** which provides a specific procedure for the performance of the borehole camera inspections of the in-situ jet grouted columns.
- **In-Situ Water Testing,** which provides a specific procedure for the performance of the in-situ water permeability tests.
- **Rotary Exploratory Drilling** which provides a specific procedure for the performance of the rotary exploratory drilling of the in- situ jet grout columns.

A current factory calibration will be required on all instruments used for control of drilling and injection activities. Factory calibration and certifications will be maintained at the site for the duration of the soil-cement barrier wall remedial construction. Copies of these calibration and certifications will be required to be submitted to National Grid for review and approval.

4.0 PS&S QUALITY ASSURANCE PROCEDURES

4.1 Overview

PS&S will perform on-site inspections of the Jet Grouting Contractor's work and complete a daily, detailed review of all aspects of the construction. Results of the on-site inspections will be documented, in writing and through photographic images, into daily field reports. Copies of the daily field reports will be compiled and will be used to prepare the required NYSDEC Remedial Action Report for the Rockaway Park site.

4.2 PS&S Quality Assurance Team

PS&S has assigned a professional team to provide construction quality assurance for the Rockaway Park site soil-cement barrier wall remedial construction. Table 1 below provides a detailed review of the roles and responsibilities of the PS&S QA Team. Joseph Lifrieri PhD., P.E. P.G. P.P. will serve as the Engineer of Record for the site. In this function, Dr. Lifrieri will discuss project procedures and data results with the Project Quality Assurance (QA) Officer and Project Manager. The designated QA Officer will be Mr. Walter Burke, P.E. and Mr. Janos Szeman, P.E. will serve as the Project Manager and will provide office oversight of the field QA operations. Three personnel will be assigned full-time to on-site roles.

TABLE 1
PS&S ROCKAWAY QUALITY ASSURANCE TEAM

Team Member	Position	Functions
Joseph Lifrieri, PhD., P.E., P.G., P.P.	Engineer of Record	• Responsible to certify the remedial action is performed in accordance with the RDR
Walter Burke, P.E.	Project QA Officer	• Provides oversight of the PS&S QA Team and reports to the Engineer of Record
Janos M. Szeman, P.E.	Project Manager	• Office oversight of the field QA operations
Alain Noel	Resident Engineer	• On-site leader of PS&S QA Team • Interacts with the National Grid CM on contractor issues, work progress and compliance with the NYSDEC ROD and the approved RDR and FCR-6a • Briefs the PS&S Project Manager and Project QA officer on a daily basis on the jet grouting production • Compiles information provided by other on-site QA team members • Review schedule with the CM and Specialty Contractor for the required constant head pump tests of the column cores • Prepares QA Reports for distribution to CM

TABLE 1 PS&S ROCKAWAY QUALITY ASSURANCE TEAM		
Team Member	**Position**	**Functions**
Jonathan Knittel or Jerold Blustein	Drill Inspector	• Provides daily oversight of drilling, injection and core drilling operations • Compiles daily data on drilling, borehole deviation measuring and injection progress/operations • Provides daily oversight of noise and vibration monitors • Completes daily checks of vibrating wire piezometers
Walter Radomsky or Shane LaFord	Sampling Specialist	• Provides daily oversight of grout batch plant operations • Completes on-site sampling and testing of the fresh grout and grouting spoils • Prepares fresh grout samples from batch plant (grout cubes) and grouting spoils samples (cylinders) for off-site laboratory analysis by the contracted laboratory (splits samples with Jet Grouting Contractor) • Acquires waste samples from the current operating cells of the waste management facility for off-site laboratory analysis by the contracted laboratory • Stores and coordinates the daily pickup of grout cubes and cylinders by the contracted laboratory • Photographs, measures and logs the jet grouted column core drilling runs
Donald Whitehead	Pump Test Manager	• Review schedule with the CM and Jet Grouting Contractor for the required constant head pump tests of the column cores • Procures the required equipment for the testing and implements the testing. • Calculates the results of the testing and renders a determination on the in-situ permeability

4.3 Borehole Drilling Deviation Review

PS&S will review the drilling deviation measurements, performed by the Jet Grouting Contractor, of the pre-drilled boreholes for compliance with the technical specification documents. PS&S will perform a review of the drilling deviation data and provide an appropriate recommendation as to: if the borehole should be abandoned (backfilled with grout and re-drilled at another time) or if the contractor can proceed with the grout injection. As part of the borehole drilling deviation analysis, PS&S will also review the borehole trajectory graphics prepared by the Jet Grouting Contractor to determine if the

overlapping columns will meet the minimum wall thickness as specified in the Technical Specifications and Contract Documents. PS&S will utilize the as-built drawings provided by the Jet Grouting Contractor, our own graphic representations of the installed columns and the probability equation for a determination of the wall thickness.

A continuing review of the calibration of the Jet Grouting Contractor's slope inclinometer, used for determining drilling deviations, will be performed. Observations of inadequate data will be reported to National Grid. The PS&S review will also include a determination as to the need and frequency of third party calibration checks of the Jet Grouting Contractor slope inclinometer during jet grouting operations.

4.4 Jet Grouting Equipment Inspection

PS&S will regularly inspect the Jet Grouting Contractor's equipment used for drilling and jet grouting. Information on the size of the grout and water nozzles will be compiled along with the pressures and flow rates of the grout and water. The setup of the drilling and injection equipment on the working platform will be reviewed daily, including the required leveling and calibration of the inclinometers.

4.5 Grout Batch Plant Review

The Jet Grouting Contractor's grout batch plant operations will be inspected multiple times during each day of operation. The Jet Grouting Contractor's computer reports on the operations of the batch plants will be reviewed and analyzed. PS&S will acquire batch plant grout samples for physical testing and split these samples with the Jet Grouting Contractor. PS&S will retain an independent testing laboratory to analyze and prepare reports on the unconfined compressive strength testing of batch plant samples. PS&S's contract with the independent laboratory requires pickup of the batch plant samples and rapid turnaround of the results to provide the most current data on the fresh grout produced by the batch plants. Results of the batch plant samples will be reported to National Grid, the CM, and the Jet Grouting Contractor. PS&S will compare the results of its samples with those received from the Jet Grouting Contractor. Any inconsistencies or concerns based upon review will be identified.

4.6 On-Site Laboratory

PS&S will setup and maintain an on-site quality assurance laboratory. The Prime Contractor will furnish and power this on-site laboratory. This laboratory will be operated by a member of the PS&S on-site QA team. Basic physical tests of the fresh grout and jet grouting spoils samples will be completed at the on-site laboratory on a daily basis for the following properties: density, viscosity, pH, temperature, filtrate loss, and sand content. The laboratory will include field testing equipment and a large curing box for wet storage for cube and cylinder samples to be analyzed by the contracted independent laboratory.

4.7 Waste Management Facility Review

The operations of the on-site waste management facility will be inspected daily. Daily reports on the operations will be reviewed and analyzed. PS&S will receive and review the results of the waste characterization samples. PS&S will review waste disposal data, quantities generated, and the physical character and disposal locations of the wastes being disposed.

PS&S will acquire three inch by six inch (3" x 6") cylindrical mold samples from the on-site waste management facility to assess the quality of grouting spoils being generated and, by reference, the material quality of the fresh grout being injected to install each jet grouted column. PS&S will retain an independent testing laboratory to analyze and prepare reports on the unconfined compressive strength testing of the grouting samples. PS&S's contract with the independent laboratory will require pickup of the waste management facility samples and rapid turnaround of the results to provide the most current data on the physical character of the jet grouting wastes received at the waste management facility. Results of the waste management facility samples will be reported to National Grid and to the Jet Grouting Contractor.

4.8 Core Samples

PS&S will inspect and analyze the core samples acquired by Jet Grouting Contractor from the jet grouted column(s). Inspections will be completed in accordance with Technical Specification 02332 of the National Grid's contract documents. Cores will be logged as to depth and soil type. Observations of core recovery, core quality index (RQD), grout penetration and contact with soil horizons will be compiled and recorded. Specific observation of the column's contact, including the depth of penetration, will be noted and documented. Photographic images of the cores will be acquired and compiled for further review. Cores will be stored in core boxes at a secure on-site area maintained by PS&S so that they can be retrieved and reviewed at later date, as required.

4.9 Core Hole Videos

The Jet Grouting Contractor will perform core hole video surveillance for each of the quality assurance core exploratory drilling core holes. Copies of core hole videos made by the Jet Grouting Contractor will be received by PS&S. The videos will be independently reviewed and analyzed by PS&S. The videos will be used to analyze the quality of the soil-cement treatment and the soil horizons contacted by the soil-cement barrier wall columns. Results of the core hole video reviews will be reported to National Grid. PS&S will identify any concerns based on our review.

4.10 By-Pass Packer Testing

In the event that the casing seal in the top of the jet grouted column is leaking or a section of the jet grouted column needs to be hydraulically assessed based on review of the Core Hole Video, the Jet Grouting Contractor will perform packer testing to assess a casing

leak rate. The packer will be lowered into the core hole and set approximately 5 feet below the bottom of the casing using the suspension cable. The depth of the packer is to be verified using a weighted tape. A slug test will be performed on the water within the casing. During the slug test, the water in the casing is rapidly pumped down to the depth setting of the pump. Depth to water level measurements will be obtained during the pump down and recovery at predetermined intervals using both manual and automated methods. The data is to be provided to the Engineer for evaluation of permeability and to determine approximate leakage.

4.11 In-Situ Hydraulic Testing

Two types of in-situ water tests will be performed on the core holes:

- Stage 1 - Slug Removal/Recovery tests will be performed inside core holes drilled from 55 feet (the top of the jet grouted column) to an estimated a depth of 90 feet.

- Stage 2 - Constant Head Drawdown with Camera Monitoring tests will be performed inside of core holes drilled to 115 feet.

The in-situ permeability of the jet grouted columns will be evaluated by conducting water tests. The video survey on open boreholes cored into the jet grouted column will provide a means to assess the consistency of the soil-cement treatment in-situ. During the constant head pump test, a remotely controlled down-hole camera will be used to assess the open face of the borehole. The video footage resolves on the condition of the soil-cement and to assess potential seepage from the casing seal. The combination of water testing with camera monitoring allows assessing the permeability and evaluates its consistency.

The water tests will be conducted in two stages (Stage 1 and Stage 2) as the core holes are advanced into the jet grouted columns. Stage 1 water tests will be performed on the core hole interval from the bottom of the casing to a depth of 90 feet. Stage 2 water tests and camera monitoring will be performed on the core hole to a depth of 115 feet.

4.11.1 Slug Removal / Recovery Tests

During the slug removal / recovery test the water level is rapidly dropped by at least 50 ft with high rate pumping and water levels are monitored during recovery. Volumes of water removed from the core hole and depth to water versus time of water level recovery will are to be recorded manually (meter readings). The slug removal/recovery test will be performed by the Jet Grouting Contractor or an experienced contractor that has drilled and conducted water tests in soil-cement or weak rock formations. These tests will be performed by the Jet Grout Contractor under the supervision of PS&S. One slug test will be performed for each of the two stages (Stage 1 and Stage 2).

4.11.2 Constant Head Pump Tests with Camera Monitoring

During the constant head pump tests with camera monitoring, the pump will be used to lower the water level in the core hole to the submersible pump set near the bottom of the core hole approximately 115 feet bgs. With the water level lowered in the core hole to just above the pump setting, a remotely controlled camera will be inserted into the core hole and slowly lowered to inspect the interior quality and consistency of the core hole. During the camera monitoring (and after), the water level will be maintained by pumping to keep the water level depressed. Discharge volumes, water levels, and video footage will provide information on the soil-cement barrier wall performance under large and sustained hydraulic loading. These tests will be performed jointly by the Jet Grouting Contractor and PS&S.

4.12 Vibrating Wire Piezometers Monitoring Program

The vibrating wire piezometer (VWP) monitoring program will be performed by PS&S to measure the subsurface pore water pressure and temperature generation data from vibrating wire piezometer clusters before, during and after the soil-cement barrier wall construction. The VWPs will be installed prior to the pre-production jet grout column activities. PS&S will assess the data to determine the influences caused by the pre-drilling and injection grouting activities in the containment zone.

4.13 Documentation

Proper management and documentation of field activities is essential to provide that all necessary work will be conducted in accordance with the sampling plan and CQCP in an efficient and high quality manner. Field management procedures will include following proper chain of custody procedures to track a sample from collection through analysis, noting when and how samples will be split (if required); preparing a location sketch; completing sample summary forms, chain of custody forms, boring, coring, drilling and jet grouting logs; maintaining a daily field log book; completing daily equipment calibration logs; preparing daily field activity reports; completing field change forms; and maintenance of photographic documentation. Copies of each of these forms will be maintained on-site for the Project Record. Proper completion of these forms and the field log book will be necessary to support the consequent actions that may result from the sample analysis. This documentation will demonstrate that the samples were handled properly.

4.14 Data Reduction, Validation and Reporting

A New York State Department of Health (NYSDOH) Environmental Laboratory Accreditation Program (ELAP) and Contract Laboratory Program (CLP) certified laboratory meeting the New York state requirements for documentation, data reduction and reporting will be used. All data will be cataloged according to sampling locations and sample identification nomenclature. NYSDEC "Sample Identification and Analytical

Requirement Summary" and "Sample Preparation and Analysis Summary" forms (for volatile organic compound (VOC) and inorganic analysis) will be completed and included with each data package.

Data validation will be performed by an independent contractor to define and document analytical data quality in accordance with NYSDEC requirements that investigation data must be of known and acceptable quality. A two-phased approach to validate data will be used. The first phase is called checklisting and the second phase is the analytical quality review.

- **Checklisting** - The data package will be checked for correct submission of the contract required deliverables, correct transcription from the raw data to the required deliverable summary forms and proper calculation of a number of parameters.

- **Analytical Quality Review** - The data package will be closely examined to recreate the analytical process and verify that proper and acceptable analytical techniques have been performed. Additionally, overall data quality and laboratory performance will be evaluated by applying the appropriate data quality criteria to the data to reflect conformance with the specified, accepted QC/QA standards and contractual requirements.

At the completion of the data validation, a Summary Data Validation/Usability Report will be prepared and submitted to NYSDEC.

5.0 TESTING SUMMARY

Daily field and laboratory testing by PS&S and the Jet Grouting Contractor during the jet grouting operations is essential to the construction quality control and quality assurance program to be implemented for the Phase 3 remedial construction. A summary of the materials to be tested, the test, the required test methods, the Technical Specification reference, the responsible party, the testing frequency and the estimated number of test samples to be acquired is listed in Table 2 - Rockaway Park Jet Grouting Production Testing Summary. For consistency, Table 2 - Rockaway Park Jet Grouting Production Testing Summary also lists the tests to be performed by the Jet Grouting Contractor.

TABLE 2 ROCKAWAY PARK JET GROUTING PRODUCTION TESTING SUMMARY						
MATERIAL	**TEST**	**TEST METHOD**	**RESPONSIBLE PARTY**	**SPECIFICATION REFERENCE**	**FREQUENCY**	**TOTAL ESTIMATED TESTS[1]**
Fresh Cement Grout Mix (2" x 2" Cubes)	pH and Temperature	---	PS&S	02332, Part 3	Minimum 2 tests per column	150
	Viscosity	API Marsh Funnel	PS&S	02332, Part 3	Minimum 5 tests per column	375
	Density	Mud Balance	PS&S	02332, Part 3		
	Unconfined Compressive Strength at 7, 14, and 28 days	ASTM C 109	PS&S; Jet Grouting Contractor	02332, Part 3	Minimum 9 tests per column	675
Grout Mix Water	pH and Temperature	---	PS&S	02332, Part 3	Minimum 2 tests per column	150
Attapulgite Slurry	Viscosity and Filtrate Loss	API Marsh Funnel and Standard Filter Press	PS&S	02332, Part 3	Minimum 2 tests per column	150
Jet Grouted Column Core Holes	In-Situ Water Testing	Slug Removal / Recovery Test	Jet Grouting Contractor	02332, Part 3	Minimum 2 tests per core hole	14
		Constant Head Pump Test with Camera Survey	PS&S; Jet Grouting Contractor	02332, Part 3	Minimum 1 test per core hole	7
Core Hole Casing	In-Situ Water Testing	By-Pass Packer Testing	PS&S; Jet Grouting Contractor	02332, Part 3	As needed	7
Core Samples (4.0" dia.)	Unconfined Compressive strength at 14, 28 and 56 days	ASTM D 4832	PS&S Lab	02332, Part 3	Minimum 3 tests per core hole	21
Jet Grouting Cuttings (Spoils) (3" x 6" Cylinders)	pH, Temperature, Density, Viscosity, Sand Content	Mud Balance; API Marsh Funnel; Sand Content Kit	PS&S	02332, Part 3	Minimum 2 tests per column	675
	Unconfined Compressive strength at 4, 7, and 14 days	ASTM D 4832	PS&S Lab	02332, Part 3	Minimum 9 tests per column	

6.0 QUALITY ASSURANCE APPROVAL CHECKLIST

As a means to track the installation progress of the lower section of the Composite 120-foot deep DNAPL Migration Barrier, PS&S has developed the Table 3 – National Grid Rockaway Park Former MGP Site Remedial Action Jet Grouted Column Barrier Wall Quality Assurance Checklist (QA Summary Checklist). PS&S's resident engineers will observe the daily installation activities and will update this QA Summary Checklist on a routine basis. PS&S will compile quality assurance data on each column and enter this data into the QA Summary Checklist). This QA Summary Checklist will be updated frequently and posted for review prior to each weekly construction meeting.

Four types of data will be included in the QA Summary Checklist. Design data on the assigned column number, date of injection, and the top and bottom elevations will be compiled from daily records. The column diameter is estimated by PS&S from the results of column coring. The Jet Grouting Contractor data includes information on the ASCII drilling/injection files, inclinometer calibrations, drilling deviation, minimum wall thickness and as-built plans. Manual measurements of the Jet Grouting Contractor equipment will be completed by PS&S and summarized in the Checklist. Coring and permeability data will be completed by the Jet Grouting Contractor and PS&S at the selected coring locations.

On the basis of the data received and analyzed, its own testing and the criteria included in the Contract Documents, PS&S, as the Engineer of Record, will review the data and will determine as to the acceptance, rejection and repair installed jet grouted columns and soil-cement barrier wall sections. The QA Summary Checklist provides for entry of these determinations by the Engineer of Record and will be provided at four stages: column report/graphics, drilling /injection ASCII files, as-built column core hole plan view and then column approval or repair.

PS&S's resident engineers will observe the daily installation activities and will update this QA Summary Checklist on a routine basis.

APPENDIX A

Project Technical Specification 02332
Jet Grouted Vertical Containment Wall

APPENDIX B

Project Technical Specification 02111
Waste Management and Emergency Response