SECTION 02261
WATERLOO BARRIER® SYSTEM
STEEL SHEET PILING WITH SEALED INTERLOCK SYSTEM

PART 1- GENERAL

1.1 Description of Work

Two parallel subsurface DNAPL migration barriers are planned to be installed at varying depths along the northern portion of the Site. The first barrier, located immediately south of Beach Channel Drive, extends to within 15 feet of the eastern edge of the existing Electric Substation to within 15 feet of the eastern corner of the Site at the intersection of Beach 108th Street and Beach Channel Drive for a total of approximately 695 linear feet. This migration barrier, known as the on-site barrier, will be installed at two different depths. The center section of the on-site barrier will extend to a depth of 120 feet bgs for a linear distance of approximately 250 feet. Two flanking 50 foot bgs barriers will be installed on either side of the center section of the on-site barrier for a total linear distance of approximately 445 feet. The second migration barrier, known as the bulkhead area barrier, will be installed within the bulkhead area to a depth of 70 feet bgs and a linear distance of approximately 170 feet. The alignment of the migration barriers are depicted on the Design Drawings. The installation of the migration barriers will serve two purposes. First, both barriers will inhibit the migration of DNAPL to areas located downgradient of the Site, including Jamaica Bay. Second, the on-site barrier will allow DNAPL to be passively recovered via recovery wells to be installed upgradient and immediately downgradient of the on-site migration barrier.

The migration barrier locations and configurations were selected based on the results of the conceptual groundwater flow modeling conducted as part of the pre-design activities as well as limitations imposed by the existing LIPA overhead electric transmission/distribution lines. As presently configured, the migration barrier is expected to have little to no effect on groundwater elevations outside the immediate area of concern. Given the geology, site access constraints, and desire to minimize short-term impacts on the surrounding community, the migration barrier is currently proposed to be constructed utilizing steel sheeting with sealed interlocks. Based on the results of the completed field demonstration program, the steel sheeting with sealed interlock system will consist of the Waterloo Barrier® system.

1.2 Description Approach

The subsurface migration barrier, consisting of a Waterloo Barrier® sheet pile system, will be installed by the Contractor or its subcontractor along the proposed alignment as depicted on the Design Drawing Drawings. The barrier will consist of unmodified Waterloo Barrier® EZ95 steel

SECTION 02261
WATERLOO BARRIER® SYSTEM
STEEL SHEET PILING WITH SEALED INTERLOCK SYSTEM

sheeting. Both the top and bottom 5 feet of each steel sheet will be reinforced to improve driving mechanics. The sheeting will be installed by the Contractor or its subcontractor in a manner consistent with the field demonstration program and with manufacturer's recommendations.

All sheeting will be driven by Contractor or its subcontractor using a high frequency vibratory hammer due to both the relative speed of installation and lower noise and vibration generation compared to use of an impact hammer. The center 120 foot depth section of the on-site barrier will likely be installed first followed by the two 50 foot depth sections. The bulkhead area barrier will be installed after the completion of the on-site barrier or as approved by KeySpan.

The Waterloo Barrier® sheet pile system shall be installed by the Contractor using proper installation procedures in accordance with applicable OSHA guidelines and regulations.

Due to the proximity of the overhead electrical service lines that extend along Beach 108th Street and along Beach Channel Drive, the Contractor shall use extreme care during the installation of the DNAPL migration barriers so as not to damage or interfere with these utilities. The minimum setbacks from these overhead lines for all equipment and personnel are as follows:

- 15 feet for the 33 kV overhead electrical lines;
- 10 feet for the 13 kV overhead electrical lines; and
- 5.5 feet for the insulated 33 kV overhead electrical line.

In addition to maintaining the required setbacks from the overhead electrical lines, the Contractor shall adhere to the following requirements when installing each Waterloo Barrier® sheet pile along the specified alignment of the on-site DNAPL migration barrier:

- All sheet piles shall be temporarily staged on the south side of the DNAPL migration barrier alignment and all sheet piles are to be lifted from the ground surface at that location;
- All sheeting will be driven using an ABI Mobilram TM18/22B or equivalent installation system. This system is ideal for vibration free sheet piling. The Contractor will install the sheet piles in manner consistent with the manufacturer's recommendations.

SECTION 02261
WATERLOO BARRIER® SYSTEM
STEEL SHEET PILING WITH SEALED INTERLOCK SYSTEM

- The tracks of the installation equipment used to install the Waterloo Barrier® sheet piles shall be parallel to the DNAPL migration barrier alignment at all times during the installation process;

- Once the installation equipment system lifts a sheet pile off of the ground, each Waterloo Barrier® sheet pile shall remain attached to the equipment at all times until the sheet pile is installed; and

- A racking system or driving template shall be used during the driving of the Waterloo Barrier® sheet piles to ensure proper alignment and verticality. The racking system will also minimize the potential for movement during sheet pile positioning, threading, or welding. During the development of the remedial design, the Contractor shall provide a design submittal for the racking system for review and approval by KeySpan and PS&SPC.

Following installation of the sheets, the interlocks will be properly flushed by Contractor or its subcontractor to remove soils/debris. The full length of the interlock channels between each of the installed sheets will be flushed by Contractor or its subcontractor with clean water to remove soil/debris. Flush water will be allowed to percolate onto the ground surface immediately adjacent to the installed sheets. If necessary, in instances where interlock obstructions can not be cleared by standard flushing, high-pressure jetting will be employed by Contractor or its subcontractor to clear obstructions within the interlocks.

Finally, the seams in the sheet piles will be sealed by Contractor or its subcontractor with WBS-301 joint sealants as defined in the Technical Specifications.

1.3 Summary

This section specifies the requirements for furnishing all methods, means, materials, labor, supervision, insurance and equipment and for performing all operations to install the Waterloo Barrier® steel sheet pile systems as detailed on the Design Drawings.

1.4 Reference Standards

1.4.1 American Society for Testing and Materials (ASTM):

1. A 328 – Standard Specification for Steel Sheet Piling.

SECTION 02261
WATERLOO BARRIER® SYSTEM
STEEL SHEET PILING WITH SEALED INTERLOCK SYSTEM

2. A 572 – High Strength Low Alloy Columbium-Vanadium Steels of Structural Quality.

1.4.2 American Welding Society (AWS): D1.1 – Structural Welding Code.

1.4.3 Design Drawings depicting sections of the Waterloo Barrier® are provided in the Contract Documents.

1.5 Submittals

1.5.1 During the development of the remedial design, the Contractor shall provide the following details with regard to the Waterloo Barrier® system:

a) Final sequence of DNAPL migration barrier installation.
b) Estimated durations for the installation of each segment of the DNAPL migration barrier.
c) Qualifications for the subcontracted pile driving contractor procured to install the Waterloo Barrier® system.
d) Detailed approach as to how the Waterloo Barrier® system will be installed including proposed equipment to be used, splicing requirements, quality control and assurance measures, and joint preparation prior to sealing.
e) A plan depicting the crane locations and material picks during the installation of the migration barriers.
f) Design for reinforced sheet piles, to be used to improve driving capabilities.
g) Plan for mitigation of vibrations and noise caused by the installation of the Waterloo Barrier® system.
h) Proposed welding procedures.
i) Proposed methods to verify termination depth and alignment of parallel Waterloo Barrier® systems.
j) Certification of the License Agreement with Waterloo Barrier Inc. for the provision of quality control services for the sheet pile installation and joint sealing.
k) Mill test documentation for the piling to be used on the project.

SECTION 02261
WATERLOO BARRIER® SYSTEM
STEEL SHEET PILING WITH SEALED INTERLOCK SYSTEM

1.6 Coordination

1.6.1 Notify KeySpan, PS&SPC and/or the CM at least 5 working days prior to beginning pile driving operations at any location. This will not relieve Contractor or its subcontractor of the responsibilities for performing the work in accordance with these Technical Specifications and the Contract Documents.

1.6.2 The Contractor shall coordinate with the pertinent utility companies regarding protecting and supporting utilities impacted by the remedial construction activities.

1.6.3 Contractor or its subcontractor shall endeavor to flush and grout the sheet interlocks as soon as practical after the installation to avoid any unnecessary obstructions.

1.6.4 The Contractor shall minimize direct communications with members of the public and other interested parties (excluding regulatory agency personnel). Direct communication with these entities is the sole responsibility of KeySpan.

1.7 Quality Assurance/Quality Control

1.7.1 The Quality Assurance/Quality Control (QA/QC) program and joint sealing operations shall be implemented by Contractor or its subcontractor.

1.7.2 Horizontal Alignment: The maximum permissible horizontal tolerance in pile driving shall be a deviation of not more than 150mm (6 inches) from the plan location indicated on the Design Drawings.

1.7.3 The installed alignment and top elevations of the containment barrier shall be surveyed by a Professional Surveyor licensed in the State of New York.

PART 2- PRODUCTS

2.1 Sheet Piles

2.1.1 WEZ95 sheet piles will be used for the Waterloo Barrier® system. The EZ95 sheets shall be manufactured by Canadian Metal Rolling Mills (CMRM) or approved equivalent, and will be supplied in custom rolled or custom cut lengths as

SECTION 02261
WATERLOO BARRIER® SYSTEM
STEEL SHEET PILING WITH SEALED INTERLOCK SYSTEM

specified by the final Design Drawings and Technical Specifications. The sheets will be driven to the depths depicted on the Design Drawings. Contractor or its subcontractor shall be responsible for verifying the termination depth of each sheet in the Waterloo Barrier® system.

2.1.2 The subsurface DNAPL migration barriers consisting of a Waterloo Barrier® sheet pile system will be installed along the proposed parallel alignment depicted on the Design Drawings.

2.1.3 The top and bottom five feet of the Waterloo Barrier® sheets shall be reinforced with a 3/8" stiffener plate to improve driving mechanics, as depicted in the Design Drawings.

2.1.4 The 120 foot sections Waterloo Barrier® sheets shall be composed of two 60 foot sections spliced together with a 24" x 6" x 3/8" splice plate on both sides, as depicted in the Design Drawings.

2.1.5 All sheeting will be driven using a high frequency vibratory hammer due to both the relative speed of installation and lower noise and vibration generation compared to use of an impact hammer.

2.1.6 Following installation of the sheets, the interlocks will be properly flushed to remove soils/debris. The full length of the interlock channels between each of the installed sheets will be flushed with clean water to remove soil/debris. Flush water will be allowed to percolate into the ground surface immediately adjacent to the installed sheets. If necessary, in instances where interlock obstructions can not be cleared by standard flushing, high-pressure jetting will be employed to clear obstructions within the interlocks.

2.1.7 The seams in the sheet piles will be sealed with WBS-301 joint sealants defined in the Technical Specifications. The joint sealant shall be tested for permeability at a frequency of 1 test per 500 linear feet of sheet piles installed. Permeability samples shall be taken prior to injecting the sealant in the joints. KeySpan may request additional permeability testing of the joint sealants to verify the results. Contractor or its subcontractor will provide the labor, equipment, materials, and services to assist in testing and inspection.

SECTION 02261
WATERLOO BARRIER® SYSTEM
STEEL SHEET PILING WITH SEALED INTERLOCK SYSTEM

2.1.8 A foot plate shall be welded to the base of each female joint of the sealable sheet piling to prevent soil from entering the joint as the pile is driven into the subsurface. The Contractor will be responsible for all cutting and patching of the sheet piles and attachment of the foot plates. The Contractor shall make the necessary arrangements to assure that attachment of the foot plates does not delay the installation of the Waterloo Barrier® system.

2.1.9 Section Properties of non-modified WEZ95 Piling:

	Imperial	**Metric**
Thickness:	0.375 in.	9.50 mm
Nominal Width:	25 in.	635 mm
Section Area:	14.9 $in.^2$	96.2 cm^2
Weight:	50.5 lbs./lineal ft.	75.2 kg/lineal m
Moment of Inertia:	134 $in.^4$/wall ft.	18300 cm^4/wall m
Radius of Gyration:	4.33 in.	110 mm
Section Modulus:	24.9 $in.^3$/wall ft.	1340 cm^3/wall m

2.1.10 Waterloo Barrier® Sealant Materials: The material used to seal the sheet pile wall shall be WBS 301 supplied and installed by the Contractor or its subcontractor in accordance with the Contractor Documents, and shall be compatible with the Waterloo Barrier® system.

PART 3- EXECUTION

3.1 Sheet Pile Installation

3.1.1 Prior to installation of the sheet piles for the Waterloo Barrier® system, the Contractor or its subcontractor shall perform a visual inspection to ensure:

a) Pile Thickness: Verify the thickness of the sheet pile;
b) Linearity Inspection: Ensure that the piles have not been bent, bowed or damaged during transport to the Site;
c) Surface Condition: Inspect the surface of the piles for defects and/or deformations;
d) Sheet Pile Length: Measure each sheet pile to confirm the specified length;
e) Pile Markings: Mark each sheet pile with one-foot graduations to assist in the recording of driving logs during the installation of the piles.

SECTION 02261
WATERLOO BARRIER® SYSTEM
STEEL SHEET PILING WITH SEALED INTERLOCK SYSTEM

f) Foot Plate Inspection: Visually inspect each foot plate for proper installation;

The Contractor or its subcontractor shall perform the inspections with a KeySpan and/or PS&SPC representative. Any deficiencies in a sheet pile shall be photographed, documented and visibly marked with a large X to ensure the sheet pile is not installed. The Contractor shall be responsible for all cost and schedule impacts associated with installation of a sheet pile that does not confirm to the above criteria.

The Contractor shall replace and repair the deficient sheet pile. If a repair of the sheet pile is proposed, the Contractor shall notify KeySpan, PS&SPC and/or the CM of how the sheet will be field modified for review and approval. KeySpan, PS&SPC and/or the CM shall make the final determination as to whether a sheet pile can be installed or requires replacement.

3.1.2 Installation Depth: The Waterloo Barrier® system shall be installed to the design depths depicted on the Design Drawings. The Contractor shall be responsible for verifying the termination depth of all sheet piles. The top elevation of the Waterloo Barrier® system will be established two feet below the existing ground surface.

3.1.3 During installation of the sheet piles, the Contractor shall:

3.1.3.1 Lift in a manner which will not cause excessive bending stresses;
3.1.3.2 Avoid damaging sheet piles during the handling or installing operations;
3.1.3.3 The joint of each sheet pile shall be visually inspected by the Contractor or its subcontractor prior to installation. Any foreign material shall be removed, and damaged joints and/or sheet piles shall be rejected;
3.1.3.4 Replace or repair sheet piles which are damaged during installation; and
3.1.3.5 During the handling and lifting of each sheet pile, the Contractor or its subcontractor shall not endanger any overhead utilities.

3.1.4 Any changes to this proposed work sequencing shall be determined during the development of the remedial design. However, changes shall be accepted only if they result in net reductions to the cost of the project either through material/equipment/labor costs or through a reduction in the project duration. The Contractor will be responsible for supporting the remedial design as required by KeySpan, PS&SPC and/or the CM.

SECTION 02261
WATERLOO BARRIER® SYSTEM
STEEL SHEET PILING WITH SEALED INTERLOCK SYSTEM

3.1.5 Location and Tolerances:

a) The Contractor or its subcontractor shall drive sheet piles vertically plum and in a correct alignment so that the top of the sheet piles are installed on a straight line to ensure proper interlocking throughout the entire alignment of the containment barrier.
b) Sheet pile locations on the Design Drawings are approximate and will be field verified and located as approved by KeySpan, PS&SPC and/or the CM.
c) Deviation in the horizontal alignment shall not exceed 10 degrees at each joint.
d) The maximum permissible vertical tolerance (plumbness) in the sheet pile installation shall not be greater than a deviation of 1/5 inch per 1 foot vertical. The integrity of the interlock between adjacent piles shall be verified by flushing the joint. Joint inspection and flushing shall be performed by the Contractor's Quality Assurance/Quality Control Technician and as approved by KeySpan, PS&SPC and/or the CM.

3.1.6 The Contractor or its subcontractor shall use suitable templates to ensure alignment and plumbness during driving as approved by KeySpan, PS&SPC and/or the CM.

3.1.7 Crane Operations: Due to the heavy volume of vehicular traffic in close proximity to the Site, the Contractor shall take special precautions during sheet pile installation to ensure the safety of Site workers and the general public as described below:

3.1.7.1 The Contractor shall be responsible for the positioning of the crane and for preparing the ground surface in which the crane will be positioned on. The Contractor shall repair any damage caused by positioning, moving, lifting, assembly or disassembly of the crane. The Contractor shall utilize crane mats or approved equivalent to protect existing surfaces proposed not be disturbed (i.e. asphalt, concrete, etc.) during the remedial work. The Contractor shall submit a plan, for review and approval by KeySpan and PS&SPC, depicting the crane locations during movement of sheets, installation, and demobilization.

3.1.7.2 The Contractor shall install sheet piles with an appropriately specified vibratory hammer as approved by KeySpan and/or PS&SPC. The

proposed equipment to be used and the method for installation will be provided by the Contractor and will require approval by KeySpan and/or PS&SPC during the development of the remedial design. The Contractor shall ensure that no damage will occur to the sheets piles during the installation.

3.1.8 Pile Installation:

a) During installation, the Contractor shall prevent and correct any tendency of the sheet piles to bend, twist, or rotate, or to pull out of interlock. The integrity of each sheet pile and interlocked joint shall be maintained during and after driving.
b) Working from the start location, the Contractor will install the sheet piling with the smaller (male) joint leading and thread the larger (female) joint with attached foot plate on to the installed male joint to form the sealable cavity (as depicted on the Design Drawings). The Contractor will ensure that the enlarged female joint is not driven to an elevation lower than the previously installed male joint in order to prevent obstructions from entering the sealable cavity.
c) The top of each sheet pile shall be within 1 inch of the specified elevation. Manipulation of sheet piles to force them into position will not be permitted. The Contractor shall check the sheet piles for heave. Sheet piles found to have heaved shall be re-driven, at the Contractor's expense, to the required top elevation. Where required, the Contractor shall trim sheet piling to specified design elevations as required by KeySpan and/or PS&SPC. Costs associated with sheet pile trimming are to be included in the sheet pile installation pricing provided by the Contractor.
d) Sheet piling damaged or driven outside the specified tolerances shall be replaced. Any sheet pile damaged during installation shall be immediately pulled and replaced, at the Contractor's expense.
e) All sheet piles shall be driven to the design depth. Sheet pile driving will be considered complete when the sheet piling has been installed to the design depth.
f) Once the sheet piling has been installed, the Contractor's Quality Control Technician shall confirm that the sealable cavity is open for the full length and free of obstructions. This work will include providing the necessary labor, equipment, and materials to vibrate the sheet piling while the Quality Control Technician flushes the sealable cavity of the problem joints, and/or removing

and replacing sheet piling damaged during driving at no additional cost to KeySpan, PS&SPC and/or the CM.

g) The Contractor shall pull any sheet piles that are known to have pulled out of the interlock or are suspected of having tip or interlock damage, as determined by the Quality Control Technician and KeySpan/PS&SPC, for visual inspection before proceeding further.
h) Splicing is permitted if shown on the Design Drawings or as approved by KeySpan and/or PS&SPC.
i) The Contractor shall make splices using a full penetration weld or as otherwise directed by KeySpan, PS&SPC and/or the CM for structural purposes.

3.2 Joint Sealing

3.2.1 All sheet pile joints are to be sealed. Joint sealing shall be completed by the Contractor.

3.2.2 Joint sealing shall not be performed within 100 feet of the sheet pile installation operation or until a satisfactory joint inspection is achieved.

3.2.3 A tremie hose or tube for pressure injection of the sealant shall be inserted into the sealable cavity. When the tube has reached the bottom of the hole, the sealant injection will begin. The hose shall be withdrawn progressively up the hole as the sealant fills the space below. Keep tremie nozzle at least 1 foot below the rising surface of sealant.

3.3 Records

The Contractor's QA/QC Technicians will document the following information and provide it (via the CM) to KeySpan and/or PS&SPC in report format upon completion of the barrier wall installation:

3.3.1 Provide accurate records of each sheet pile driven. Submitted records shall include the following information:

a) Pile identification number.
b) Date and time of driving.
c) Elevation of top of pile.
d) Length of sheet pile in the ground when driving is complete.
e) Driving logs showing the time to install each foot of each sheet pile.

SECTION 02261
WATERLOO BARRIER® SYSTEM
STEEL SHEET PILING WITH SEALED INTERLOCK SYSTEM

f) Detailed remarks concerning alignment, obstructions, etc.
g) Plumbness records of each sheet pile installed.
h) Joint flushing records for each joint installed.

3.3.2 Mark a waterproof identification number that is clearly visible on each sheet pile, within 2 feet from the top and bottom of the pile.

3.3.3 Spray paint all sheet piles rejected form the work for any reason, at the time of rejection, with the letter "X" within 3 feet of both ends.

3.3.4 Provide accurate sealant installation records. Submitted records shall include the following information:

a) Joint identification number.
b) Date and time of sealing operation.
c) A complete list of the equipment used during the installation.
d) Volume of sealant required to seal each joint.

3.4 Rejection

3.4.1 If rejected from the work because of deviation from location, plumbness requirements, excessive bending, twisting, pulling out of interlock, or other reasons, take suitable corrective action at no additional cost to KeySpan, PS&SPC and/or the CM. Suitable action includes extracting, furnishing, and driving of replacement sheet piles, so that all sheet piles installed meet the requirements of the Technical Specifications and Design Drawings.

3.5 Subsurface Obstructions

Geotechnical records are included in Attachments. The Contractor shall review this geotechnical data and determine if the Waterloo Barrier® system can be installed to the design depths. In addition, the Contractor shall pre-trench along the proposed alignment of the containment barrier to manage subsurface utilities and to remove subsurface obstructions. Should the Contractor encounter a subsurface obstruction during the installation of the sheet piling for the Waterloo Barrier® system that precludes driving the sheet pile to the proposed design depth, the Contractor shall consult with KeySpan, PS&SPC and/or the CM to confirm the presence of the subsurface obstruction. As approved by KeySpan, PS&SPC and/or the CM, additional pre-trenching may be undertaken or the alignment of

SECTION 02261
WATERLOO BARRIER® SYSTEM
STEEL SHEET PILING WITH SEALED INTERLOCK SYSTEM

the containment barrier may be slightly modified to go around the subsurface obstruction to the extent practical as determined by field conditions. The re-alignment of the sheet piling shall be included with the pricing detailed in Section 01025 – Measurement and Payment of the Technical Specifications.

3.6 Certification

The Contractor shall provide a written certification stating that the bulk hydraulic conductivity of the Waterloo Barrier® system will be equal to or less than $1x10^{-5}$ cm/sec for up to one year after completion of the containment barrier installation.

END OF SECTION