**Langan Engineering, Environmental, Surveying and Landscape Architecture, D.P.C.**
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**To:** Ruth Curley, P.E. – NYSDEC

**From:** Gregory C. Wyka, P.G., LEED AP ND, Jason Hayes, P.E., LEED AP, and Tasos Papathanasiou, P.E.

**Info:** Brian Bradley Jr., Christian Restrepo and Lauren Cahill (Queens Plaza North New York LLC); Linda Shaw (Knauf Shaw LLP); Langan Team

**Date:** February 6, 2023

**Re:** Remedial Action Work Plan Design Modification
Queensboro Lanes Site
25-01 Queens Plaza North
Long Island City, Queens, New York
BCP Site No.: C241257
Langan Project No.: 170652801

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This technical memorandum presents a proposed modification to the New York State Department of Environmental Conservation (NYSDEC)-approved Remedial Action Work Plan (RAWP), dated November 1, 2022 for the Queensboro Lanes Site (the site). The Remedial Action Work Plan (RAWP) selected a Track 4 cleanup plan for the site. The purpose of this memorandum is to amend part of the Track 4 remedy concerning an approximately 2,150-square-foot area of residual petroleum-contaminated soil (source material) and groundwater in the northeastern part of the site. The area is located between the secant pile support-of-excavation (SOE) system surrounding the footprint of the partial cellar and the northern-adjoining property, which is supported on shallow foundations.

The NYSDEC-approved RAWP states that the petroleum-contaminated soil in this area should be excavated to the groundwater table (about el 12 to 14 NAVD88[1]) and that an alternate remedial approach should be presented to the NYSDEC in the event that stained and odorous soil remains after the remedial excavation. The petroleum-contaminated zone was vertically delineated during the remedial investigation (RI) and was found to extend from the bottom of the former cellar slab (about el 14) to about 12 feet below the former cellar slab, or about el 2.[2] For reference, adjacent sidewalk grades in this area are at about el 27. Based on this RI information and engineering feasibility analysis, only the upper 1 to 2 feet of the petroleum-contaminated area can be safely excavated without disturbing the adjacent foundations and dewatering. Therefore, an alternative

[1] All elevations includes in this memo are in feet and are referenced to the North American Vertical Datum of 1988 (NAVD88), which is 1.1 feet below the mean sea level at Sandy Hook, New Jersey, 1929 (NGVD 1929).

[2] Evidence of petroleum contamination was found in RI boring SB6 to about el. 2, in RI boring SB18 to about el. 8, and in waste characterization boring SB29 to about el. 2.

remedial approach is necessary to address the impacted area below the groundwater table. This technical memorandum provides relevant background information, a remedial alternatives evaluation, and the selected remedial alternative remedial that will achieve the remedial action objectives (RAOs) specified in the NYSDEC-approved RAWP.

## BACKGROUND AND SOURCE IDENTIFICATION

The site is located at 25-01 Queens Plaza North in the Long Island City neighborhood of Queens, New York and is identified as Block 415, Lot 4 on the Queens Borough Tax Map. The site was formerly identified as Lots 4 and 10 before a lot merger in February 2022. The New York State (NYS) Brownfield Cleanup Agreement (BCA) was fully executed for the site on October 15, 2021 and Brownfield Cleanup Program (BCP) Site No. C241257 was assigned. The site is about 30,540 square feet or 0.699 acres in area. The previous commercial structure that occupied the site was demolished in July to September 2022 as a pre-requisite to site remediation.

Petroleum contamination in soil and groundwater were identified in the northeastern corner of the site by Langan during the 2021 Phase II Environmental Site Investigation (ESI) and 2022 Remedial Investigation (RI).The contamination is attributed to a historical release from an upgradient, off-site source. In 2003, a spill (Spill No. 0305348) that originated at 41-28 27th Street (Block 415 Lot 31) migrated to the northern-adjoining property at 41-32 27th Street (Block 415, Lot 36). According to the NYSDEC database, the cause of the spill was a tank failure but no further detail was included, and the spill was closed in 2007; the database does not provide any additional details regarding the cleanup action that was completed or required by the NYSDEC. Based on the RI findings and data, it is likely that impacts from this spill incident also migrated onto the northeastern part of the project site.

Petroleum contamination is primarily evidenced by visual and olfactory observations (staining and odors), photoionization detector (PID) readings above background, and soil and groundwater analytical data; no light non-aqueous phase liquid (LNAPL) was found in monitoring wells during the ESI and RI. Petroleum-related volatile organic compounds (VOC) exceeded the Unrestricted Use and Protection of Groundwater soil cleanup objectives (SCOs) in soil; only one VOC (1,2,4-trimethylbenzene) exceeded the Restricted Use Restricted-Residential (RURR) SCO. The concentrations of petroleum-related VOCs in groundwater are either one or less than one order of magnitude above the NYSDEC Title 6 NYCRR Part 703.5 and the NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values for Class GA water (collectively the NYSDEC SGVs) and are collectively below 250 micrograms per liter (µg/L). The petroleum-contaminated zone was vertically delineated during ESI and RI and extends from directly below the former cellar slab to about 12 feet below the former cellar slab (about el 2). The zone appears mostly confined to a silt layer with varying amounts of clay and fine sand that is nearly ubiquitous across the site as documented by Langan's environmental and geotechnical investigations. For reference, the groundwater table, as determined by the RI and Langan's geotechnical investigation, is at about el 12 to 14.

## TECHNICAL DESIGN CONSTRAINTS

A complete cleanup of all petroleum contaminated soil and groundwater is problematic and risky because of the presence of the 16-story structure on the northern-adjoining property (41-32 27th Street, Block 415, Lot 36). This property occupies a footprint of about 4,300 square feet and is supported on shallow foundations (footings and mat). The bottom of the foundation is at about el 17, which is about 3 feet above groundwater table and about 15 feet above the bottom of the contaminated zone of interest. Removal of all contaminated soil within the site limits will require removing soil within the influence zone of the neighbor's foundations. To avoid underpinning of the adjacent foundations, a rigid SOE system (i.e., a secant pile wall) must be installed first. Considering the type of foundations and bearing soils, extensive drilling of secants and soil excavation within the influence line of the neighbor's foundation carries significant risk to the safety and stability of the neighbor's building and is not recommended. For the same reason, the project team decided to offset the proposed building's partial cellar 12 to 40 feet away from the northern property line and forfeit the additional building space.

## DESCRIPTION OF REMEDIAL ALTERNATIVES AND EVALUATION

The RAWP stipulates the site will be remediated to site-specific soil cleanup objectives (SCOs) for a Track 4 cleanup plan (RURR SCOs). The approved Track 4 remedy includes excavation of petroleum-contaminated soil in the northeastern part of the site to the groundwater table (about el 14) and indicated that an alternate remedial approach would be presented to the NYSDEC to address residual stained and odorous soil that remains after the remedial excavation.

Because of the proximity to the northern-adjoining property, we determined that excavating all contaminated soil is unsafe. Therefore, we evaluated the following three remedial alternatives as potential options to achieve the RAOs and to address the petroleum-contaminated mass that cannot be safely excavated:

1. Treatment via a vertical injection program of chemical oxidant, oxygen releasing compounds (ORC), and/or activated carbon solutions;
2. Limited remedial excavation above the influence line of the adjacent foundations followed by treatment via in-situ stabilization (ISS) of the remaining petroleum-contaminated mass with soil mixed columns (using a dual paddle mixer attachment on a top-mast drilling rig) using pre-mixed grout to about el 2; and

3. Installation of an impermeable subsurface containment barrier around the petroleum-contaminated area followed by limited remedial excavation and treatment via ISS of the upper portion of the remaining contaminated mass via soil mixing (using a skeleton bucket attachment on an excavator) with pre-mixed grout to about el 11 and deeper ISS by soil mixing (using a dual paddle mixer attachment on a top-mast drilling rig) at the locations of borings SB6 and SB29 to about el. 5.

*Option 1*

This remedial alternative would involve addition of aqueous fluids through direct-push injection points into the contaminated zone to reduce the concentrations of the residual petroleum-related VOCs through chemical destruction, physical adsorption, and/or stimulation of naturally-occurring aerobic biodegradation. The residual petroleum-contaminated soil appears mostly confined to a silt layer with varying amounts of clay and fine sand that is nearly ubiquitous across the site as documented by Langan's environmental and geotechnical investigations. The characteristics of this stratum are not conducive to an effective vertical injection program and cannot achieve uniform treatment coverage. Grain-size analyses were performed on representative samples from this stratum as part of Langan's geotechnical investigation. The lab test results indicated that the samples were comprised of silts and clays (about 62% to 97% by weight passing through the No. 200 sieve). The geotechnical investigation classified this stratum as a loose to medium-dense to dense silt. Available reference values for the hydraulic conductivity of silts are less than $10^{-5}$ centimeters per second (cm/s)[3]. The low hydraulic conductivity expected in the treatment zone will reduce the effectiveness of any injections by restricting the flow of injection fluids through the treatment area via groundwater flow and thereby reducing the radius of influence at each injection point. The low expected hydraulic conductivity is also supported by field evidence[4] during the implementation of the NYSDEC-approved RAWP.

*Option 2*

This remedial alternative would involve limited additional remedial excavation followed by treatment via ISS of the remaining subsurface petroleum-contaminated mass via soil mixing (columns) with pre-mixed grout to about el 2. The ISS would consist of more than 700 24-inch-diameter overlapping soil mix columns occupying the entire approximately 2,150-square-foot contaminated area; the northern limits of the ISS zone would be offset from the northern-adjoining structure by 5 feet because of construction equipment limitations.

[3] Foundation Engineering Handbook (Fang, Hsai-Yang, 1991)

[4] A test pit was excavated downgradient of the former location of the 5,000-gallon underground storage tank (UST) on December 21, 2022 to search for evidence of petroleum impacts downgradient of the UST. The test pit penetrated and terminated in the silt stratum and no groundwater or seepage was observed.

The steps involved with this option are as follows:

- Limited remedial excavation of petroleum-contaminated soil (up to 1 foot or to the observed groundwater table [if present]) will be completed and the contaminated soil will be transported off-site for disposal.
- Collect confirmation endpoint soil samples for laboratory analysis per the NYSDEC-approved RAWP to document final soil conditions.
- Perform ISS using 24-inch-diameter overlapping soil mix columns to about el 2.

Any construction work performed below the influence line of a footing carries a risk of destabilizing or settling the footing. The ISS work involved with this option will require installing about 80% of the soil mix columns below the descending influence line of the neighboring foundation, which will compound the risk of causing settlement to the neighboring building.

*Option 3*

This remedial alternative would involve installation of an impermeable subsurface containment barrier wall around the petroleum-contaminated area followed by limited remedial excavation and treatment via ISS of the remaining subsurface contaminated mass via soil mixing (using a skeleton bucket) with pre-mixed grout to about el 11 and deeper ISS by soil mixing at the locations of borings SB6 and SB29 to about el. 5.

The subsurface containment barrier wall would consist of about 85, 24-inch diameter overlapping (4 inches of overlap) soil mix columns advanced down to the top of the bedrock surface (about el -30). The barrier wall will run along the northern property line (about 5 feet away and parallel to the neighboring building) and turn south on both ends to connect with the secant pile SOE wall.

The steps involved with this option are as follows:

- Install the subsurface containment barrier wall as described above.
- Perform remedial excavation of petroleum-contaminated soil (up to 1 foot or to the observed groundwater table [if present]).
- Collect confirmation endpoint soil samples for laboratory analysis per the NYSDEC-approved RAWP to document final soil conditions.
- Perform ISS of petroleum contamination by soil mixing (using a dual paddle mixer attachment on a top-mast drilling rig) at the locations of borings SB6 and SB29 to about el. 5. The soil mixing would extend below the neighboring building foundation’s influence line at SB6 only.

- Perform ISS of the remaining contaminated mass by soil mixing (using a skeleton bucket) to about el 11. Care will be exercised through depth control to not cause soil disturbance below the neighboring building foundation's influence line.

Because this option only involves limited work below the neighboring building foundation's influence line (i.e., the containment barrier wall and the ISS at SB6), the risk associated with this activity is substantially less compared to Option 2.

## REMEDIAL ALTERNATIVES EVALUATION AND SELECTION

The remedial alternatives were evaluated using the same BCP remedy evaluation criteria (threshold and balancing criteria) stipulated in the NYSDEC-approved RAWP.

- Although Option 1 would likely be the most cost effective alternative, Option 1 was not determined to be a reliable and effective alternative as it would be difficult to implement given the physical characteristics of the subsurface, would likely not be effective in the short and long terms, and would likely not sufficiently reduce the mobility, toxicity and volume of contaminants.
- Option 2 in concept would be most effective and likely result in the greatest reduction in volume, toxicity, and mobility of contaminants; however, Option 2 was not determined to be an acceptable alternative as it is considered unsafe and carries the most risk of causing settlement, cracking, and potential instability of the neighboring building. This option is also the most time-consuming and costly of the three.
- Option 3, while not as extensive as Option 2, is still effective in the long-term and will permanently contain the contaminated soil in-place, thereby reducing mobility of contaminants and protecting human health by mitigating potential ingestion, inhalation, and dermal contact pathways for the residual petroleum contamination. In addition, this option carries the least amount of risk with regards to potential structural impacts to the neighboring building.

Based on the evaluation of the remedial alternatives, Option 3 is the recommended remedial alternative as it achieves the RAOs established for the project in the NYSDEC-approved RAWP and is effective in the short and long terms. The selected alternative effectively reduces mobility, toxicity, and volume of contaminants and will mitigate potential exposure pathways. The approach is feasible, safer, and provides protection to human health and the environment.

Attached to this memorandum is a PE-signed and sealed letter from the project's geotechnical engineer in support of Option 3 (Attachment 1).

**DESCRIPTION OF THE SELECTED REMEDIAL ALTERNATIVE**

Option 3 is the selected remedial alternative. This alternative includes a plan for source removal, treatment via ISS, and containment. Figures 1 and 2 illustrate the selected alternate remedial approach in layout view and cross-section.

As described above, the plan includes installation of a subsurface containment barrier wall, consisting of about 85, 24-inch-diameter overlapping (4 inches of overlap) soil mix columns (using a dual paddle mixer attached to a top-mast drilling rig) advanced down to the top of the bedrock surface (about el -30). The barrier wall will run along the northern property line (about 5 feet away and parallel to the neighboring building) and turn south on both ends to connect with the secant pile SOE wall. The residual petroleum contamination within and below this buffer zone would be managed in place under a site cover system, consisting of imported clean fill and a concrete slab. Inside the barrier wall, remedial excavation of residual petroleum-contaminated soil (up to 1 foot or to the observed groundwater table [if present]) will be completed. After the remedial excavation, confirmation endpoint soil samples will be collected for laboratory analysis per the NYSDEC-approved RAWP to document final soil conditions. Sampling will be followed by additional treatment via ISS of the contaminated mass at the locations of borings SB6 and SB29 via soil mixing using a dual paddle mixer to about el. 5. The ISS at the two locations will consist of four, 24- to 28-inch overlapping and over-drilled (horizontally) soil mix columns creating an about 4-foot by 4-foot x 6-foot deep stabilized mass. The soil mixing would extend below the neighboring building foundation's influence line at SB6 only. After the localized deeper ISS, the remaining contaminated mass inside of the containment barrier wall will be treated via ISS via soil mixing using a skeleton bucket to about el 11. Care will be exercised through depth control to not cause soil disturbance below the neighboring building foundation's influence line. The ISS will stabilize the upper 2-3 feet of the remaining contaminated zone. One permanent groundwater monitoring well will be installed within the containment zone per the NYSDEC-approved RAWP to allow for least one round of post-remediation groundwater sampling to document groundwater conditions and assess the effectiveness of the remedy.

Soil mixing for the barrier wall and ISS will be achieved by either mixing dry cement with soil or pre-mixed grout with soil. The cured soil mix shall exhibit a minimum unconfined compressive design strength of 250 to 300 pounds per square inch (psi) at 28 days and a hydraulic conductivity not exceeding $1x10^{-6}$ centimeters per second (cm/sec). Quality assurance/quality control (QA/QC) practices consistent with NYSDEC ISS guidance (Attachment 2) will be employed during the soil mixing program to control field activity and to assess performance and effectiveness relative to design criteria. QA/QC practices will include a field testing program consisting of wet soil mix sampling for lab compression testing (ASTM C39), post-mixing coring to collect core samples for visual inspection, photographs, lab compression testing (ASTM C39) and lab hydraulic conductivity testing (ASTM D5084), and/or field hydraulic conductivity testing via packer tests (USBR 7310 Designation *Constant Head Hydraulic Conductivity Tests in Single Drill Holes*). The field hydraulic conductivity testing will be conducted on the soil mix columns only because the skeleton bucket-mixed area is too short for packer test equipment. Cores will be tremie-grouted with neat cement grout after sample collection. The field QA/QC plan is included as Attachment 3. Field QA/QC results, field photographs, PE-signed and sealed installation logs for the soil mix columns of the barrier wall, and an as-built survey of the barrier wall and ISS area signed and sealed prepared by a professional land surveyor licensed in the State of New York will be incorporated into the Final Engineering Report (FER).

## CONCLUSION

This memorandum documents the proposed modification to the Track 4 remedy to include remedial alternative (Option 3) to address the residual petroleum-contaminated area in the northeast corner of the site and provides justification for its selection as the acceptable alternative. We kindly request the Department review and approve this modification to the Track 4 remedy.

## CERTIFICATION

*I, Jason Hayes, PE, certify that I am currently a NYS registered professional engineer as defined in 6 NYCRR Part 375 and that this RAWP Design Modification was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).*

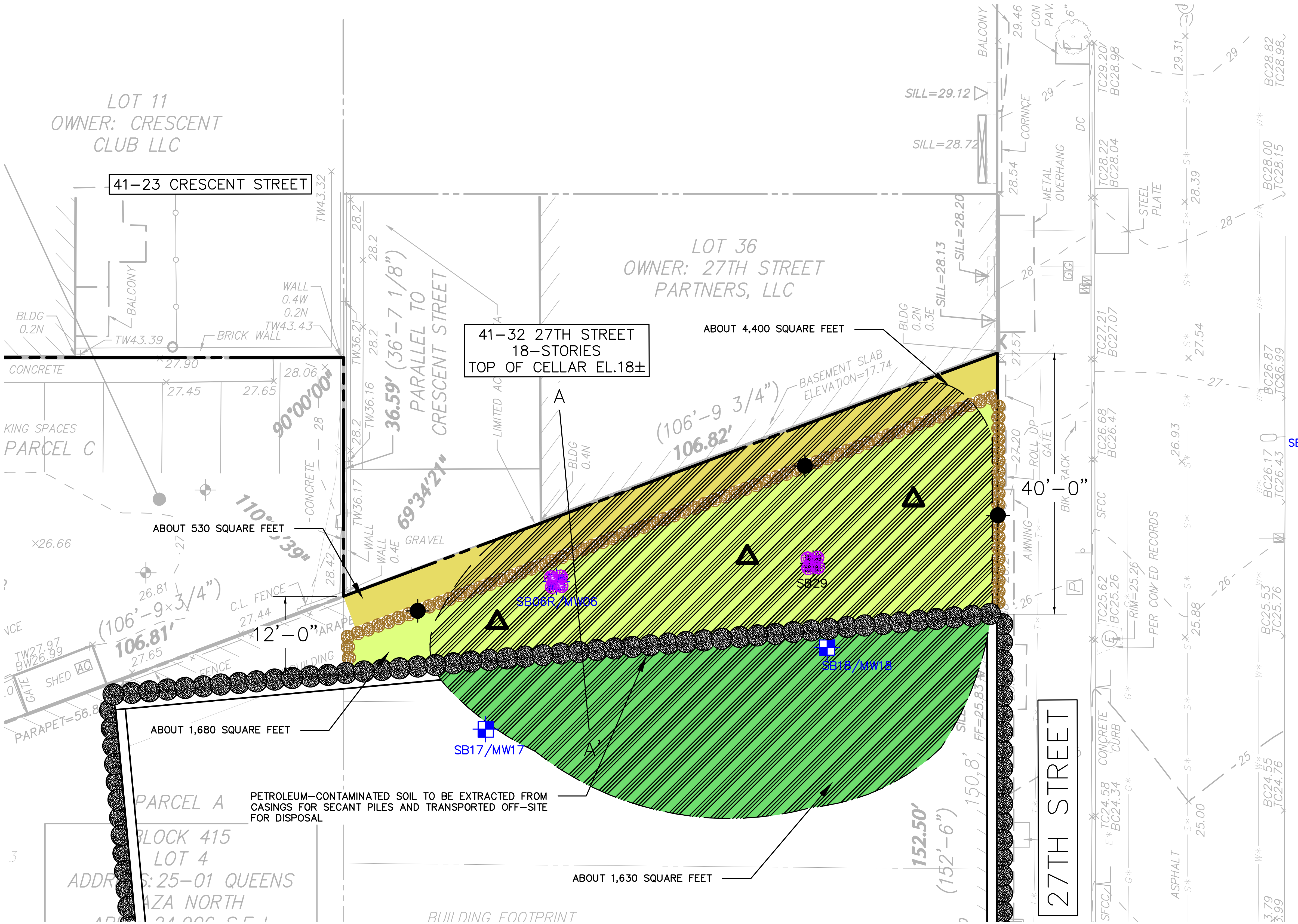
STATE OF NEW YORK
JASON JAMES HAYES
089491
LICENSED PROFESSIONAL ENGINEER

| JASON HAYES | 2/6/2023 | 2/6 |
|---|---|---|
| NYS Professional Engineer 089491 | Date | Signature |

**Figures**

Figure 1 – Design Drawing – Selected Remedial Alternative (Plan View)
Figure 2 – Design Drawing – Selected Remedial Alternative (Cross-Section View)
Attachment 1 – Letter from Geotechnical Engineer
Attachment 2 – NYSDEC ISS Guidance
Attachment 3 – Field QA/QC Plan

**FIGURES**




LEGEND:

- APPROXIMATE BCP SITE BOUNDARY
- APPROXIMATE HORIZONTAL EXTENT OF RESIDUAL PETROLEUM-CONTAMINATED AREA
- CONTAINMENT BARRIER WALL COMPRISED OF 24-INCH OVERLAPPING (4-INCH MINIMUM SOIL MIX COLUMNS INSTALLED USING DUAL PADDLE MIXERS TO BEDROCK SURFACE (ABOUT EL. -30)
- APPROXIMATE LOCATION OF ISS VIA 24-28-INCH OVERLAPPING SOIL MIX COLUMNS INSTALLED USING DUAL PADDLE MIXERS TO EL. 5
- APPROXIMATE AREA OF COMPLETE REMEDIAL EXCAVATION OF PETROLEUM-IMPACTED SOIL (TO ABOUT EL. 2)
- APPROXIMATE HORIZONTAL EXTENT REMEDIAL EXCAVATION OF 1 FOOT OR TO GROUNDWATER TABLE (WHICHEVER IS SHALLOWER), FOLLOWED BY ISS VIA SOIL MIXING USING SKELETON BUCKET TO EL. 11
- APPROXIMATE 5-FOOT BUFFER ZONE
- SB17/MW17 PREVIOUS SOIL BORING/MONITORING WELL
- SB29 PREVIOUS WASTE CHARACTERIZATION SOIL BORING
- SECANT PILE FOR SOE
- PROPOSED LOCATION OF CORE THROUGH SOIL MIX COLUMN OVERLAP FOR INSPECTION AND IN-SITU HYDRAULIC CONDUCTIVITY TEST
- PROPOSED LOCATION OF CORE THROUGH ISS FOR INSPECTION

NOTES:

1. BASE MAP IS DRAWING TITLED "ALTA/NSPS LAND TITLE SURVEY" DRAWING NO. VL101 BY LANGAN ENGINEERING, ENVIRONMENTAL, SURVEYING, LANDSCAPE, ARCHITECTURE, AND GEOLOGY D.P.C. (LANGAN), DATED 6 MAY 2021 AND SUPPORT OF EXCAVATION PLAN BY LANGAN, DATED 3 NOVEMBER 2022.
2. SOIL MIX SHALL EXHIBIT A MINIMUM UNCONFINED COMPRESSIVE STRENGTH OF 250 TO 300 PSI AT 28 DAYS AND A HYDRAULIC CONDUCTIVITY NOT EXCEEDING 1X10-6 CM/SEC.
3. QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PRACTICES WILL BE EMPLOYED DURING THE SOIL MIXING PROGRAM TO CONTROL FIELD ACTIVITY AND TO ASSESS PERFORMANCE AND EFFECTIVENESS RELATIVE TO DESIGN CRITERIA.
4. ELEVATIONS SHOWN IN FIGURE REFER TO NATIONAL VERTICAL DATUM OF 1988 (NAVD88)
5. ISS: IN-SITU STABILIZATION
6. SOE: SUPPORT OF EXCAVATION



16 0 8 16
1/16" = 1'0"

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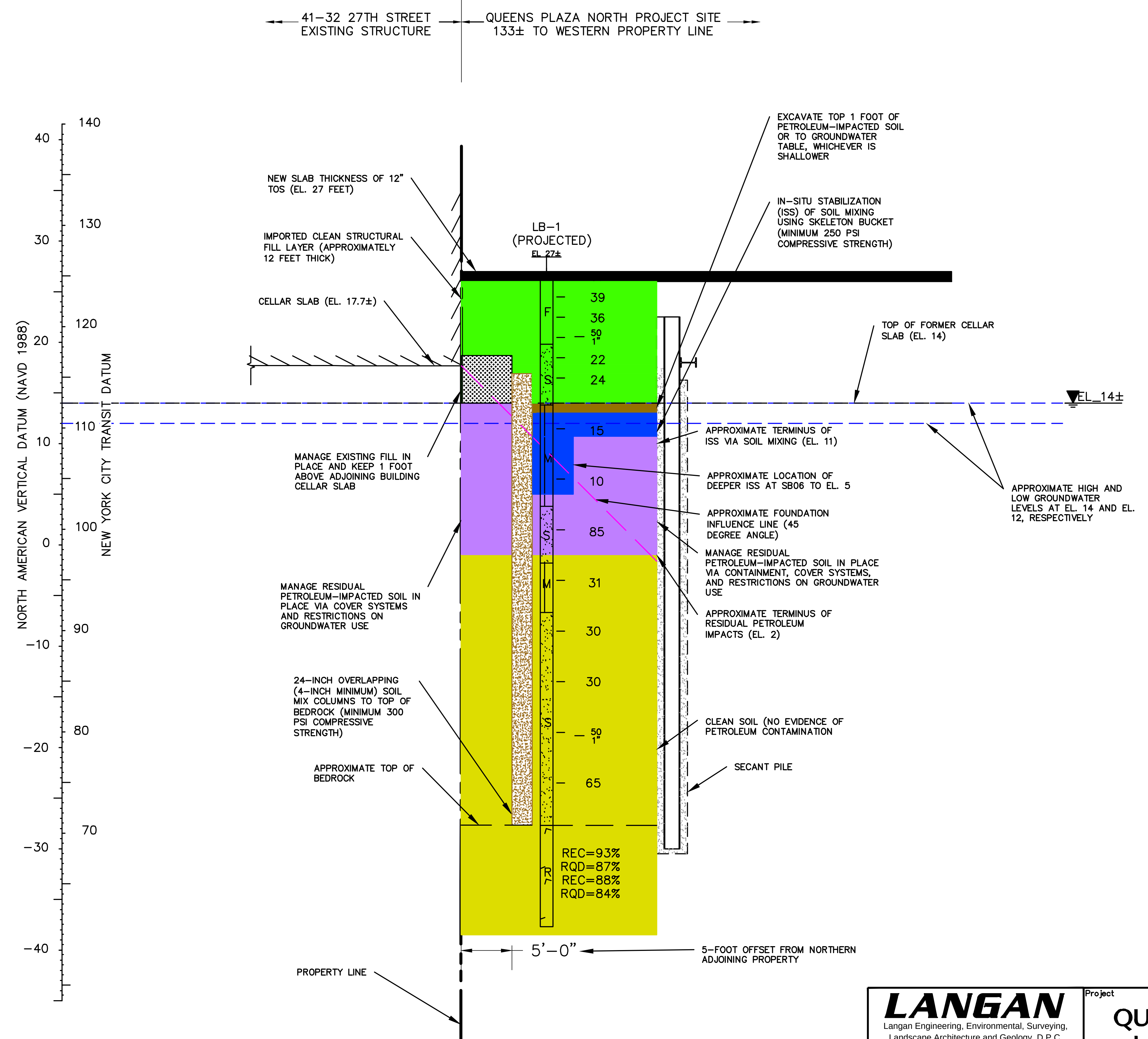
| Project | Figure Title | Project No. | Figure No. |
|---|---|---|---|
| QUEENSBORO LANES SITE<br>BLOCK No. 415, LOT No. 4<br>NEW YORK<br>QUEENS NEW YORK | SELECTED REMEDIAL ALTERNATIVE (PLAN VIEW) | 170652801<br>Date: 1/19/2023<br>Drawn By: AZ<br>Checked By: TG | 1<br>Sheet 1 of 2 |




NOTES:

1. BASE DRAWING SOURCE IS DRAWING TITLED "SUPPORT OF EXCAVATION SECTION SOE-303.02, PREPARED BY LANGAN ENGINEERING, ENVIRONMENTAL, SURVEYING, LANDSCAPE, ARCHITECTURE, AND GEOLOGY, D.P.C., DATED 3 NOVEMBER 2022.
2. ELEVATIONS SHOWN IN FIGURE REFER TO NAVD88 VERTICAL DATUM

WARNING: IT IS A VIOLATION OF THE NYS EDUCATION LAW ARTICLE 145 FOR ANY PERSON, UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS ITEM IN ANY WAY.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Project
QUEENSBORO LANES SITE
BLOCK No. 415, LOT No. 4
QUEENS NEW YORK

Figure Title
SELECTED REMEDIAL ALTERNATIVE (CROSS-SECTION A - A' VIEW)

Project No. 170652801
Date 1/19/2023
Drawn By AZ
Checked By TG

Figure No. 2

Sheet 2 of 2

PROJECT NO. 170652801

LANGAN

## ATTACHMENT 1

## LETTER FROM GEOTECHNICAL ENGINEER

LANGAN

Technical Excellence
Practical Experience
Client Responsiveness

January 25, 2023

Ruth Curley, P.E.
Professional Engineer 1 (Environmental)
Division of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway, 12th Floor, Albany NY 12233-7016

**Re: Remedial Action Work Plan Design Modification**
**Queensboro Lanes Site**
**25-01 Queens Plaza North, Long Island City**
**Langan Project No.: 170652801**

Dear Ms. Curley:

I am the lead geotechnical engineer for the referenced project and I am writing this letter in support of the Remedial Action Work Plan (RAWP) design modification proposed by the environmental engineer (Jason J. Hayes, P.E.) on this project.

I reviewed and evaluated three remedial alternatives (Options 1, 2 and 3) proposed by the environmental engineer (and in consultation with this engineer) for their effectiveness in achieving the remedial action objectives, satisfying the DEC requirements, and being safely implemented with respect to the adjacent buildings. Considering the subsurface conditions, only Options 2 and 3 satisfy the remedial action objectives. However, Option 2 carries considerable risk of damaging the adjacent building by causing foundation settlement from extensive soil disturbance below the influence zone of the adjacent foundations and is not recommended.

Based on the above, it is my professional opinion that Option 3 is the appropriate remedial alternative for this project.

If you have any questions, please feel free to reach me at tasos@langan.com or at 212-479-5419.

STATE OF NEW YORK
ANASTASIOS PAPATHANASIOU
085629
LICENSED PROFESSIONAL ENGINEER

Sincerely,
**Langan Engineering, Environmental, Surveying, Landscape Architecture and Geology, D.P.C.**

Tasos Papathanasiou, P.E.
Principal/ Vice President

INITIAL:TOP
cc: Langan Team
\\langan.com\data\NYC\data8\170652801\Project Data_Discipline\Environmental\Reports\BCP - RAWP Design Modification Memo\Attachments\Attachment 1 - Geotechnical Engineer Letter\Attachment 1 - Letter from Geotechnical Engineer_v2.docx

**ATTACHMENT 2**

**NYSDEC ISS GUIDANCE**

# NYSDEC In-Situ Solidification QA/QC

# 1.0 GENERAL

## 1.1 Introduction

Technology Description

In-situ solidification (ISS) is an established remediation treatment technology which can prevent migration of and exposure to certain contaminants in media including soil, sludge, and sediment. The ISS process is increasingly being used within remedial programs in the New York State Department of Environmental Conservation (Department).

ISS is a process that involves the mixing of reagents with contaminated soil to create a low permeability mass which encapsulates the contamination in the soil in place. Bucket excavators augers, or other technologies are used to mix the contaminated media and one or more reagents, entrapping the contaminated material within a low permeability mass. This reduces or eliminates non-aqueous phase liquid (NAPL) mobility and contaminant migration into exposure pathways, thus eliminating the treated area as a source of future exposure or contamination of groundwater, surface water, or vapor.

Complete mixing of the contaminated soil and the ISS reagents must be achieved for the process to be effective and protective of human health and the environment. Incomplete mixing can result in a non-homogenous mass, untreated areas, or large fractures within the ISS mass, which may allow mobility of NAPL and groundwater within the treated areas.

## 1.2 Document Purpose

The purpose of this document is to provide a method of Quality Assurance (QA)/Quality Control (QC) to ensure the effectiveness of ISS after field implementation is complete. This includes coring, and testing for hydraulic conductivity and unconfined compressive strength. The use of coring for QA/QC may not be suitable for all ISS projects and other QA/QC methods such as excavation/visual inspection will be considered an option on a case by case basis.

Failure to meet QA/QC goals, particularly incomplete mixing, is of greatest concern when it occurs along the edges of the solidified mass. The Department has noted a tendency for DNAPL to accumulate in permeable soils and sediments immediately above the bedrock surface, creating a potential pathway for DNAPL migration. Such zones can be quite difficult to mix adequately, whether using augers or bucket mixing. Thus, attention is required to ensure that “top of rock” zones are thoroughly solidified, and that this solidification is adequately documented.

To ensure the integrity of the treated material, the Department has identified QA/QC procedures, specifically coring, which are essential to ensure that ISS treatment processes are protective of the environment. This document has been developed to provide guidance on a coring program to be conducted to ensure confidence regarding complete mixing and ISS installation in the remedial area.

# 2.0 EQUIPMENT

## 2.1 Coring Drilling Method

To allow early coring information to be used for adjusting ISS operations, it is recommended that coring operations be conducted prior to complete curing of the ISS material. For high-strength material, a rock core is frequently required. Driven split spoons (typically using Direct Push tools but potentially using augers as well) may be used to collect core samples of the ISS material for lower strength materials. Rotosonic and compressed air drilling methods have not been successful in obtaining representative core samples.

Cores must be no longer than five (5) feet. If less than 60% of the core material is recovered from any of the coring runs, one (1) new core hole must be drilled adjacent to the previous location. If the recovery from the adjacent core hole continues to be less than 60%, the contractor may abandon the location. This is not intended to justify an inadequate sampling program. A representative number of successfully completed cores must be provided. Close communication with the Department's project manager (PM) is strongly encouraged to discuss and reach concurrence on the coring program.

## 2.2 Trenching

While trenching has not been used to date, there could potentially be instances where trenching would be a viable alternative. A trenching plan would have to be submitted to the Department during the remedial design. In the event trenching is proposed after the remedial design phase, but prior to field implementation of the ISS, a minimum of two weeks' notice should be provided to the Department for review of the trenching design.

## 2.3 Sample Collection for strength and permeability

Samples of the mixed soil will be collected while wet and formed into cylinders in accordance with the approved testing methods (ASTM D5084 for hydraulic conductivity, ASTM D2166 or D1633 for unconfined compressive strength). Samples should be collected every 500 cubic yards. Additional sampling may be appropriate on a site-specific basis in areas of particular concern.

# 3.0 EXECUTION

### 3.1.1 Coring Implementation

- One core borehole shall be completed for every 5,000 square feet of ISS treatment area, but not less than two bore holes per treatment area.
- To allow early coring information to be incorporated in adjusting ISS operations, the first coring location shall be completed when the ISS treatment project area is no more than 25 percent complete.
- Core borehole locations shall be biased towards areas with the greatest soil contamination, areas where contamination is in direct contact with the bedrock surface, and/or locations where difficulties in the ISS process were encountered.

- Core boreholes shall be placed in locations where individual treatment columns or cells overlap, to the extent possible.
- Core boreholes should be advanced to at least a foot below the monolith design or bedrock, if encountered. If coring reveals previously undocumented areas of contamination, delineation (and remediation, as necessary) of that contamination may be required outside the QA/QC program.
- Cores shall be archived following coring activities. Cores may be discarded upon final inspection by the Department. Following initial inspection, the Department may require cores to be retained to compare to future cores or to document issues that will need to be resolved.
- To allow any needed corrective actions to commence before the monolith cures to a point making corrective action difficult or impossible, core inspection by the Department will occur as soon as possible but not later than 48 hours of the core's collection.
- In order to identify potential areas of concern for the coring program, documentation on the volume/shrinkage of grout obtained during ISS installation shall be reviewed. Areas where excessive grout was lost during ISS implementation should be targeted for coring.

### 3.1.2 Trenching Implementation

- If trenching is used, it will be completed at the perimeter of the ISS treatment area and locations within the ISS treatment area. The minimum depth of excavation should be the design depth of the ISS treatment.
- If the bottom of the ISS treatment cannot be visually inspected, the Department may require cores to be collected.
- To allow inspection information to be incorporated in adjusting ISS operations, trenching shall commence when the ISS treatment project area is no more than 25 percent complete.

### 3.1.3 Sample analysis

- Typically, multiple cylinders are collected at each location for testing unconfined compressive strength. This allows testing after 3-5 days to get an initial indication of the strength of the mix, while reserving cylinders for compliance testing after they have achieved full strength (28 days).
- Cylinders tested for hydraulic conductivity in accordance with the approved plans. The maximum permeability should generally be 1x10-6 cm/sec, as measured using ASTM D 5084-00.

## 3.2 Performance Evaluations

### 3.2.1 Visual Inspection

Core samples and related equipment will be visually inspected for the following criteria, and the results recorded:

- Visible NAPL
- Non-mechanical induced cracking within the core
- Percent of core sample recovered

In addition, indirect indications of unmixed NAPL should be recorded, such as:

- NAPL coating on drilling tools
- NAPL in drill wash tub, if water-based drilling methods are employed

### 3.2.2 Performance Concerns

Performance testing must be completed early enough to identify problems. <u>Substandard results cannot be ignored with the intention to "average-out" the results over the course of project.</u> The purpose of this guidance is to detect installation of an inadequate remedy in time to correct the problems and avoid costly retreatment or repairs to ensure effectiveness of the ISS remedy, the following conditions will warrant further attention and will be documented during ISS implementation:

- A continuous layer or seam of NAPL is noted within the core.
- NAPL coating is visible on drilling tools
- Visible NAPL is noted in the drill wash tub
- Unconfined compressive strength below 50 psi
- Hydraulic conductivity greater than 1.0 x 10-6 cm/sec or project specific goal.
- Large sections (> 1 cf) of unmixed material.

If one or more of the above conditions are noted, the Department must be notified to discuss the severity of the problem, the degree of concern, and whether any corrective action will be necessary.

A notification, by itself, does not necessarily mean a corrective action or additional borings or testing are warranted. For instance, small NAPL blebs may be present within properly mixed areas of the ISS monolith, and coring through such a bleb, especially before the monolith has achieved its maximum strength, could result in NAPL coating on drilling tools and/or NAPL in the drill wash water. The first step to determining whether corrective action is required will be to complete additional borings around the area of concern and determine if identified NAPL within the ISS mass is encapsulated, thus eliminating NAPL mobility and impact to the surrounding environment. The results of all the samples taken within a given treatment area cannot be averaged to show compliance. While each sample must satisfy the definition on its own, a single test showing slightly elevated hydraulic conductivity would not necessarily require corrective action for that cell/column, but evaluation to ensure that it is not a systemic problem is required.

If NAPL is detected in the additional borings, particularly on the edges of the ISS monolith, or at the bottom of the ISS monolith, corrective actions may be necessary in order to fully encapsulate the source area.

### 3.2.3 Corrective Actions

If the ISS installation is deemed unsatisfactory after a collaborative evaluation of the coring program, measures will be put in-place to address the deficiencies and ensure that the remedy is protective of human health and the environment. Such measures may include:

- Repair, re-mixing, or isolation of the concerned area using jet grouting or other suitable method
- Excavation and disposal of the concerned area, where feasible and practicable.

### 3.2.4 Core Hole/Trench Abandonment

When a core has been drilled from the top to the bottom elevation of the targeted ISS treatment zone, and samples collected, it will be considered complete. Following completion of each coring location, the borings will be filled with grout using tremie methods.

If trenching is used for QA/QC activities, backfill material should meet the approved ISS specifications.

## 3.3 Field Documentation and Approvals

### 3.3.1 Field Documentation

Documentation of the ISS QA/QC activities shall be included with the Final Engineering Report (FER). Documentation will include (but not be limited to):

- Figure depicting boring/trenching locations
- Photographs of each core boring/trench referenced
- Type of drilling method or excavator used
- Field coring/trench logs

### 3.3.2 Department Approval

The Department should be notified of the ISS QA/QC activities as soon as possible, with a minimum of 72 hours' notice or two business days. Department personnel will attempt to be on-site, unless the remedial party is informed otherwise, to inspect the QA/QC activities and provide informal approval or recommend corrective actions.

Following on-site Department inspection of the ISS QA/QC, email correspondence should be sent to the Department project manager which summarizes observations of the coring results. The Department project manager will provide an email reply within 48 hours confirming that the ISS QA/QC objectives have been met. If the Department project manager does not feel the ISS

QA/QC objectives have been adequately satisfied, the response email will include any additional corrective actions required.

### 3.3.3. Resolution of Disagreements

In the event there is a disagreement regarding the ISS QA/QC program the remedial party will submit a written request for resolution to the project manager's supervisor. The correspondence shall include the ISS QA/QC activities, relevant documentation, and the nature of the dispute. The project manager's supervisor will meet with the Project Manager, Construction Inspector (if applicable) and the Bureau Director to discuss the request. If necessary, a meeting will be arranged which will include the remedial party, Department project manager, supervisor, and the Bureau Director to discuss the matter.

Following the meeting, the supervisor will send correspondence to the remedial party outlining the Department final decision.

## ATTACHMENT 3

## FIELD QA/QC PLAN

**Field QA/QC Plan**
**Containment and In-Situ Stabilization**
**Queensboro Lanes**
**BCP Site No. C241257**

The quality assurance/quality control (QA/QC) measures to be implemented in the field during the selected remedial alternative work include the following:

1. Soil Mix Columns of the Containment Barrier Wall
    a. Wet soil mix sampling
        i. Collect a minimum of 6 samples for compression testing in accordance with ASTM C39 per 4 days of soil mixing
        ii. Within each sample set, break 3 samples at 7 days and break the other 3 samples at 28 days
    b. Coring program
        i. Advance and collect three cores to about 3 feet above bedrock) at overlaps of the soil mix columns at locations specified on Figure 1 for core logging, visual inspection and photographs.
        ii. Cores shall have a minimum diameter of 3.18-inches (PQ-size) and shall be performed in accordance with ASTM D2113.
        iii. Core recovery shall exceed 85 percent and core pieces greater than 6-inches long shall be a minimum of 50 percent. Additional cores shall be taken where this criteria is not achieved.
        iv. Coring shall not be performed until the soil mix has set for a minimum of 120 hours.
        v. A minimum of three representative core samples (at least 3 times the diameter of the core) from varying depth intervals shall be compression tested at 7 days following installation
        vi. A minimum of three representative core samples (at least 3 times the diameter of the core) from varying depth intervals shall be compression tested at 28 days following installation.
        vii. Perform a hydraulic conductivity field tests at all three core hole locations at varying depths intervals (generally one near the surface of the core, one near the middle of core, one near the bottom of the core) via packer tests in accordance with USBR 7310 Designation Constant Head Hydraulic Conductivity Tests in Single Drill Holes
            1. The packer test would utilize pneumatic packers (double packer system) to isolate a 5-foot test section in each core hole, providing constant water head within each test section, and measuring the loss of water through the borehole walls with time)
        viii. After the completion of all hydraulic conductivity testing, tremie-grout all core holes with neat cement grout (5 gallons of water to 94 pounds of cement).
2. Soil Mixing / In-Situ Stabilization of Contaminated Area (el. 14-11)
    a. Wet soil mix sampling

    i. Collect a minimum of 6 samples per 2 days of soil mixing
    ii. Within each sample set break 3 samples at 7 days and break the other 3 samples at 28 days

b. Coring program
    i. Advance and collect three cores to about 6 inches above bottom of cured soil mix at locations specified on Figure 1 for visual inspection and photographs.
    ii. Cores shall have a minimum diameter of 3.18-inches (PQ-size) and shall be performed in accordance with ASTM D2113.
    iii. Core recovery shall exceed 85 percent and core pieces greater than 6-inches long shall be a minimum of 50 percent. Additional cores shall be taken where this criteria is not achieved.
    iv. Coring shall not be performed until the soil mix has set for a minimum of 120 hours.
    v. A minimum of three representative core samples (at least 3 times the diameter of the core) from each 1-foot interval of the stabilized mass (i.e., el. 14-13, el. 13-12, and el. 13-11) shall be compression tested at 7 days following installation
    vi. A minimum of three representative core samples (at least 3 times the diameter of the core) from each 1-foot interval of the stabilized mass (i.e., el. 14-13, el. 13-12, and el. 13-11) shall be compression tested at 28 days following installation.
    vii. A minimum of three representative core samples from each 1-foot interval of the stabilized mass (i.e., el. 14-13, el. 13-12, and el. 13-11) shall be lab-tested for hydraulic conductivity in accordance with (ASTM D5084.
        1. Note: The field hydraulic conductivity testing cannot be completed in this area as the stabilized interval is too short for packer test equipment
    viii. After the completion of all cores, tremie-grout all core holes with neat cement grout (5 gallons of water to 94 pounds of cement).