

**PIERS 84 MARINE TERMINAL**  
**REHABILITATION**

**Philadelphia, PA**

**Bid Document**

**Philadelphia Regional Port Authority**  
**3460 N. Delaware Avenue**  
**Philadelphia, PA 19134**

**Urban Engineers, Inc.**  
**September, 2016**

**Urban Project #: 601300**  
**PRPA Project #: 16-126.1**

**Issued for Bid**

SECTION 00010

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## **Technical Specifications**

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## SECTION 01 11 00 – SCOPE OF WORK

### **PART 1: GENERAL DESCRIPTION**

- 1.1 Pier 84 South, located at 2401 S. Columbus Boulevard, Philadelphia, PA 19148, is owned by the Philadelphia Regional Port Authority (PRPA), hereafter referred to as the Owner. The pier was built circa 1919, with later additions of a transit shed, hereafter referred to as the warehouse, circa 1922, and apron extensions in 1924. The pier is currently being used to handle cocoa beans, stored in the 503,000 square feet warehouse. Pier 84 South is a finger pier, approximately 855 feet long and 336 feet wide; the warehouse it supports is 867 feet by 290 feet, with 23 feet wide aprons on both the upriver and downriver sides.

In the original construction, the pier was built as a 38 feet wide, low deck timber structure around a soil core. A timber cut-off wall forms the inboard edge of the low deck structure that retains the fill in the core. In 1924, the upriver and the downriver aprons of this pier were widened by approximately 18 feet for railroad access. The widened aprons were constructed as a low deck timber structure with five pile bents, consisting of timber piles, clamps, and cap, at approximately five feet spacing. These bents span upriver and downriver. In 1985, about 500 feet of the upriver apron was raised by 3'-6" to bring the deck elevation to the elevation of the warehouse finished floor. The raising of the deck was achieved by filling on top of the apron and casting a reinforced concrete slab spanning between the warehouse and the existing seawall.

- 1.2 There has been evidence of structural distress at the outshore end of the warehouse. This has raised concerns over the long-term stability and structural integrity of the warehouse structure, and the pier itself. It is the intent of the Owner to rehabilitate the outshore end of the pier to remediate the problem and promote the long-term stability of the structure. Rehabilitation work includes providing a new structural slab inside of the warehouse. The slab will be supported on Micropiles and topped with asphalt. In the northeast and southeast corners, the micropiles will support a new structural slab atop the existing timber low-deck, and clean stone fill will be placed between the new lower slab and the new upper slab. The outshore apron was found to be inadequate to support its own weight so the apron will be strengthened by driving new piles and placing new concrete to support the outshore apron. The outshore portion of the north apron will be raised to match the elevation further inshore. New steel pipe piles and concrete will be installed to act in concert with the newer piles, installed in 2004, and support the north apron. The northeast corner shall be completely rebuilt: after the fill has been excavated and existing concrete demolished, new steel pipe piles will be installed to support the corner and the new pipe bollard; a new concrete slab will be poured on the existing timber decking; the seawall will be renewed and a new concrete slab will be placed at the deck elevation. The details of the rehabilitation work are shown in the Contract Drawings. All construction work shall be performed in strict accordance with the Technical Specifications included in the Contract Document.

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- 1.3 The micropiles shall be designed, tested and installed to the capacities indicated on the Contract Drawings by a specialty micropile subcontractor with a minimum of five (5) years of experience installing micropiles in similar conditions. Final micropile design calculations and working drawings shall be signed and sealed by a Professional Engineer registered in the Commonwealth of Pennsylvania, and shall be submitted to the Engineer for review prior to the start of testing and production installation. It is anticipated that hard drilling conditions will exist, particularly inboard of the timber mud fence, with the existing fill potentially including large rubble and timber debris.
- 1.4 The operations of the pier and warehouse, as directed by Dependable Distribution, hereafter referred to as the Tenant, take precedence over any proposed rehabilitation work. Therefore, the Contractor shall familiarize himself with the pier operations and submit a work schedule for the approval of the Owner and Tenant. The Contractor shall not be compensated for delays due to pier operations.
- 1.5 It is the Contractor's responsibility to obtain the vessel schedule from the Tenant on a daily basis.
- 1.6 It will be required to temporarily relocate floating equipment from the upriver slip if and when a vessel is scheduled at this berth. The use of pier bollards is prohibited. Construction equipment shall use spuds. When a vessel is at the upriver slip, construction equipment shall be moved to the inshore bulkhead. The Contractor shall become familiar with the site conditions, access to the site, and existing utilities. Any damage to the existing structures or utilities shall be repaired by the Contractor at his own expense.
- 1.7 The Contractor shall be responsible for the layout of all structural elements, pile records, all construction work, and continuously updating and submitting the schedule and as-built drawings. Contemporary soil borings and a hydrographic survey have been included in this package for the contractor's review and use to plan construction activities.
- 1.8 The contractor shall maintain a full-time employee on the site who has a minimum of ten (10) years of supervising experience in marine construction. This employee shall be interviewed by the PRPA and be empowered by the contractor to make binding decisions that may affect the financial and daily schedule of work. This employee shall be on site each hour the work is in progress and remain on the site until the Contract is determined complete by the Owner.
- 1.9 The Contractor shall not initiate construction activity prior to receiving all the related Submittals stamped "Reviewed" or "Reviewed As Noted" by Urban Engineers, Inc., hereafter referred to as the Engineer. All construction activity initiated without this authorization shall be at the Contractor's risk and may not be approved for payment by the Engineer/Owner. Furthermore, the construction

## **SECTION 01 11 00 – SCOPE OF WORK**

installed prior to a received submittal may be required to be removed and removed to accommodate the submittal, at the Contractor's expense.

- 1.10 All insurance documents are to be presented with the bid. The Philadelphia Regional Port Authority and Urban Engineers, Inc. shall be named as additionally insured.
- 1.11 The Contractor is responsible for providing access to all dock structures during construction when needed by the Owner and his representatives.
- 1.12 It is the Contractor's responsibility to make timely Submittals. The Contractor shall not initiate a construction activity prior to receiving ALL the submittals related to the construction activity, reviewed by the Engineer, indicating an authorization to proceed with the construction activity. Any construction activity performed without this authorization shall be at Contractor's risk and cost. Delays arising due to the failure in making timely submittals shall be at Contractor's cost. The Contractor shall not be compensated for construction activities performed without the authorization of the Engineer.
- 1.13 The Contractor shall submit a Submittal Log, documenting the list of submittals to be made during the project, prior to mobilization.
- 1.14 Hot work permit shall be obtained from the Owner on a daily basis.
- 1.15 Any exceptions and/or modifications to the design proposed by the Contractor shall be clearly stated in the bid. No requests for modification to the design will be accepted after the award of work.
- 1.16 The Contractor shall be solely responsible for coordinating and de-energizing electricity in the work area on a daily basis during construction.
- 1.17 Field verify the existing utilities and their location. The Contractor shall temporarily relocate and support the interfering utilities, as required. Utilities shall be reinstalled at their original location, immediately after the construction work in that area is complete. Costs associated with these activities shall be included in the base bid. The Contractor shall repair any damage to the existing utilities and structures during construction at no cost to the Owner. Information regarding the existing utilities can be obtained during the pre-bid meeting, site visits, and by communicating with the Owner prior to the submission of Bid.
- 1.18 The Contractor shall identify his staging area and water equipment needs in his Bid.
- 1.19 The Contractor shall follow the safety and security procedure of the facility. Pier 84 is a secure port facility conforming to Homeland Security regulations in

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regards to access. Accordingly, contractor personnel shall possess Transportation Worker Identity Credentials (TWIC).

- 1.20 All coated material shall be shop coated, except miscellaneous steel work. Only touch up will be allowed in the field. Coating close to the splice or any other weld location shall be removed and cleaned by the Contractor, prior to welding. Field touch up after the welding is complete.
- 1.21 The Contractor shall engage a Professional Engineer registered in the State of Pennsylvania to design falsework, connections, temporary supports, temporary structures, and other construction related elements. Submittals of drawings and calculations for these items, if requested by the Owner or Owner's Engineer, shall be promptly made with signatures, seal and stamp of this Professional Engineer. Costs of these items shall be included in the Bid.
- 1.22 The Owner may choose to test 20 percent of the total field welding using visual and other non-destructive testing techniques, including ultrasonic testing, at their own cost. The Contractor shall cooperate and provide access for such testing. The Contractor shall not be compensated for delays due to this testing. Any anticipated loss of time due to this activity shall be included in the Bid. Deficient welds shall be corrected by the Contractor at no additional cost to the Owner.
- 1.23 The Owner may choose to keep pile and structural steel cut-offs. Under such conditions, the Contractor shall store such items at the Owner designated location.
- 1.24 All demolished material shall be disposed of, off site in accordance with the applicable local and federal rules and regulations, unless specifically directed otherwise by the Owner.
- 1.25 Extraction of piles within 25 feet of new piles and piles of structures to remain shall not be permitted. Piles within 25 feet of new piles and piles to remain shall be cut at or below mudline. Cutting of piles at mudline shall be performed using OSHA compliant diving crew.
- 1.26 No diving work (demolition or pile encasement) shall be permitted during vessel berthing operations. The contractor shall submit a diving and diving safety plan at least four weeks prior to diving operations for review and acceptance.
- 1.27 The Contractor shall attend weekly progress meetings. A Contractor employee with the authority of making decisions will be present at each of these meetings.
- 1.28 The Contractor shall notify the neighboring property Owners of the pile driving operation and schedule, at least 10 days in advance of initiating the pile driving operation.

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- 1.29 In their bid, the bidder shall provide separate daily and hourly standby rates for the labor and equipment. These rates will be used for work performed on time and material basis.

### **PART 2: SCOPE**

The scope of work includes providing the labor, material, equipment, and all other services and expense as may be necessary for and incidental to the proper execution and completion of work including but not limited to performing the following tasks.

- 2.1 The successful bidder shall obtain all local permits necessary to perform the work and submit all applicable permits to the Owner one (1) week prior to mobilization. Only the legal permit fee shall be paid by the Owner.
- 2.2 Make submittals required by the Contract and as requested by the Engineer for review.
- 2.3 Submit the design calculations and working drawings for the micropiles, signed and sealed by the micropile subcontractor's professional engineer.
- 2.4 Perform and submit the results of the Driveability Analysis for the pile driving hammers for all types of pipe piles. The Contractor shall perform this driveability analysis to confirm that the hammer proposed by the Contractor is capable of driving the piles to the required tip elevations and bearing capacities specified in the Contract Drawings. If the geotechnical information provided in the geotechnical report attached to the Contract Document is not sufficient to perform the driveability analysis, the Contractor shall request the additional information as an exception in his Bid. No additional geotechnical information will be provided by the Owner after the award of work. Any required additional geotechnical information identified after the award of work shall be obtained by the Contractor at his own cost.
- 2.5 Mobilize and install the office trailer at a location designated by the Owner. Secure necessary permits for this trailer.
- 2.6 Install temporary barriers and signs prohibiting access to any structures and and/or walkways where construction or demolition work is in progress. Such barriers and signs shall remain in place until the completion of construction work, when the structure is safe for access. The Contractor is solely responsible for the safety of its employees and all other personnel using the dock during construction.
- 2.7 Furnish, install, and maintain a floating boom to prevent construction debris from becoming waterborne. The boom installed by the Contractor shall not impact vessel traffic.

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- 2.8 The Contractor is responsible for procurement of all materials required to perform work. No material is being supplied by the Owner.
- 2.9 Attributes of the existing structure, including dimensions and elevations, have been obtained from historical drawings. Site conditions may vary. Contractor shall verify all dimensions and elevations prior to procurement of materials. Historical drawings can be obtained from the owner at the Philadelphia Regional Port Authority Offices.
- 2.10 Fabricate, coat, handle and transport all material to the project site as and when required. Deliveries will be made without impacting the normal dock operations. The Contractor is responsible for coordinating these deliveries with the Owner and Tenant and ensuring adequate space to stockpile material.

### **Interior Concrete Slab**

- 2.11 Install a temporary wall around the work area inside the first floor of the warehouse to prevent dust, dirt and debris generated during demolition or construction from entering the active warehouse.
- 2.12 Demolish the existing floor slab inside the warehouse and excavate soil to the elevations indicated on the contract drawings. Excavate soil in the upriver and downriver corners to the existing timber decking using care not to damage the existing timber decking. The original construction drawings indicate a rail pit in the center of the warehouse. Demo rail pit walls to the limits indicated on the contract drawings. Contractor shall verify the existence of the railstops, rail tracks, track anchors and ties and remove as indicated on the contract drawings.
- 2.13 After cutting or coring holes, install one type “L” micropile and one type “H” micropile and perform verification testing.
- 2.14 Cut holes in the existing timber decking at the upriver and downriver outshore corners at locations indicated on the contract drawings for placement of micropiles.
- 2.15 Install all type “L” micropiles and perform proof testing. Proof testing must be performed regularly throughout micropile installation. It shall not be acceptable to perform proof testing only after all micropiles have been installed.
- 2.16 Install forms for the lower concrete slabs. While the existing timber decking may be used as formwork, the Contractor may need to patch areas of the deck to ensure a seal and must ensure that the existing timber piles will provide adequate support to the wet concrete.

## **SECTION 01 11 00 – SCOPE OF WORK**

- 2.17 Place reinforcement, pour and cure concrete for the new lower slabs in the upriver and downriver corners of the pier.
- 2.18 Install dowels into the existing apron beam concrete as indicated on the Contract Drawings.
- 2.19 Core holes in the downriver, outshore and upriver concrete apron (outside of the timber sheeting) for placement of type “H” micropiles at the locations indicated in the contract drawings.
- 2.20 Install the type “H” micropiles and perform proof testing. Proof testing must be performed regularly throughout micropile installation. It shall not be acceptable to perform proof testing only after all micropiles have been installed.
- 2.21 Once the concrete for any new lower slabs has fully cured and reached its design strength, place fill to the elevations of the bottom of the upper slabs to be constructed. Shape the fill at each micropile location as indicated on the Contract Drawings to provide thicker slab section at each micropile. At beam ends and around existing warehouse foundations provide a grade beam per the Contract Drawings. Ensure that the new slab is constructed to be independent of the warehouse foundations by providing expansion joint material at the intersection of the new and existing concrete.
- 2.22 Place reinforcement, pour and cure concrete for the upper slab supported on Type “H” micropiles as indicated on the Contract Drawings. Saw cut contraction joints into the concrete within twenty-four (24) hours after placement of concrete as indicated on the Contract Drawings. Where construction joints have to be provided in the slab, the joints must be centered between rows of Micropiles, providing sufficient splice length of reinforcement.
- 2.23 Place reinforcement, pour and cure concrete for the upper slab supported on fill in the upriver and downriver corners of the pier. Ensure the two slabs act independently by providing expansion joint material at the intersection of the concrete slabs.
- 2.24 Place bituminous asphalt overlay on the concrete slab such that the finished floor elevation matches the pre-construction elevations along the perimeter of the building.
- 2.25 Remove the temporary dust wall and refinish any affected surfaces.

### **Outshore Apron Beam**

- 2.26 Demolish the existing pavement and slab and excavate fill from the outshore apron as indicated on the Contract Drawings.

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- 2.27 Demolish the two existing bollards on the outshore apron.
- 2.28 Drill holes in the existing concrete pile cap as indicated on the Contract Drawings for support rods. Holes must be vertical and spaced to avoid the timber caps, clamps and piles under the concrete cap. Core holes in the apron concrete slab for steel pipe piles as indicated in the Contract Drawings.
- 2.29 Perform PDA testing on the first installed new 16" diameter pipe plumb pile, as indicated on the Contract Drawings, and submit the results and CAPWAP analyses to the Engineer for the development of drive criteria.
- 2.30 Once the Engineer has issued drive criteria, drive the remaining outshore apron piles to the designated criteria, splicing as necessary.
- 2.31 Install PVC sleeves, beam reinforcement and guard rail anchors, then pour concrete for the apron beam as indicated on the Contract Drawings. Form notches at the locations of the PVC sleeves as indicated on the Contract Drawings.
- 2.32 Once the concrete has cured to its design strength, install threaded rods with plates, washers and nuts at the top of the beam. Install Channels under the existing concrete apron beams between timber piles. Ensure that the new channels fully bear on the timber decking; timber keys that extend below the timber decking may need to be notched to allow for channels to properly bear in timber decking. Shim as required to ensure full bearing. Lock the bottom nuts in place as indicated on the Contract Drawings.
- 2.33 Snug tighten the threaded rods from the top to the pull the channels tight against the bottom of apron beam. Plug the bottoms of cored holes and install grout into the holes.
- 2.34 Pour the concrete topping deck.
- 2.35 Install the guard rail.

### **Upriver (North) Apron Modifications**

- 2.36 Demolish the upper concrete slab, concrete wall and a portion of the seawall at the upriver apron as indicated on the Contract Drawings from near column line 43 to near column line 37. Remove the existing bollard at column line 42 to be reinstalled in the proposed construction. Demolish the existing bollard at column line 38. Excavate existing fill to the existing timber low deck structure, preserving the existing steel tie rods and timber decking.
- 2.37 Drill holes in the existing timber deck for new 12.75" diameter steel pipe piles.

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- 2.38 Perform PDA testing on the first installed new 12.75” diameter pipe pile, as indicated on the Contract Drawings, and submit the results and CAPWAP analyses to the Engineer for the development of drive criteria.
- 2.39 Once the Engineer has issued drive criteria, drive the remaining upriver apron piles to the designated criteria, splicing as necessary.
- 2.40 Install steel collars below timber decking, drilling holes in timber deck for all threaded rods. Install upper steel collar at pile cut-off, install shear rods, and follow the steps on the Contract Drawings to complete collar installation.
- 2.41 Place reinforcement and pour concrete for lower concrete slab.
- 2.42 Install reinforcement and concrete for the downriver closure wall and upriver seawall, as indicated on Contract Drawings.
- 2.43 Place #57 stone backfill after the lower slab and walls have cured to the elevation indicated on Contract Drawings.
- 2.44 Place reinforcement and pour concrete for the upper slab to the grades indicated on Contract Drawings.
- 2.45 Place reinforcement and anchors for the replaced bollard and pour concrete for the bollard strap block, as indicated on the Contract Drawings.

### **Upriver / Outshore (Northeast) Corner Construction**

- 2.46 Remove steel armor plate from the northeast corner of pier
- 2.47 Excavate existing fill from northeast corner, limits of excavation as shown on Contract Drawings. Preserve the upriver seawall and steel tie rods.
- 2.48 Demolish the existing concrete seawall to the limits indicated on the Contract Drawings. Remove the existing corner bollard.
- 2.49 Drill holes in the existing timber deck for new 16” diameter steel pipe piles.
- 2.50 Perform PDA testing on the first installed new 16” diameter batter pile and 16” diameter Type “U” plumb pile, as indicated on the Contract Drawings, and submit the results and CAPWAP analyses to the Engineer for the development of drive criteria.
- 2.51 Once the Engineer has issued drive criteria, drive the remaining northeast corner piles. Note that the 16” diameter pipe plumb piles that are not Type “U” piles may be driven based on the drive criteria established for the 16” diameter plumb piles on the outshore apron.

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- 2.52 Weld connection plate and uplift plate assemblies to the four three-pile tripods that will be strapped to the new corner bollard. Weld reinforcement hooks to the four Type "U" plumb piles adjacent to the new corner bollard.
- 2.53 Place reinforcement and pour the lower concrete slabs over the existing timber decking where indicated on the Contract Drawings.
- 2.54 Place reinforcement for new corner and seawall concrete and set the new pipe bollard, making sure that strap reinforcement for the new bollard is pulled tight to the new bollard and the support tripods. pour concrete seawall and concrete cap at as indicated on the Contract Drawings.
- 2.55 After lower slab and wall concrete has cured, place #57 backfill fill to the elevations shown on the Contract Drawings.
- 2.56 Place reinforcement and pour the upper slab in outshore and upriver side areas adjacent to corner as indicated in the Contract Drawings.
- 2.57 Perform additional work if required and as directed by the Owner.
- 2.58 Walk-thru with the Owner and the Engineer and complete punch list items.
- 2.59 Clean up all work areas and demobilize. Submit As-Built Drawings to the Owner.

**END OF SECTION**

## **SECTION 01 20 00 – PRICE & PAYMENT PROCEDURES**

### **PART 1 : GENERAL**

- 1.1 The Bid Pay Items as included on the Schedule of Quantities shall be defined as included herein.
- 1.2 In all cases, contract conditions and payment procedures shall be governed by the General Conditions of the Philadelphia Regional Port Authority.

### **PART 2 : SCOPE, PRICE and PAYMENT OF PAY ITEMS**

- 2.1 Item No. 2 - Install and maintain floating booms around the work area
  - A. The work shall consist of providing, installing and maintaining all floating booms and all other materials and equipment necessary to contain construction materials at the site and prevent them from dropping into the water and becoming waterborne.
- 2.2 Item No. 3 - Install and maintain personnel barriers and signage around the work area
  - A. The work shall consist of providing, installing and maintaining all barriers, fences and all other materials and equipment necessary to provide proper safety, access restriction around work areas.
- 2.3 Item No. 4 - Temporary interior wall
  - A. The work shall consist of the surveying to determine dimensions, designing, furnishing and erecting a temporary wall inside the first floor of the warehouse to prevent dust, dirt and debris from entering the active warehouse. This item shall include the eventual demolition and removal of the wall after the interior work is complete. Work shall be performed in accordance with Sections 01 73 00.
  - B. The Contractor shall field-verify existing conditions and dimensions and coordinate the wall location with the tenant prior to beginning the work.
- 2.4 Item No. 5 - Demolition of existing interior warehouse floor slab/paving
  - A. The work shall consist of the surveying, demolition and offsite disposal of the interior warehouse floor slab, as shown on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19 and 02 41 19.

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- B. The Contractor shall field-verify existing conditions, utilities and dimensions at all areas prior to initiating demolition activities. Any potential interferences discovered during field verification shall be resolved with the Engineer.
- C. Note that all floor slab material may contain reinforced concrete, bituminous pavement, or some combination thereof. Demolished material must be removed and may not be allowed to fall into the river.

### 2.5 Item No. 6 - Demolition of existing rail pit

- A. The work shall consist of the surveying, demolition and offsite disposal of the rail pit, as shown on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19 and 02 41 19.
- B. The Contractor shall field-verify existing conditions, utilities and dimensions at all areas prior to initiating demolition activities. Any potential interferences discovered during field verification shall be resolved with the Engineer.

### 2.6 Item No. 7 – Excavation of existing fill

- A. The work shall consist of the surveying, excavation and offsite disposal of the existing fill above the timber low deck, both inside and outside of the warehouse, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, and 02 20 00.
- B. Care must be taken during excavation to prevent damage to existing features that shall remain.
- C. Existing fill may be composed of site fill, cinders, stone, rubble, or other granular or clayey materials.
- D. The existing grades in the project area vary. The excavation quantity listed in the Schedule of Quantities is calculated based on assumed grade elevations of +13.5' inside the warehouse and +11'-8" outside the warehouse. The Contractor may perform and submit a premobilization survey of the existing grades, with volume calculations, to contest the listed excavation quantity.

### 2.7 Item No. 8 – Design, installation and *verification* load testing of Type “H” micropiles

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- A. The work shall consist of the design, installation and verification load testing of Type “H” micropiles, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 46 30 and 09 96 70.
  - B. The bid shall include all aspects of the micropile installation, including: coring and/or cutting of holes through existing concrete and timber; drilling and removal of fill materials; furnishing and placing of reinforcing steel and casing; grouting; and installing pile cap attachments shown on the Contract Drawings. The micropile contractor shall be responsible for estimating the grout take, and there shall be no extra payment for grout overruns.
  - C. The bid shall include all aspects of verification load testing, including the furnishing and installation of reaction micropiles and the reaction frame, as well as the cost of sacrificial micropiles.
  - D. The micropile contractor shall be solely responsible for successfully conducting the verification load testing; any costs associated with redesign and additional testing, should the verification load testing fail, shall be the micropile contractor’s responsibility
  - E. Micropiles that fail to meet the required performance criteria shall be replaced at no cost to the Owner; only micropiles that achieve the required performance criteria shall be accepted and paid.
- 2.8 Item No. 9 – Design, installation and *verification* load testing of Type “L” micropiles
- A. The work shall consist of the design, installation and verification load testing of Type “L” micropiles, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 46 30 and 09 96 70.
  - B. The bid shall include all aspects of the micropile installation, including: coring and/or cutting of holes through existing concrete and timber; drilling and removal of fill materials; furnishing and placing of reinforcing steel and casing; grouting; and installing pile cap attachments shown on the Contract Drawings. The micropile contractor shall be responsible for estimating the grout take, and there shall be no extra payment for grout overruns.
  - C. The bid shall include all aspects of verification load testing, including the furnishing and installation of reaction micropiles and the reaction frame, as well as the cost of sacrificial micropiles.

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- D. The micropile contractor shall be solely responsible for successfully conducting the verification load testing; any costs associated with redesign and additional testing, should the verification load testing fail, shall be the micropile contractor's responsibility.
  - E. Micropiles that fail to meet the required performance criteria shall be replaced at no cost to the Owner; only micropiles that achieve the required performance criteria shall be accepted and paid.
- 2.9 Item No. 10 – Design, installation and *proof* load testing of Type “H” micropiles
- A. The work shall consist of the design, installation and proof load testing of Type “H” micropiles, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 46 30 and 09 96 70.
  - B. The bid shall include all aspects of the micropile installation, including: coring and/or cutting of holes through existing concrete and timber; drilling and removal of fill materials; furnishing and placing of reinforcing steel and casing; grouting; and installing pile cap attachments shown on the Contract Drawings. The micropile contractor shall be responsible for estimating the grout take, and there shall be no extra payment for grout overruns.
  - C. The bid shall include all aspects of proof load testing, including the furnishing and installation of reaction micropiles and the reaction frame.
  - D. The micropile contractor shall be solely responsible for successfully conducting the proof load testing; any costs associated with redesign, additional testing, and additional piles should the proof load testing fail, shall be the micropile contractor's responsibility.
  - E. Micropiles that fail to meet the required performance criteria shall be replaced at no cost to the Owner; only micropiles that achieve the required performance criteria shall be accepted and paid.
- 2.10 Item No. 11 – Design, installation and *proof* load testing of Type “L” micropiles
- A. The work shall consist of the design, installation and proof load testing of Type “L” micropiles, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 46 30 and 09 96 70.

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- B. The bid shall include all aspects of the micropile installation, including: coring and/or cutting of holes through existing concrete and timber; drilling and removal of fill materials; furnishing and placing of reinforcing steel and casing; grouting; and installing pile cap attachments shown on the Contract Drawings. The micropile contractor shall be responsible for estimating the grout take, and there shall be no extra payment for grout overruns.
- C. The bid shall include all aspects of proof load testing, including the furnishing and installation of reaction micropiles and the reaction frame.
- D. The micropile contractor shall be solely responsible for successfully conducting the proof load testing; any costs associated with redesign, additional testing, and additional piles should the proof load testing fail, shall be the micropile contractor's responsibility.
- E. Micropiles that fail to meet the required performance criteria shall be replaced at no cost to the Owner; only micropiles that achieve the required performance criteria shall be accepted and paid.

### 2.11 Item No. 12 – Design and installation of Type "H" micropiles

- A. The work shall consist of the design and installation of accepted Type "H" micropiles, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 46 30 and 09 96 70.
- B. The bid shall include all aspects of the micropile installation, including: coring and/or cutting of holes through existing concrete and timber; drilling and removal of fill materials; furnishing and placing of reinforcing steel and casing; grouting; and installing pile cap attachments shown on the Contract Drawings. The micropile contractor shall be responsible for estimating the grout take, and there shall be no extra payment for grout overruns.
- C. Micropiles that fail to meet the required performance criteria shall be replaced at no cost to the Owner; only micropiles that achieve the required performance criteria shall be accepted and paid.

### 2.12 Item No. 13 – Design and installation of battered Type "H" micropiles

- A. The work shall consist of the design and installation of accepted battered Type "H" micropiles, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 46 30 and 09 96 70.

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- B. The bid shall include all aspects of the micropile installation, including: coring and/or cutting of holes through existing concrete and timber; drilling and removal of fill materials; furnishing and placing of reinforcing steel and casing; grouting; and installing pile cap attachments shown on the Contract Drawings. The micropile contractor shall be responsible for estimating the grout take, and there shall be no extra payment for grout overruns.
- C. Micropiles that fail to meet the required performance criteria shall be replaced at no cost to the Owner; only micropiles that achieve the required performance criteria shall be accepted and paid.

### 2.13 Item No. 14 – Design and installation of Type “L/H” micropiles

- A. The work shall consist of the design and installation of accepted Type “L/H” micropiles, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 46 30 and 09 96 70.
- B. The bid shall include all aspects of the micropile installation, including: coring and/or cutting of holes through existing concrete and timber; drilling and removal of fill materials; furnishing and placing of reinforcing steel and casing; grouting; and installing pile cap attachments shown on the Contract Drawings. The micropile contractor shall be responsible for estimating the grout take, and there shall be no extra payment for grout overruns.
- C. Micropiles that fail to meet the required performance criteria shall be replaced at no cost to the Owner; only micropiles that achieve the required performance criteria shall be accepted and paid.

### 2.14 Item No. 15 – Design and installation of Type “L” micropiles

- A. The work shall consist of the design and installation of accepted Type “L” micropiles, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 46 30 and 09 96 70.
- B. The bid shall include all aspects of the micropile installation, including: coring and/or cutting of holes through existing concrete and timber; drilling and removal of fill materials; furnishing and placing of reinforcing steel and casing; grouting; and installing pile cap attachments shown on the Contract Drawings. The micropile

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contractor shall be responsible for estimating the grout take, and there shall be no extra payment for grout overruns.

- C. Micropiles that fail to meet the required performance criteria shall be replaced at no cost to the Owner; only micropiles that achieve the required performance criteria shall be accepted and paid.

### 2.15 Item No. 16 – Pour new interior warehouse lower slab

- A. The work shall consist of the surveying, layout, furnishing, and installation of the new dowels and reinforcement; the providing, placing and curing of cast-in-place concrete; and all associated shoring, falsework, formwork, and other details required to complete the work shown in the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 03 10 00, 03 20 00, and 03 30 00.
- B. The Contractor shall field-verify existing conditions and dimensions prior to initiating forming. Any potential interferences discovered during field verification shall be resolved with the Engineer.
- C. The Contractor shall note that the existing timber low deck may require patching, reinforcement, and additional support in order to serve as formwork.
- D. The Bid shall include the costs of hiring a Professional Engineer licensed in the Commonwealth of PA to design all the formwork components, including investigating the ability of existing structural components, such as timber piles, to act as formwork or support formwork.
- E. All formwork materials shall remain the property of the Contractor and shall be removed from the site upon completion of the Contract work.
- F. The Bidder shall note that when scheduling concrete placement during cold weather, ACI cold weather concreting requirements must be strictly adhered to. The Bid shall include the cost of any anticipated measures needed for concreting in cold weather where anticipated. No additional payment will be made for procedures necessary to properly cure the concrete under cold weather conditions.

### 2.16 Item No. 17 – Pour new interior warehouse upper slab

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- A. The work shall consist of the surveying, layout, furnishing, and installation of the new dowels and reinforcement; the providing, placing and curing of cast-in-place concrete; and all associated shoring, falsework, formwork, and other details required to complete the work shown in the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 02 20 00, 03 10 00, 03 20 00, and 03 30 00.
- B. The Contractor shall field-verify existing conditions and dimensions prior to initiating forming. Any potential interferences discovered during field verification shall be resolved with the Engineer.
- C. The bid shall include the costs to provide stone backfill and compaction, as necessary to support the slab forms at the appropriate grades, or shall include the costs of any additional concrete required to pour the slabs on grade with minimal compaction/formwork. The bid shall also include all costs to shape the existing fill at micropile tops as shown on the Contract drawings, and to saw contraction joints after the concrete curing has begun.
- D. The Bid shall include the costs of hiring a Professional Engineer licensed in the Commonwealth of PA to design all the formwork components.
- E. All formwork materials shall remain the property of the Contractor and shall be removed from the site upon completion of the Contract work.
- F. The Bidder shall note that when scheduling concrete placement during cold weather, ACI cold weather concreting requirements must be strictly adhered to. The Bid shall include the cost of any anticipated measures needed for concreting in cold weather where anticipated. No additional payment will be made for procedures necessary to properly cure the concrete under cold weather conditions.

### 2.17 Item No. 18 - Demolition of upper slab at outshore apron

- A. The work shall consist of the surveying, demolition and offsite disposal of the high deck slab on the outshore apron between bent 24 and the outshore/upriver corner, as shown on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19 and 02 41 19.

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- B. The Contractor shall field-verify existing conditions, utilities and dimensions at all areas prior to initiating demolition activities. Any potential interferences discovered during field verification shall be resolved with the Engineer.
- C. Note that slab material may contain reinforced concrete, bituminous pavement, or some combination thereof. Demolished material must be removed and may not be allowed to fall into the river.

### 2.18 Item No. 19 – Perform and submit Wave Equation drivability analyses

- A. The work shall consist of performing and submitting wave equation drivability analyses for all pile-hammer combinations that the Contractor intends to use. Work shall be performed in accordance with Sections 01 73 00, 01 33 00, and 02 46 00.
- B. Drivability analyses must demonstrate that each pile type can be safely driven with the proposed hammer. No additional payments shall be made for analyses that do not demonstrate safe driving. Should the Contractor choose to propose a different hammer than the one used for the original drivability analysis, a new analysis will be performed and submitted at no additional cost.

### 2.19 Item No. 20 – Dynamically test 16” diameter pipe plumb pile

- A. The work shall consist of the surveying, layout, furnishing and testing of the 16” diameter pipe plumb pile, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 41 19, 02 46 00 and 09 96 67.
- B. The bid shall include all aspects of the pipe pile installation and testing, including: coring and/or cutting of holes through existing concrete and timber; furnishing, shop coating, and splicing the steel pile; dynamic testing and driving; installation of cap plates; touch up coating; and submission of test results and CAPWAP analyses.
- C. The contractor shall survey the existing timber piles prior to cutting and coring holes for new piles. Should obstructions be found, whether prior to coring, or during setting and driving of the pile, the Contractor shall notify the Engineer and receive approval for proposed relocation of the new piles. No additional payment shall be made for such relocation.

### 2.20 Item No. 21 – Furnish and install 16” diameter pipe plumb pile

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- A. The work shall consist of the surveying, layout, furnishing and installation of the 16" diameter pipe plumb piles to the drive criteria issued by the Engineer, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 41 19, 02 46 00 and 09 96 67.
- B. The bid shall include all aspects of the pipe pile installation, including: coring and/or cutting of holes through existing concrete and timber; furnishing, shop coating, and splicing the steel pile; installing the pile to drive criteria issued by the Engineer; installation of cap plates; and touch up coating.
- C. The contractor shall survey the existing timber piles prior to cutting and coring holes for new piles. Should obstructions be found, whether prior to coring, or during setting and driving of the pile, the Contractor shall notify the Engineer and receive approval for proposed relocation of the new piles. No additional payment shall be made for such relocation.

### 2.21 Item No. 22 – Install hanger rods and channels in the outshore apron

- A. The work shall consist of the surveying, layout, furnishing and installation of the hanger rod and channel beam assembly at the outshore apron, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 41 19, 05 12 00 and 09 91 11.
- B. The bid shall include all aspects of the installation, including: coring and/or cutting of holes through existing concrete and timber for hanger sleeves; setting and securing the A193 threaded rod and hardware; and furnishing, welding stiffeners to, galvanizing and installing the channel beams according to the procedures in the Contract Drawings.
- C. The contractor shall survey the existing timber piles prior to cutting and coring holes for the threaded hanger rods to ensure that hanger rods fit between timber pile bents as shown on the Contract Drawings.

### 2.22 Item No. 23 – Pour new outshore apron slab and topping deck

- A. The work shall consist of the surveying, layout, furnishing, and installation of the new dowels and reinforcement; the providing, placing and curing of cast-in-place concrete; and all associated shoring, falsework, formwork, and other details required to complete the work shown in the Contract Drawings. Work shall be

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performed in accordance with Sections 01 73 00, 03 10 00, 03 20 00, and 03 30 00.

- B. The Contractor shall field-verify existing conditions and dimensions prior to initiating forming. Any potential interferences discovered during field verification shall be resolved with the Engineer.
- C. All formwork materials shall remain the property of the Contractor and shall be removed from the site upon completion of the Contract work.
- D. The Bidder shall note that when scheduling concrete placement during cold weather, ACI cold weather concreting requirements must be strictly adhered to. The Bid shall include the cost of any anticipated measures needed for concreting in cold weather where anticipated. No additional payment will be made for procedures necessary to properly cure the concrete under cold weather conditions.

### 2.23 Item No. 24 – Furnish and install new guard rail

- A. The work shall consist of the surveying, layout, furnishing, and installation of the new guard rail and anchors as shown in the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 05 12 00, and 09 90 00.
- B. The Contractor shall cast guardrail anchors into new cast-in-place concrete, where possible. Where this is not possible, the Contractor shall drill into existing concrete and epoxy anchors with HILTI RE-500 epoxy.

### 2.24 Item No. 25 - Demolition of upper slab at upriver apron

- A. The work shall consist of the surveying, demolition and offsite disposal of the high deck slab on the upriver apron between near column line 37 and the upriver/outshore corner near column line 52, as shown on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19 and 02 41 19.
- B. The Contractor shall field-verify existing conditions, utilities and dimensions at all areas prior to initiating demolition activities. Any potential interferences discovered during field verification shall be resolved with the Engineer.
- C. Note that slab material may contain reinforced concrete, bituminous pavement, or some combination thereof. Demolished material must

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be removed and may not be allowed to fall into the river. Demolition shall include the removal of the existing rail in the slab.

### 2.25 Item No. 26 - Demolition of interior wall at upriver apron

- A. The work shall consist of the surveying, demolition and offsite disposal of the interior wall on the upriver apron, as shown on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19 and 02 41 19.
- B. The Contractor shall field-verify existing conditions, utilities and dimensions at all areas prior to initiating demolition activities. Any potential interferences discovered during field verification shall be resolved with the Engineer.
- C. Note that all demolished concrete sections must be removed and may not be allowed to fall into the river. All lift calculations, anchors and rigging required to safely demolish and extract the existing concrete sections shall be included in this bid item.

### 2.26 Item No. 27 - Demolition of seawall and pedestal wall at upriver and outshore aprons

- A. The work shall consist of the surveying, demolition and offsite disposal of the seawall on the upriver apron, between near column line 37 and the upriver/outshore corner near column line 52, and on the outshore apron between outshore bent 1 and near column line A, as shown on the Contract Drawings. The work shall also include the partial demolition of the pedestal wall at column line 43. Work shall be performed in accordance with Sections 01 73 00, 01 74 19 and 02 41 19.
- B. The Contractor shall field-verify existing conditions, utilities and dimensions at all areas prior to initiating demolition activities. Any potential interferences discovered during field verification shall be resolved with the Engineer.
- C. Note that all demolished concrete sections must be removed and may not be allowed to fall into the river. All lift calculations, anchors and rigging required to safely demolish and extract the existing concrete sections shall be included in this bid item.
- D. The work shall include: cutting the tops of the recently installed 12.75" diameter steel pipe piles, and the welding of cap plates on those piles; and temporarily removing the existing guard rail;

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temporarily removing one existing bollard and demolishing the other existing bollard.

### 2.27 Item No. 28 – Dynamically test 12.75" diameter pipe plumb pile

- A. The work shall consist of the surveying, layout, furnishing and testing of the 12.75" diameter pipe plumb pile, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 41 19, 02 46 00 and 09 96 67.
- B. The bid shall include all aspects of the pipe pile installation and testing, including: coring and/or cutting of holes through existing concrete and timber; furnishing, shop coating, and splicing the steel pile; dynamic testing and driving; installation of collar assembly, shear rod and hanger rods; touch up coating; and submission of test results and CAPWAP analyses.
- C. The contractor shall survey the existing timber and steel piles prior to cutting and coring holes for new piles. Should obstructions be found, whether prior to coring, or during setting and driving of the pile, the Contractor shall notify the Engineer and receive approval for proposed relocation of the new piles. No additional payment shall be made for such relocation.

### 2.28 Item No. 29 – Furnish and install 12.75" diameter pipe plumb pile

- A. The work shall consist of the surveying, layout, furnishing and installation of the 12.75" diameter pipe plumb piles to the drive criteria issued by the Engineer, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 41 19, 02 46 00 and 09 96 67.
- B. The bid shall include all aspects of the pipe pile installation, including: coring and/or cutting of holes through existing concrete and timber; furnishing, shop coating, and splicing the steel pile; installing the pile to drive criteria issued by the Engineer; installation of collar assembly, shear rod and hanger rods; and touch up coating.
- C. The contractor shall survey the existing timber and steel piles prior to cutting and coring holes for new piles. Should obstructions be found, whether prior to coring, or during setting and driving of the pile, the Contractor shall notify the Engineer and receive approval for proposed relocation of the new piles. No additional payment shall be made for such relocation.

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### 2.29 Item No. 30 – Pour new upriver apron low slab

- A. The work shall consist of the surveying, layout, furnishing, and installation of the new dowels and reinforcement; the providing, placing and curing of cast-in-place concrete; and all associated shoring, falsework, formwork, and other details required to complete the new concrete low deck between near column line 37 and the grade wall at column line 43, as shown in the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 03 10 00, 03 20 00, and 03 30 00.
- B. The Contractor shall field-verify existing conditions and dimensions prior to initiating forming. Any potential interferences discovered during field verification shall be resolved with the Engineer.
- C. The Contractor shall note that the existing timber low deck may require patching, reinforcement, and additional support in order to serve as formwork.
- D. The Bid shall include the costs of hiring a Professional Engineer licensed in the Commonwealth of PA to design all the formwork components, including investigating the ability of existing structural components, such as timber piles, to act as formwork or support formwork.
- E. All formwork materials shall remain the property of the Contractor and shall be removed from the site upon completion of the Contract work.
- F. The Bidder shall note that when scheduling concrete placement during cold weather, ACI cold weather concreting requirements must be strictly adhered to. The Bid shall include the cost of any anticipated measures needed for concreting in cold weather where anticipated. No additional payment will be made for procedures necessary to properly cure the concrete under cold weather conditions.

### 2.30 Item No. 31 – Pour new upriver apron interior wall

- A. The work shall consist of the surveying, layout, furnishing, and installation of the new dowels and reinforcement; the providing, placing and curing of cast-in-place concrete; and all associated shoring, falsework, formwork, and other details required to complete the new concrete interior wall between near column line 37 and the grade wall at column line 43, as shown in the Contract

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Drawings. Work shall be performed in accordance with Sections 01 73 00, 03 10 00, 03 20 00, and 03 30 00.

- B. The Contractor shall field-verify existing conditions and dimensions prior to initiating forming. Any potential interferences discovered during field verification shall be resolved with the Engineer.
  - C. The Bid shall include the costs of hiring a Professional Engineer licensed in the Commonwealth of PA to design all the formwork components, including investigating the ability of existing structural components, such as timber piles, to act as formwork or support formwork.
  - D. All formwork materials shall remain the property of the Contractor and shall be removed from the site upon completion of the Contract work.
  - E. The Bidder shall note that when scheduling concrete placement during cold weather, ACI cold weather concreting requirements must be strictly adhered to. The Bid shall include the cost of any anticipated measures needed for concreting in cold weather where anticipated. No additional payment will be made for procedures necessary to properly cure the concrete under cold weather conditions.
- 2.31 Item No. 32 – Pour new bollard interior concrete and reinstall bollard on upriver apron
- A. The work shall consist of the surveying, layout, furnishing, and installation of the new dowels. Reinforcement and bollard straps and anchors; the providing, placing and curing of cast-in-place concrete; and all associated shoring, falsework, formwork, and other details required to pour the concrete bollard anchor and replace the bollard at column line 42, as shown in the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 03 10 00, 03 20 00, 03 30 00, and 09 90 00.
  - B. The Contractor shall field-verify existing conditions and dimensions prior to initiating forming. Any potential interferences discovered during field verification shall be resolved with the Engineer.
  - C. The Bid shall include the costs of hiring a Professional Engineer licensed in the Commonwealth of PA to design all the formwork components, including investigating the ability of existing structural components, such as timber piles, to act as formwork or support formwork.

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- D. All formwork materials shall remain the property of the Contractor and shall be removed from the site upon completion of the Contract work.
- E. The Bidder shall note that when scheduling concrete placement during cold weather, ACI cold weather concreting requirements must be strictly adhered to. The Bid shall include the cost of any anticipated measures needed for concreting in cold weather where anticipated. No additional payment will be made for procedures necessary to properly cure the concrete under cold weather conditions.

### 2.32 Item No. 33 – Pour new upriver apron seawall

- A. The work shall consist of the surveying, layout, furnishing, and installation of the new dowels and reinforcement; the reinstallation of the existing guard rail; the providing, placing and curing of cast-in-place concrete; and all associated shoring, falsework, formwork, and other details required to complete the new concrete seawall between near column line 37 and the grade wall at column line 43, as shown in the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 03 10 00, 03 20 00, and 03 30 00.
- B. The Contractor shall field-verify existing conditions and dimensions prior to initiating forming. Any potential interferences discovered during field verification shall be resolved with the Engineer.
- C. The Bid shall include the costs of hiring a Professional Engineer licensed in the Commonwealth of PA to design all the formwork components, including investigating the ability of existing structural components, such as timber piles, to act as formwork or support formwork.
- D. All formwork materials shall remain the property of the Contractor and shall be removed from the site upon completion of the Contract work.
- E. The Bidder shall note that when scheduling concrete placement during cold weather, ACI cold weather concreting requirements must be strictly adhered to. The Bid shall include the cost of any anticipated measures needed for concreting in cold weather where anticipated. No additional payment will be made for procedures necessary to properly cure the concrete under cold weather conditions.

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### 2.33 Item No. 34 – Backfill with No. 57 clean stone

- A. The work shall consist of the surveying, furnishing, placing and minimally compacting No. 57 clean stone, as shown in the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, and 02 20 00.

### 2.34 Item No. 35 – Pour new upriver apron upper slab

- A. The work shall consist of the surveying, layout, furnishing, and installation of the new dowels and reinforcement; the providing, placing and curing of cast-in-place concrete; and all associated shoring, falsework, formwork, and other details required to complete the new concrete upper slab on the upriver apron between near column line 37 and the grade wall at column line 43, as shown in the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 03 10 00, 03 20 00, and 03 30 00.
- B. The Contractor shall field-verify existing conditions and dimensions prior to initiating forming. Any potential interferences discovered during field verification shall be resolved with the Engineer.
- C. All formwork materials shall remain the property of the Contractor and shall be removed from the site upon completion of the Contract work.
- D. The Bidder shall note that when scheduling concrete placement during cold weather, ACI cold weather concreting requirements must be strictly adhered to. The Bid shall include the cost of any anticipated measures needed for concreting in cold weather where anticipated. No additional payment will be made for procedures necessary to properly cure the concrete under cold weather conditions.

### 2.35 Item No. 36 - Demolition of upriver/outshore corner

- A. The work shall consist of the surveying, demolition, excavation and offsite disposal of: the concrete seawall and upper slab; the existing bollard; the existing fill; and the existing timber low deck at the upriver/outshore, as shown on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19 and 02 41 19.

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- B. The Contractor shall field-verify existing conditions, utilities and dimensions at all areas prior to initiating demolition activities. Any potential interferences discovered during field verification shall be resolved with the Engineer.
- C. The existing armor plate on the upriver/outshore corner shall be temporarily removed for reinstallation.
- D. Note that all demolished concrete sections must be removed and may not be allowed to fall into the river. All lift calculations, anchors and rigging required to safely demolish and extract the existing concrete sections shall be included in this bid item.

### 2.36 Item No. 37 – Dynamically test 16” diameter pipe Type “U” plumb pile

- A. The work shall consist of the surveying, layout, furnishing and testing of the 16” diameter pipe Type “U” plumb pile, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 41 19, 02 46 00 and 09 96 67.
- B. The bid shall include all aspects of the pipe pile installation and testing, including: coring and/or cutting of holes through existing concrete and timber; furnishing, shop coating, and splicing the steel pile; dynamic testing and driving; welding of uplift hooks, cap plates, connection plates and uplift plates; touch up coating; and submission of test results and CAPWAP analyses.
- C. The contractor shall survey the existing timber and steel piles prior to cutting and coring holes for new piles. Should obstructions be found, whether prior to coring, or during setting and driving of the pile, the Contractor shall notify the Engineer and receive approval for proposed relocation of the new piles. No additional payment shall be made for such relocation.

### 2.37 Item No. 38 – Dynamically test 16” diameter pipe batter pile

- A. The work shall consist of the surveying, layout, furnishing and testing of the 16” diameter pipe batter pile, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 41 19, 02 46 00 and 09 96 67.
- B. The bid shall include all aspects of the pipe pile installation and testing, including: coring and/or cutting of holes through existing concrete and timber; furnishing, shop coating, and splicing the steel pile; dynamic testing and driving; welding of, cap plates, connection

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plates and uplift plates; touch up coating; and submission of test results and CAPWAP analyses.

- C. The contractor shall survey the existing timber and steel piles prior to cutting and coring holes for new piles. Should obstructions be found, whether prior to coring, or during setting and driving of the pile, the Contractor shall notify the Engineer and receive approval for proposed relocation of the new piles. No additional payment shall be made for such relocation.

### 2.38 Item No. 39 – Furnish and install 16” diameter pipe Type “U” plumb pile

- A. The work shall consist of the surveying, layout, furnishing and installation of the 16” diameter pipe Type “U” plumb piles to the drive criteria issued by the Engineer, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 41 19, 02 46 00 and 09 96 67.
- B. The bid shall include all aspects of the pipe pile installation, including: coring and/or cutting of holes through existing concrete and timber; furnishing, shop coating, and splicing the steel pile; installing the pile to drive criteria issued by the Engineer; welding of uplift hooks, cap plates, connection plates and uplift plates; and touch up coating.
- C. The contractor shall survey the existing timber and steel piles prior to cutting and coring holes for new piles. Should obstructions be found, whether prior to coring, or during setting and driving of the pile, the Contractor shall notify the Engineer and receive approval for proposed relocation of the new piles. No additional payment shall be made for such relocation.

### 2.39 Item No. 40 – Furnish and install 16” diameter pipe batter pile

- A. The work shall consist of the surveying, layout, furnishing and installation of the 16” diameter pipe batter piles to the drive criteria issued by the Engineer, as indicated on the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, 02 41 19, 02 46 00 and 09 96 67.
- B. The bid shall include all aspects of the pipe pile installation, including: coring and/or cutting of holes through existing concrete and timber; furnishing, shop coating, and splicing the steel pile; installing the pile to drive criteria issued by the Engineer; welding of cap plates, connection plates and uplift plates; and touch up coating.

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- C. The contractor shall survey the existing timber and steel piles prior to cutting and coring holes for new piles. Should obstructions be found, whether prior to coring, or during setting and driving of the pile, the Contractor shall notify the Engineer and receive approval for proposed relocation of the new piles. No additional payment shall be made for such relocation.
- 2.40 Item No. 41 – Furnish and install new pipe bollard at upriver/outshore corner
- A. The work shall consist of the surveying, layout, furnishing, and installation of the new strap reinforcement and pipe bollard at the upriver/outshore corner, as shown in the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 03 10 00, 03 20 00, 03 30 00, 05 12 00, and 09 90 00.
  - B. The work shall include whatever temporary supports are required to secure the new bollard and straps within the upriver/outshore corner concrete pour.
- 2.41 Item No. 42 – Pour new mass concrete at upriver/outshore corner, north apron and outshore apron.
- A. The work shall consist of the surveying, layout, furnishing, and installation of the new dowels and reinforcement; the providing, placing and curing of cast-in-place concrete; and all associated shoring, falsework, formwork, and other details required to complete the new mass concrete beam/seawall between the grade wall at column line 43 on the outshore apron, through the upriver/outshore corner, to bent 1 on the outshore apron, as shown in the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 03 10 00, 03 20 00, and 03 30 00.
  - B. The Contractor shall field-verify existing conditions and dimensions prior to initiating forming. Any potential interferences discovered during field verification shall be resolved with the Engineer.
  - C. The work shall include the reinstallation of the corner armor plate, which may be used as formwork with the approval of the engineer.
  - D. The Bid shall include the costs of hiring a Professional Engineer licensed in the Commonwealth of PA to design all the formwork components, including investigating the ability of existing structural components, such as timber piles, to act as formwork or support formwork.

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- E. All formwork materials shall remain the property of the Contractor and shall be removed from the site upon completion of the Contract work.
- F. The Bidder shall note that when scheduling concrete placement during cold weather, ACI cold weather concreting requirements must be strictly adhered to. The Bid shall include the cost of any anticipated measures needed for concreting in cold weather where anticipated. No additional payment will be made for procedures necessary to properly cure the concrete under cold weather conditions.

### 2.42 Item No. 43 – Pour new lower slab at outshore apron

- A. The work shall consist of the surveying, layout, furnishing, and installation of the new dowels and reinforcement; the providing, placing and curing of cast-in-place concrete; and all associated shoring, falsework, formwork, and other details required to complete the new inshore lower slab at the outshore apron between outshore bent 1 and the upriver/outshore corner, as shown in the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 03 10 00, 03 20 00, and 03 30 00.
- B. The Contractor shall field-verify existing conditions and dimensions prior to initiating forming. Any potential interferences discovered during field verification shall be resolved with the Engineer.
- C. The Contractor shall note that the existing timber low deck may require patching, reinforcement, and additional support in order to serve as formwork.
- D. The Bid shall include the costs of hiring a Professional Engineer licensed in the Commonwealth of PA to design all the formwork components, including investigating the ability of existing structural components, such as timber piles, to act as formwork or support formwork.
- E. All formwork materials shall remain the property of the Contractor and shall be removed from the site upon completion of the Contract work.
- F. The Bidder shall note that when scheduling concrete placement during cold weather, ACI cold weather concreting requirements must be strictly adhered to. The Bid shall include the cost of any

## **SECTION 01 20 00 – PRICE & PAYMENT PROCEDURES**

anticipated measures needed for concreting in cold weather where anticipated. No additional payment will be made for procedures necessary to properly cure the concrete under cold weather conditions.

### 2.43 Item No. 44 – Pour new upper slab at outshore apron

- A. The work shall consist of the surveying, layout, furnishing, and installation of the new dowels and reinforcement; the providing, placing and curing of cast-in-place concrete; and all associated shoring, falsework, formwork, and other details required to complete the new inshore upper slab at the outshore apron between outshore bent 1 and the upriver/outshore corner, as shown in the Contract Drawings. Work shall be performed in accordance with Sections 01 73 00, 03 10 00, 03 20 00, and 03 30 00.
- B. The Contractor shall field-verify existing conditions and dimensions prior to initiating forming. Any potential interferences discovered during field verification shall be resolved with the Engineer.
- C. All formwork materials shall remain the property of the Contractor and shall be removed from the site upon completion of the Contract work.
- D. The Bidder shall note that when scheduling concrete placement during cold weather, ACI cold weather concreting requirements must be strictly adhered to. The Bid shall include the cost of any anticipated measures needed for concreting in cold weather where anticipated. No additional payment will be made for procedures necessary to properly cure the concrete under cold weather conditions.

### 2.44 Item No. 45 – Furnish and install bituminous stabilized base course

- A. The work shall consist of furnishing, installing and compacting the bituminous stabilized base course materials as indicated on the Contract Documents, including all incidental surface preparation necessary to receive the materials. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, and 02 64 50.

### 2.45 Item No. 46 – Furnish and install bituminous stabilized surface course

- A. The work shall consist of furnishing, installing and compacting the bituminous stabilized surface course materials as indicated on the Contract Documents, including all incidental surface preparation

**SECTION 01 20 00 – PRICE & PAYMENT PROCEDURES**

necessary to receive the materials. Work shall be performed in accordance with Sections 01 73 00, 01 74 19, and 02 64 50.

- END OF SECTION -

## SECTION 01 33 00 – SUBMITTAL PROCEDURES

### **PART 1: GENERAL**

#### 1.1 SCOPE

- A. The provisions of this section apply to the submittal of all information by the Contractor to the Engineer / Owner.

### **PART 2: PRODUCTS**

Not used.

### **PART 3: SUBMITTALS**

As specified in related sections.

### **PART 4: QUALITY ASSURANCE**

Not used.

### **PART 5: EXECUTION**

#### 5.1. SUBMITTAL PROCEDURES

- A. It is the Contractor's responsibility to make timely Submittals. The Contractor shall not initiate a construction activity prior to receiving ALL the submittals, reviewed by the Engineer, related to the construction activity, indicating an authorization to proceed with the construction activity. Any construction activity performed without this authorization shall be at Contractor's risk and cost. Delays arising due to the failure in making timely submittals shall be at Contractor's cost. The Contractor shall not be compensated for construction activities performed without the authorization of the Engineer.
- B. The Contractor shall submit a Submittal Log, documenting the list of submittals to be made during the project, prior to mobilization.
- C. Transmit each submittal with a letter of transmittal indicating the content of the submittal, quantity of submitted items and any special instructions.
- D. Submittals are to be sequentially numbered. Mark revised submittals with original number and sequential alphabetic suffix.

## **SECTION 01 33 00 – SUBMITTAL PROCEDURES**

- E. Identify Project, Contractor, Subcontractor and Supplier; pertinent drawing and detail number, and specification section number, appropriate to submittal.
- F. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents.
- G. Unless noted otherwise, or requested by the Engineer or Owner, all submittals shall be submitted digitally – whether by email or FTP server – to the Engineer and the owner. Upon review, the engineer will return submittals in digital format.
- I. For each submittal, allow for a 10-working-day review period excluding delivery time to and from Contractor, unless noted otherwise in the Contract document.
- K. Allow space on submittals for Contractor and Engineer review stamps.
- L. When revised for resubmission, identify changes made since previous submission.
- M. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.
- N. Submittals not requested will not be recognized or processed.
- O. No materials, supplies, equipment or labor shall be ordered for an item until the Engineer has reviewed the submittal.
- P. Contractor shall update the submittal log and submit to the Engineer every month at a minimum.

### 5.2. SUBMITTAL DATA

- A. Product Data: Submit to the Engineer, for the purpose of review and checking the conformance with information given and design concept expressed in Contract Documents. Provide appropriate number of copies and distribute in accordance with the section "Submittal Procedures".
- B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project. Record this information in the submittal matrix.

**SECTION 01 33 00 – SUBMITTAL PROCEDURES**

**END OF SECTION**

## SECTION 01 40 00 – QUALITY REQUIREMENTS

### **PART 1: GENERAL**

#### 1.1 SCOPE

- A. Quality control and control of installation.
- B. Tolerances.
- C. References.
- D. Examination.
- E. Operations.

### **PART 2: PRODUCTS**

Not used.

### **PART 3: SUBMITTALS**

Not used.

### **PART 4: QUALITY ASSURANCE**

As specified in related sections.

### **PART 5: EXECUTION**

#### 5.1. QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Prior to ordering any material, the Contractor is responsible to verify all material quantities and dimensions in the field.
- B. Contractor shall monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of contract specified quality.
- C. Contractor shall comply with manufacturers' instructions, including each step in sequence.
- D. When manufacturers' instructions conflict with Contract Documents, a request clarification, two weeks prior to needs, shall be submitted to the Engineer.

## **SECTION 01 40 00 – QUALITY REQUIREMENTS**

- E. Contractor shall have minimum of five (5) years of experience in performing similar work. Contractor shall use qualified employees to produce the contract specified quality.
- F. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

### 5.2. TOLERANCES

- A. Fabrication and installation tolerances shall be governed by the tolerances specified in applicable codes, standards, and contract documents. Monitor fabrication and installation tolerance control of products to produce acceptable work. Tolerances are non-additive.
- B. When tolerances mentioned in the contract document conflict with codes and standards, request a written clarification from the Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.
- D. For items found to be installed or manufactured out of the tolerance, the contractor shall remove and install an acceptable replacement at no additional cost to the Owner.

### 5.3. REFERENCES

- A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified by this contract or are required by applicable codes.
- B. Obtain copies of standards where required by product and contract specification sections.
- C. When specified reference standards conflict with Contract Documents, request clarification from the Engineer before proceeding.
- D. Neither the contractual relationships, duties, nor responsibilities of the parties to the Contract, shall be altered from the Contract Documents by mention or inference in reference documents. All changes, alterations and requirements of others shall be presented to the Engineer prior to initiation.

## **SECTION 01 40 00 – QUALITY REQUIREMENTS**

### 5.4. EXAMINATION

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Beginning new work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.

### 5.5. OPERATIONS

- A. The Contractor shall submit a schedule of work to the Owner as required by the Contract. Daily time sheets including men, equipment, and material received shall be presented at the conclusion of each working day.
- B. Construction and testing are to be scheduled to accommodate the berthing schedule of the Pier Owner or Lessee. At no time shall the arrival/departure of an incoming vessel be delayed due to construction and testing. A safe berthing facility must be provided at all times.
- C. Regular Progress Meetings will be held to update the status of the project. It is mandatory that the Contractor or Contractor's representative, empowered to engage in contract binding decisions, attend each meeting.
- D. The Contractor shall submit to the Owner and Engineer a copy of the updated work progress schedule for review and comments within 24 hours following each meeting.
- E. Continuous coordination with the project Construction Inspector and other Contractors is the responsibility of the Contractor. Failure to coordinate will not relieve the Contractor from his responsibilities.

**END OF SECTION**

## **SECTION 01 71 13 – MOBILIZATION & DEMOBILIZATION**

### **PART 1: GENERAL**

#### **1.1 SCOPE**

The work shall consist of the mobilization and demobilization of the Contractor's forces, equipment, and materials necessary for performing the work required under the contract.

Mobilization will not be considered as work in fulfilling the contract requirements for commencement of work.

### **PART 2: PRODUCTS**

The Contractor shall provide all equipment, materials, and labor required for this item.

### **PART 3: SUBMITTALS**

Not used.

### **PART 4: QUALITY ASSURANCE**

As specified in related sections.

### **PART 5: EXECUTION**

- A. Mobilization shall include all activities and associated costs for transportation and assembly of Contractor's personnel, equipment, and operating supplies to the site; establishment of offices and other necessary general facilities for the Contractor's operations at the site as required by the Specifications, as well as by Federal, State and/or local law and regulation. The determination of the adequacy of the Contractor's facilities, except for those required by government laws and regulations, shall be made by the Engineer. The cost of required bonds, insurance, permits and/or any other initial expenses required for the start of the work shall be included in this item.
- B. Demobilization shall include all activities and costs for transportation of personnel, equipment, and supplies not required or included in the contract from the site; including the disassembly, removal and site clean up, of offices, buildings and other facilities assembled on the site

## **SECTION 01 71 13 – MOBILIZATION & DEMOBILIZATION**

specifically for this contract. In addition, all storage areas and work areas shall be cleaned of all rubbish and discarded materials and left in a manner satisfactory to the Engineer. Any damage to the property of the Owner and/or any other property owner shall be repaired to the satisfaction of the Engineer at no additional cost to the Owner. The project will not be considered complete until the above work has been completed and accepted by the Engineer.

- C. This work includes mobilization and demobilization required by the contract at the time of award. If additional mobilization and demobilization activities and costs are required during the performance of the contract as a result of changed, deleted, or added items of work for which the Contractor is entitled to an adjustment in contract price, compensation for such costs will be included in the price adjustment for the item or items of work changed or added.

**END OF SECTION**

## SECTION 01 73 00 - EXECUTION

### **PART 1: GENERAL**

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

- 1. Construction Layout.
- 2. Field engineering and surveying.
- 3. Installation of the Work.
- 4. Cutting and patching.
- 5. Coordination of Owner-installed products.
- 6. Progress cleaning.
- 7. Starting and adjusting.
- 8. Protection of installed construction.

- B. Related Requirements:

- 1. Summary of Work Section 011100
- 2. Submittal Procedures Section 013300
- 3. Mobilization Section 017113
- 4. Selective Demolition Section 024119
- 5. As specifically described in other Sections.

#### 1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

#### 1.4 INFORMAL SUBMITTALS

- A. Landfill Receipts: submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- B. Final property Survey: Submit electronic (CAD & PDF) copies showing the Work performed and record survey data.

## SECTION 01 73 00 - EXECUTION

### **PART 2: PRODUCTS**

General: Comply with requirements specified in other Sections.

### **PART 3: SUBMITTALS**

#### **3.1. REQUIRED SUBMITTALS**

- A. Landfill Receipts: submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- B. Final property Survey: Submit electronic (CAD & PDF) copies showing the Work performed and record survey data.
- C. As specified in Related Sections.
- D. As specified in the Contract Drawings.
- E. Other Submittals requested by the Owner or Engineer.

### **PART 4: QUALITY ASSURANCE**

- 4.1. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in the Commonwealth of Pennsylvania and who is experienced in providing land-surveying services of the kind indicated.
- 4.2. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
  - A. Structural Elements: When cutting and patching structural elements that are not specifically addressed on the Contract Drawings, notify the Engineer of the locations and details of cutting and await directions from the Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching.
  - B. Operational Elements: Unless specifically directed by the Contract Drawings, do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements may include the following:
    - 1. Primary operational systems and equipment.

## SECTION 01 73 00 - EXECUTION

2. Fire separation assemblies.
3. Air or smoke barriers.
4. Fire-suppression systems.
5. Mechanical systems piping and ducts.
6. Control systems.
7. Communication systems.
8. Fire-detection and -alarm systems.
9. Conveying systems.
10. Electrical wiring systems.
11. Operating systems of special construction.

C. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:

1. Water, moisture, or vapor barriers.
2. Membranes and flashings.
3. Exterior curtain-wall construction.
4. Sprayed fire-resistive material.
5. Equipment supports.
6. Piping, ductwork, vessels, and equipment.
7. Noise- and vibration-control elements and systems.

D. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

4.3. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

4.4. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

## **PART 5: EXECUTION**

## SECTION 01 73 00 - EXECUTION

### 5.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, and other construction affecting the Work.
  - 1. Before construction, verify the location and invert elevation at points of connection of storm sewer and water-service piping; underground electrical services, and other utilities.
  - 2. Furnish location data for work related to the Project that must be performed by public utilities serving the Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
  - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### 5.2 PREPARATION

- A. Existing Utility Information: Furnish information that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

## SECTION 01 73 00 - EXECUTION

- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Section 013100 "Project Management and Coordination."

### 5.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify the Engineer promptly.
- B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by the Engineer.

### 5.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.

## **SECTION 01 73 00 - EXECUTION**

1. Do not change or relocate existing benchmarks or control points without prior written approval of Engineer. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to the Engineer before proceeding.
  2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on the Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
  2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
  3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Final Property Survey: Engage a land surveyor to prepare a final property survey showing significant features (real property) for the Project. Include on the survey a certification, signed by the land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
  2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

### **5.5 INSTALLATION**

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
1. Make vertical work plumb and make horizontal work level.

## SECTION 01 73 00 - EXECUTION

2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- G. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
  2. Allow for building movement, including thermal expansion and contraction.
  3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

## SECTION 01 73 00 - EXECUTION

- I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

### 5.6 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
- B. Temporary Support: Provide temporary support of work to be cut.
- C. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- D. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
  1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  3. Concrete: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
  5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  6. Proceed with patching after construction operations requiring cutting are complete.

## SECTION 01 73 00 - EXECUTION

- E. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
  2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
    - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    - b. Restore damaged pipe covering to its original condition.
  3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
  4. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- F. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

### 5.7 OWNER-INSTALLED PRODUCTS

- A. Site Access: Provide access to Project site for Owner's construction personnel.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.
1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.

## SECTION 01 73 00 - EXECUTION

2. Pre-installation Conferences: Include Owner's construction personnel at pre-installation conferences covering portions of the Work that are to receive Owner's work. Attend pre-installation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

### 5.8 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
  1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
  2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
  3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations. Use containers intended for holding waste materials of type to be stored.
  4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
  1. Remove liquid spills promptly.
  2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

## SECTION 01 73 00 - EXECUTION

- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements of other Sections as applicable.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

### 5.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion..
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

**- END OF SECTION -**

## SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT & DISPOSAL

### **PART 1 - GENERAL**

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
  - 1. Salvaging nonhazardous demolition and construction waste.
  - 2. Recycling nonhazardous demolition and construction waste.
  - 3. Disposing of nonhazardous demolition and construction waste.
- B. Related Requirements:
  - 1. Section 024119 "Selective Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements, and for disposition of hazardous waste.

#### 1.3 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

## **SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT & DISPOSAL**

### **PART 2 - PRODUCTS**

Not Used.

### **PART 3 - SUBMITTALS**

#### **3.1 ACTION SUBMITTALS**

- A. Waste Management Plan: Submit plan within 10 days of date established for the Notice to Proceed.
  - 1. Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
  - 2. Outdoor stockpiling of excavated materials will not be permitted without the prior approval of the Engineer.
- B. Details and products to be implemented for Erosion & Sediment Control.

#### **3.2 INFORMATIONAL SUBMITTALS**

- A. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- B. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- C. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

### **PART 4 - QUALITY ASSURANCE**

#### **4.1 PERFORMANCE REQUIREMENTS**

- A. General: Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:
  - 1. Demolition Waste:
    - a. Asphalt paving.

## SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT & DISPOSAL

- b. Concrete.
- c. Concrete reinforcing steel.
- d. Brick.
- e. Concrete masonry units.
- f. Wood studs.
- g. Wood joists.
- h. Plywood and oriented strand board.
- i. Wood paneling.
- j. Wood trim.
- k. Structural and miscellaneous steel.
- l. Rough hardware.
- m. Roofing.
- n. Insulation.
- o. Doors and frames.
- p. Door hardware.
- q. Windows.
- r. Glazing.
- s. Metal studs.
- t. Gypsum board.
- u. Acoustical tile and panels.
- v. Carpet.
- w. Carpet pad.
- x. Demountable partitions.
- y. Equipment.
- z. Cabinets.
- aa. Plumbing fixtures.
- bb. Piping.
- cc. Supports and hangers.
- dd. Valves.
- ee. Sprinklers.
- ff. Mechanical equipment.
- gg. Refrigerants.
- hh. Electrical conduit.
- ii. Copper wiring.
- jj. Lighting fixtures.
- kk. Lamps.
- ll. Ballasts.
- mm. Electrical devices.
- nn. Switchgear and panelboards.
- oo. Transformers.

### 2. Construction Waste:

- a. Masonry and CMU.
- b. Lumber.
- c. Wood sheet materials.

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- d. Wood trim.
- e. Metals.
- f. Roofing.
- g. Insulation.
- h. Carpet and pad.
- i. Gypsum board.
- j. Piping.
- k. Electrical conduit.
- l. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:
  - 1) Paper.
  - 2) Cardboard.
  - 3) Boxes.
  - 4) Plastic sheet and film.
  - 5) Polystyrene packaging.
  - 6) Wood crates.
  - 7) Plastic pails.

### 4.2 REGULATORY REQUIREMENTS

- A. Comply with hauling and disposal regulations of authorities having jurisdiction.

### 4.3 WASTE MANAGEMENT CONFERENCE

- A. Review methods and procedures related to waste management including, but not limited to, the following:
  - 1. Review and discuss waste management plan including responsibilities of waste management coordinator.
  - 2. Review requirements for documenting quantities of each type of waste and its disposition.
  - 3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
  - 4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
  - 5. Review waste management requirements for each trade.

## SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT & DISPOSAL

### PART 5 - EXECUTION

#### 5.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
- B. The contractor shall contact the PA-One Call System 3 to 10 days before initiating work at 800-242-1776.
- C. Protect existing aboveground and underground utilities, structures, foundations, and equipment during excavation and other operations.
- D. Take all necessary precautions for the safety and protection of the terminal employees, construction crew, and other personnel. Install and maintain barriers, fences, planking, and warning signs at the demolition site, as necessary, during construction.
- E. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
  - 1. Distribute waste management plan to everyone concerned within 3 days of submittal return.
  - 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- F. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
  - 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.

#### 5.2 PERFORMING WORK

- A. All work shall be performed in a manner that does not interfere with the terminal's daily operations. The Contractor shall notify the Owner of his schedule before beginning the demolition to allow the Owner to take appropriate measures.
- B. The Contractor shall field verify the location of any existing utilities and mark the ground or deck surface in the appropriate utility color. If an interference

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with the existing utilities is expected during the demolition / excavation work, such interference shall be brought to the attention of the Owner and the Engineer before the commencement of the work.

- C. Interfering utilities shall be temporarily relocated by the Contractor. These utilities shall be installed at the original location after the completion of the construction work. The price to perform such work shall be included in the bid by the Contractor.
- D. Should any utility or service line be disrupted or otherwise damaged, arrange for the immediate restoration of service, or temporary service until substantial and proper corrective repairs and/or replacement can be made. Immediately inform the Owner, the Engineer, and the utility company. Provide a written statement of the occurrence within 24 hrs to the Owner and the Engineer.
- E. Where an existing utility, service, equipment, or facility is damaged, the same shall be repaired to its original condition at no cost to the Owner.
- F. The demolition shall be performed as shown on the construction drawings and in conformance with the Contractor's reviewed submittals.
- G. Dispose and record all extracted material, which is not to be reused or saved by the Owner, off the site in accordance with all Federal, State and local laws and regulations unless otherwise specified elsewhere in the Contract Documents or Plans.
- H. The Contractor is solely responsible for the safety of personnel and terminal property during demolition operations.

### **5.3 RECYCLING DEMOLITION WASTE**

- A. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.
- B. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
- C. Metals: Separate metals by type.
  - 1. Structural Steel: Stack members according to size, type of member, and length.
  - 2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

### **5.4 DISPOSAL OF WASTE**

## **SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT & DISPOSAL**

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
  - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
  - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.
- C. Disposal: Remove waste materials from Owner's property and legally dispose of them.

**- END OF SECTION -**

## **SECTION 02 41 00 – DEMOLITION**

### **PART 1: GENERAL**

#### 1.1. SCOPE

- A. This section includes demolition and extraction of piles required for the work shown on contract drawings.

### **PART 2: PRODUCTS**

Not used.

### **PART 3: SUBMITTALS**

- A. Contractor shall submit a demolition plan describing the means and methods of demolition, and a protection plan describing the fencing, barriers, floating boom installation, and lighting 3 weeks prior to need.

### **PART 4: QUALITY ASSURANCE**

Not used.

### **PART 5: EXECUTION**

#### 5.1. PROTECTION

- A. Protect existing above ground and underground utilities, structures, foundations, and equipment during excavation and other operations.
- B. Take all necessary precautions for the safety and protection of the terminal employees, construction crew and other personnel. Install and maintain barriers, fence, planking, and warning signs at the demolition site, as necessary, during the construction.
- C. All work shall be performed in a manner that does not interfere with the terminal daily operations. Contractor shall notify the Owner of his schedule a minimum of two (2) weeks before beginning the demolition to allow the Owner to take appropriate measures.

## **SECTION 02 41 00 – DEMOLITION**

- D. The contractor shall field verify the location of any existing utilities and mark the deck surface in the appropriate utility color. If an interference with the existing utilities is expected during the work, such interference shall be notified to the Owner and the Engineer before the commencement of demolition.
- E. Interfering utilities shall be temporarily relocated by the Contractor. These utilities shall be re-installed at the original location after the completion of the construction work. Price to perform such work shall be included in the bid by the Contractor.
- F. Should any utility or service line be disrupted or otherwise damaged, arrange for the immediate restoration of the temporary service until substantial and proper corrective repairs and/or replacement can be made. Immediately inform the Owner, the Engineer, and the utility company. Provide a written statement of the occurrence within 24 hrs to the Owner and the Engineer.
- G. Where an existing utility, service, equipment, or facility is damaged, the same shall be repaired to its original condition at no cost to the Owner.
- H. The demolition shall be performed as shown on the construction drawings and in conformance with the Contractor's reviewed submittals.
- I. Contractor shall keep a record of all demolished structures, including information on the location, quantity and state of all demolished material. Upon request, the Contractor shall submit drawings showing the location, orientation, condition, and method of extraction for all demolished piles.
- J. Contractor is solely responsible for the safety of personnel and terminal property during demolition operations.
- K. Dispose and record all extracted material off the site in accordance with all Federal, State and local laws and regulations.

**END OF SECTION**

## SECTION 02 41 19 – SELECTIVE DEMOLITION

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Demolition and removal of selected portions of building or structure.
  - 2. Demolition and removal of selected site elements.
  - 3. Salvage of existing items to be reused or recycled.
- B. Related Requirements:
  - 1. Section 01 11 00 "Scope of Work" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.
  - 2. Section 01 73 00 "Execution" for cutting and patching procedures.

#### **1.3 DEFINITIONS**

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

#### **1.4 MATERIALS OWNERSHIP**

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

## SECTION 02 41 19 – SELECTIVE DEMOLITION

### **PART 2 - PRODUCTS**

Not Used.

### **PART 3 - SUBMITTALS**

#### **3.1 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For refrigerant recovery technician.
- B. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.
  - 1. Include a procedure to collect and/or prevent debris from falling into the water during demolition.
- C. Schedule of Selective Demolition Activities: Indicate the following:
  - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's building managers and other tenants' on-site operations are uninterrupted.
  - 2. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

### **PART 4 - QUALITY ASSURANCE**

#### **4.1 PERFORMANCE REQUIREMENTS**

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

### **PART 5 - EXECUTION**

#### **5.1 FIELD CONDITIONS**

## SECTION 02 41 19 – SELECTIVE DEMOLITION

- A. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- B. Hazardous Materials:
  - 1. It is not anticipated that hazardous materials are present in the demolition area.
  - 2. If suspected hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.
- C. On-site storage or sale of removed items or materials is not permitted.
- D. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
  - 1. Maintain fire-protection facilities not to be demolished or relocated in service during selective demolition operations.

### 5.2 PREINSTALLATION MEETINGS

- A. Pre-demolition Conference: Conduct conference at Project site or at Philadelphia Regional Port Authority Headquarters.
  - 1. Inspect and discuss condition of construction to be selectively demolished.
  - 2. Review structural load limitations of existing structure.
  - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
  - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
  - 5. Review areas where existing construction is to remain and requires protection.

### 5.3 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

## SECTION 02 41 19 – SELECTIVE DEMOLITION

- B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.
- C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Engineer.

### 5.4 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
  - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
  - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
  - 1. Strengthen or add new supports when required during progress of selective demolition.

### 5.5 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to

## **SECTION 02 41 19 – SELECTIVE DEMOLITION**

complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."

### **B. Removed and Reinstalled Items:**

1. Clean and repair items to functional condition adequate for intended reuse.

## SECTION 02 41 19 – SELECTIVE DEMOLITION

2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

### C. Existing features to remain:

1. Care must be taken during demolition to prevent damage to existing features that shall remain. Any damage to existing features, such as the timber deck or concrete foundations, shall be repaired by the Contractor at no additional cost to the owner. The repairs shall restore the original capacity of the damaged element, and be acceptable to the Engineer and Owner

## 5.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
- B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.

## 5.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
  1. Do not allow demolished materials to accumulate on-site.
  2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

## **SECTION 02 41 19 – SELECTIVE DEMOLITION**

4. Comply with requirements specified in Section 01 74 19 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

### 5.8 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

### 5.9 SELECTIVE DEMOLITION SCHEDULE

A. Existing Items and Construction to Be Removed:

1. Loading Dock
2. Loading Dock Wall
3. Portion of Rail Deck
4. Portion of Seawall

**- END OF SECTION -**

## SECTION 03 10 00 – CONCRETE FORMS & ACCESORIES

### **PART 1: GENERAL**

#### 1.01 SCOPE

- A. All labor, materials, services, and equipment necessary for furnishing, installing, and removing all formwork for cast-in-place concrete.

### **PART 2: PRODUCTS**

#### 2.01 MATERIALS

- A. Plywood: Exterior-type softwood plywood, PS 1-66.
- B. Glass Fiber Fabric-Reinforced Plastic Forms: Shall be matched, tight fitting, stiffened to support the weight of wet concrete without deflections that exceed the structural tolerances or that are detrimental to the appearance of the finished concrete.
- C. Lumber: Softwood framing lumber, PS 20-70. Grade markings shall be clearly visible and marked by grading rules approved by the American Lumber Standards Committee.
- D. Steel: Minimum 16 gauge sheet, well matched, tight fitting, stiffened to support the weight of wet concrete without deflections that exceed the structural tolerances or that are detrimental to the appearances of the finished concrete.
- A. Void Forms: Shall be moisture-resistant treated paper faces, seamless, laminated fiber material as approved by the Construction Manager. The forms shall be structurally sufficient to support the weight of a wet concrete mix and any construction or consolidation vibrations until the initial set.

#### 2.02 FORMWORK ACCESSORIES

- A. Form ties shall be left in place and equipped with swaged (waterproofing) washers or other approved devices to prevent seepage of moisture along the tie.
  - 1. Minimum 1-inch depth of breakback.
- B. Form release agent shall be a colorless material which will not stain concrete; absorb moisture; or impair finish, bonding, or color characteristics of coating intended for use on concrete.

## **SECTION 03 10 00 – CONCRETE FORMS & ACCESORIES**

- C. Fillets shall be used for all exposed vertical and horizontal corners.

### **PART 3: SUBMITTALS**

#### **3.01 GENERAL**

The Contractor shall submit the following items in accordance with Section 013300, Submittal Procedures.

- A. Shop Drawings shall be prepared and submitted, and shall meet the requirements of ACI 315 “Details and Detailing of Concrete Reinforcement”
- B. Shop Drawings must be submitted that show in detail the items of the form system affecting the appearance of architectural concrete surfaces such as joints, tie holes, liners, patterns, and textures. Items must be shown in relation to the entire form system.
- C. Manufacturers’ literature must be submitted with descriptions and recommended installation instructions for form ties, spreaders, corner formers, form liners, and form coatings.
- D. Submittals shall indicate pertinent dimensions, materials, and arrangement of joints and ties.
- E. The following field samples shall be submitted, upon request:
  - 1. Field samples of formed concrete must be submitted when the surface of the concrete is to receive a special architectural treatment.
  - 2. Construct and erect a sample formwork panel for architectural concrete surfaces receiving special treatment or finish as a result of formwork. Formwork shall include a vertical and a horizontal form joint.

### **PART 4: QUALITY ASSURANCE**

#### **4.01 REFERENCES**

The publications listed below form a part of these Specifications to the extent referenced. The publications are referred to in text by the basic description only.

- A. American Concrete Institute (ACI) 301 - Specifications for Structural Concrete for Buildings.

## **SECTION 03 10 00 – CONCRETE FORMS & ACCESORIES**

- B. ACI 347 - Recommended Practice for Concrete Formwork.
- C. ACI 306R - Cold Weather Concreting
- D. Product Standard (PS) 1 - Construction and Industrial Plywood.

### 4.02 QUALITY CONTROL

- A. The Contractor shall be responsible for designing and constructing suitable and adequate false work which shall be designed in accordance with ACI 347 "Recommended Practice for Concrete Formwork." When requested by the Owner or Engineer, formwork shall be designed and sealed by a Professional Engineer registered in the state of Pennsylvania.
- B. The design of forms will take into account the effect of construction loads during and after placement of concrete.
- C. The forms shall be substantial, unyielding, and constructed mortar-tight and of sufficient rigidity to prevent distortion due to the pressures of concrete and other loads incidental to the construction operations.

## **PART 5: EXECUTION**

### 5.01 SYSTEM DESCRIPTION

- A. Design, engineer, and construct formwork, shoring, and bracing to meet design and all applicable code requirements so that the resultant concrete conforms to the required shapes, lines and dimensions as shown on the Drawings.

### 5.02 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials with care to prevent damage to or contamination of formwork.

### 5.03 INSPECTION

- A. Verify lines, levels, and measurements before proceeding with formwork.
- B. Notice shall be given 24 hours in advance of pour so that an inspection can be scheduled.
- C. Forms shall be inspected by the Construction Manager prior to concreting.

## SECTION 03 10 00 – CONCRETE FORMS & ACCESORIES

- D. No concreting shall be done in the absence of the Construction Manager without the written permission of the Construction Manager.

### 5.04 PREPARATION

- A. Conform to ACI 347, except as specified herein.
- B. Initially and before re-use, forms shall be cleaned and a coat of non-staining form release agent applied per the manufacturer's instructions.
  - 1. Care shall be taken to avoid splashing oil on reinforcing steel or existing concrete.
  - 2. Do not apply form release agent where concrete surfaces are scheduled to receive special finishes which may be affected by agent.

### 5.05 ERECTION

- A. Provide bracing to ensure stability of formwork. Strengthen all formwork liable to be overstressed by construction loads.
- B. Camber slabs and beams to achieve ACI 301 tolerances.
  - 1. ¼-inch in 15 feet of span.
- C. Provide temporary ports in formwork to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain. Close ports with tight fitting panels, flush with inside face of forms, neatly fitted so that joints will not be apparent in exposed concrete surfaces.
- D. All form joints shall be backed up to assure that the edges of abutting panels are in the same plane, straight and true, and forced tightly together to minimize fins. The quality of the form contact surfaces shall be subject to the approval of the Construction Manager.
- E. If installing void forms, protect them from moisture before concrete placement and protect from crushing during concrete placement.
- F. Do not displace or damage vapor barriers previously placed.
- G. Forms for exposed concrete shall be given special attention to provide a surface free from defects and form marks so that rubbing and finishing shall be kept to a minimum.
- H. Construct formwork to maintain tolerances in accordance with ACI 301.

**SECTION 03 10 00 – CONCRETE FORMS & ACCESORIES**

5.06 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for Work embedded in or passing through concrete.
- B. Coordinate Work of other sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.
- C. Install accessories in accordance with manufacturer's instructions, level and plumb. Ensure items are not disturbed during concrete placement.

5.07 COLD WEATHER CONCRETING

- A. The Contractor shall adhere to the requirements of ACI 306R "Cold Weather Concreting".
- B. All materials that are to come into contact with freshly cast concrete must have a temperature above freezing at the time of concrete pour. The Contractor shall make a pertinent effort to schedule the concrete pour on a day with temperatures in excess of 40 degrees Fahrenheit, based on the weather forecast. When not possible to schedule the pour when ambient temperatures are above freezing, it may be required to preheat the formwork, reinforcement & inserts immediately prior to pouring concrete.

5.08 FORM REMOVAL

- A. Do not remove forms and shoring or bracing until concrete has sufficient strength to support its own weight, and construction and design loads which may be imposed upon it.
- B. The following schedule shall be considered the minimum period before formwork can be removed under normal conditions with the use of Type II cement. Its use shall not relieve the Contractor of responsibility for the safety and appearance of the structure.

Type of Form	Above 60 °F	50-60 °F	40-50 °F
Columns 5' high	24 hours	36 hours	72 hours
Columns 5'-10' high	3 days	5 days	7 days
Columns 10' high	5 days	7 days	10 days
Walls 5'	24 hours	36 hours	72 hours

**SECTION 03 10 00 – CONCRETE FORMS & ACCESORIES**

Walls 5-10'	3 days	5 days	7 days
Walls 10'	5 days	7 days	10 days
Beam Side Forms	24 hours	36 hours	72 hours
Beam Bottom Forms		14 days	18 days 21 days
Slabs 6' Span*	5 days	7 days	14 days
Construction Joint	24 hours	36 hours	72 hours
Bulk Heads	24 hours	36 hours	72 hours

\* For slabs of more than 6-foot span, add 12 hours for each additional foot over 5 feet.

1. When the temperature to which the forms or concrete surfaces are exposed to falls below 40 degrees F, the forms shall remain in place an additional time equal to the time of the sub-40 degrees F exposure. If form insulation is used, concrete surface temperature shall apply.
  2. The Construction Manager may modify the form removal schedule if compressive tests indicate that the in-place concrete is of sufficient strength. Methods of field curing the cylinders shall simulate that of the concrete and shall be approved by the Construction Manager. All such tests shall be at the option and expense of the Contractor at no additional cost to the Owner.
  3. When Type III cement or retarders are used, the form removal schedule above does not apply and may be modified by the Construction Manager.
- C. Immediately following the removal of the forms, the projecting ties shall be removed and all holes filled with grout flush with the wall. Care shall be taken to use the same brand of cement and same mix proportions used in the wall to prevent color differences.

**5.09 CLEANING**

- A. Clean forms to remove foreign matter as erection proceeds.
- B. Ensure that water and debris drain to exterior through clean-out ports.

**SECTION 03 10 00 – CONCRETE FORMS & ACCESORIES**

- C. During cold weather, remove ice and snow from forms. Do not use deicing salts. Do not use water to clean out completed forms unless formwork and construction proceed within heated enclosure. Use compressed air to remove foreign matter.

**- END OF SECTION -**

## SECTION 03 20 00 – CONCRETE REINFORCEMENT

### **PART 1 - GENERAL**

#### 1.01 WORK SPECIFIED

- A. Provide all labor, materials, equipment, and services necessary for furnishing and installing all steel reinforcement, welded steel wire fabric, and accessories for concrete required for the completion of the Work.

### **PART 2 - PRODUCTS**

#### 2.01 MATERIALS

- A. Reinforcing Steel:
  - a. General Applications: ASTM A615, 60 ksi yield grade billet-steel deformed bars, uncoated finish.
  - b. Welding Applications: ASTM A706, 60 ksi yield grade billet-steel deformed bars, uncoated finish,
- B. Welded Steel Wire Fabric: ASTM A185 plain type; in flat sheets, coiled rolls, uncoated finish.
- C. Stirrup Steel: ASTM A82.

#### 2.02 ACCESSORY MATERIALS

- A. Tie Wire: Minimum 16 gage annealed type.
- B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during installation and placement of concrete, including load bearing pad on bottom to prevent vapor barrier puncture.
- C. Chairs, Bolsters, Bar Supports, Spacers Adjacent to Architectural Concrete Surfaces: Plastic tipped-type, sized and shaped as required.

#### 2.03 FABRICATION

- A. Unless otherwise shown or directed, the following minimum concrete cover shall be provided for reinforcement.

	<u>Minimum Cover (inches)</u>
1. Concrete cast against and permanently exposed to earth	3

## SECTION 03 20 00 – CONCRETE REINFORCEMENT

2. Concrete exposed to earth or weather:
- |                          |      |
|--------------------------|------|
| No. 6 through No. 18 bar | 2    |
| No. 5 bar and smaller    | 1-1½ |

3. Concrete not exposed to weather or in contact with ground

Slabs, nails, joists:

- |                        |    |
|------------------------|----|
| No. 14 and No. 18 bars | 1½ |
| No. 11 and smaller     | ¾  |

Beams, columns:

- Primary reinforcement, ties, stirrups, spirals 1½

4. Concrete exposed to water or sewerage slabs, walls 2

- B. Locate reinforcing splices not indicated on Drawings at points of minimum stress. Indicate the proposed location of splices on the Shop Drawings for approval. Splices shall be staggered such that adjacent bars located in the same plane of reinforcement are not lapped at the same location. The projecting ends of horizontal bars that extend across construction joints shall be furnished at different lengths, such that in no place will laps in adjoining bars occur in the same plane.
- C. Unless noted otherwise, longitudinal reinforcing shall be closed off at end faces and cold joints of all concrete elements by 90 degree bends, U-stirrups, or some other engineer-approved method such that the faces of the element normal to the longitudinal reinforcing are laterally reinforced against cracking. In all cases, the lateral reinforcement shall be adequately developed or lapped with the longitudinal reinforcing. This provision may not apply where longitudinal reinforcing is continued across the plane of construction joints.

### **PART 3: SUBMITTALS**

#### **3.01 GENERAL**

The Contractor shall submit the following items, in accordance with Section 013300:

- A. Shop Drawings that indicate sizes, spacings, locations, and quantities of reinforcing steel, wire fabric, bending and cutting schedules, splicing, stirrup spacing, supporting, and spacing devices.

## SECTION 03 20 00 – CONCRETE REINFORCEMENT

- B. Mill test certificates of supplied concrete reinforcing indicating physical and chemical analysis.

### **PART 4: QUALITY ASSURANCE**

#### 4.01 REFERENCES

- A. American Concrete Institute (ACI)
  - 1. 301 Specifications for Structural Concrete for Buildings.
  - 2. 315 Details and Detailing of Concrete Reinforcement.
  - 3. 315R Manual of Engineering and Placing Drawings for Reinforced Concrete Structures.
  - 4. 318 Building Code Requirements for Reinforced Concrete.
- B. American Society for Testing and Materials (ASTM)
  - 1. A185 Welded Steel Wire Fabric for Concrete Reinforcement.
  - 2. A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
  - 3. A706 Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
  - 3. E329 Recommended Practice for Inspection Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction.
- C. Concrete Reinforcing Steel Institute (CRSI)
  - 1. CRSI Manual of Practice.
  - 2. 63 Recommended Practice for Placing Reinforcing Bars.
  - 3. 65 Recommended Practice for Placing Bar Supports, Specifications and Nomenclature.
- D. American Welding Society (AWS)
  - 1. D1.4 Reinforcing Steel Welding Code for Reinforcing Steel.

## **SECTION 03 20 00 – CONCRETE REINFORCEMENT**

### 4.02 QUALITY CONTROL

- A. Perform concrete reinforcement Work in accordance with referenced Standards.

## **PART 5: EXECUTION**

### 5.01 INSTALLATION

- A. Before placing concrete, clean reinforcement of foreign particles or coatings.
- B. Place, support, and secure reinforcement against displacement. Do not deviate from alignment or measurement.
- C. Do not displace or damage vapor barrier, if required.
- D. The Contractor shall follow the requirements of ACI 306R "Cold Weather Concreting" when applicable.
- E. Do not flame-cut rebar.

**- END OF SECTION -**

## SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

### **PART 1: GENERAL**

#### 1.01 SCOPE

- A. Provisions of this section apply to furnishing and placing all cast-in-place cement concrete indicated on the Drawings, described in these Specifications or otherwise required for proper completion of the Work.
- B. This section does not include pre-cast, post-tensioned or pre-stressed concrete work.

### **PART 2: PRODUCTS**

#### 2.01 MATERIALS

- A. Cement & Cementitious Materials
  - 1. ASTM C 150, Portland Cement - Type II except as modified herein. The blended cement shall consist of a mixture of ASTM C 150, Type II, and ASTM C 618 Type F or C pozzolan or fly ash. The pozzolan or fly ash content shall not exceed 25% by weight of the total cementitious material. Use one manufacturer for each type of cement, fly ash, and pozzolan.
- B. Admixtures
  - 1. When required or permitted, use admixtures conforming to the following specifications:
    - a. Air Entertaining - ASTM C260
    - b. Water Reducing, Retarding and Accelerating - ASTM C494.
- C. Water
  - 1. Water used in the mix shall conform to the requirements specified in ASTM C1602.
- D. Aggregates
  - 1. Maximum nominal size of aggregate shall be  $\frac{3}{4}$  inch, unless stated otherwise on the contract drawings, and shall conform to the requirements specified in ASTM C33. Regard fine and coarse aggregates as separate ingredients. Conform to the appropriate

## **SECTION 03 30 00 - CAST-IN-PLACE CONCRETE**

grading requirements for each size of coarse aggregate, as well as the combination of sizes when two or more are used.

- E. Curing Materials
  - 1. Waterproof Sheets
    - a. Conform to the requirements specified in ASTM C171.
  - 2. Liquid Membrane Forming Compounds
    - a. Conform to the requirements specified in ASTM C309.
- F. Expansion Joint Filler
  - 1. Conform to the requirements specified in ASTM D1751.

### **PART 3: SUBMITTALS**

3.01 The Contractor shall submit the following for approval in accordance with the Contract:

- A. Submit shop drawings of proposed construction two (2) weeks prior to fabrication of reinforcement. Shop drawings shall contain the following:
  - 1. Meet requirements of applicable portions of "Details and Detailing of Concrete Reinforcement" by ACI 315, latest edition.
  - 2. Show bending, assembly, splicing, sizes, bar lengths, and marking of bars. Indicate bar spacing by dimension.
  - 3. Show reinforcing with necessary details in elevations, sections and plans. Locate sleeves, holes, accessories, and anchors by dimensions.
  - 4. Furnish prints of approved shop drawings to trades that have items to be embedded in, or connected to concrete work.
- B. Submit a plan showing the location and details of proposed construction joints two (2) weeks prior to fabrication of reinforcement.
- C. Submit data on proposed concrete admixtures thirty (30) days before concrete placement.

## **SECTION 03 30 00 - CAST-IN-PLACE CONCRETE**

- D. Submit Samples of materials as requested by the Engineer, including names, sources, and descriptions.
- E. Submit a brief plan stating the proposed method of pouring and testing concrete, providing details on site access for delivery trucks, staging area, means of conveyance, washout locations, testing and cylinder curing locations, and proposed curing procedures thirty (30) days before concrete placement.
- F. Submit proposed concrete mix design and supporting laboratory test reports for concrete materials and mix design test for approval thirty (30) days before concrete placement. Provide materials certificates in lieu of materials laboratory test reports. Materials certificates shall be signed by the manufacturer and contractor, certifying that each material item complies with, or exceeds specified requirements.
- G. Submit results of strength tests for samples taken at site within ten (10) days after test is completed

### **PART 4: QUALITY ASSURANCE**

#### **4.01 CODES, STANDARDS & PROVISIONS**

- A. Comply with the provisions specified in the latest revision of the following ASTM standards, including all supplements and addenda:
  - 1. C31 - Standard Method of Making and Curing Concrete Test Specimens in the Field
  - 2. C33 - Standard Specification for Concrete Aggregates.
  - 3. C39 - Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens.
  - 4. C94 - Standard Specification for Ready-Mixed Concrete
  - 5. C138 - Standard Method of Test for Unit Weight, Yield, and Air Content (Gravi-metric) of Concrete.
  - 6. C143 - Standard Method of Test for Slump of Portland Cement Concrete.
  - 7. C150 - Portland Cement.
  - 8. C171 - Standard Specification for Sheet Materials for Curing Concrete.

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9. C172 - Standard Method of Sampling Fresh Concrete.
10. C173 - Standard Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method.
11. C192 - Standard Method of Making and Curing Concrete Test Specimens in the Laboratory.
12. C231 - Standard Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method.
13. C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
14. C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
15. C494 - Standard Specification for Chemical Admixtures for Concrete.
16. C618 - Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolans for Use in Portland Cement Concrete.
17. C685 - Specifications for Concrete Made by Volumetric Batching and Continuous Mixing.
18. C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
19. C1602 - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
20. D1751 - Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
21. E329 - Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction.

B. Comply with the provisions specified in the latest revision of the following publications of the American Concrete Institute (ACI):

1. Committee 212 Report - Guide for Use of Admixtures in Concrete.

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2. ACI 214 - Recommended Practice for Evaluation of Strength Test Results of Concrete.
3. ACI 301 - Specifications for Structural Concrete for Buildings.
4. ACI 302 - Recommended Practice for Concrete Floor and Slab Construction.
5. Committee 303 Report - Guide to Cast-In-Place Architectural Concrete Practice, 1974.
6. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete.
7. Committee 304 Report - Placing Concrete by Pumping Methods.
8. Committee 305 Report - Hot Weather Concreting.
9. Committee 306 Report - Cold Weather Concreting.
10. ACI 308 - Recommended Practice for Curing Concrete.
11. ACI 309 - Recommended Practice for Consolidation of Concrete
12. ACI 318 - Building Code Requirements for Reinforced Concrete.
13. ACI 347 - Guide to Formwork for Concrete.
14. ACI 357R - Design and Construction of Fixed Offshore Concrete Structures
15. ACI 546.2R - Guide to Underwater Repair of Concrete
16. SP-19 - Cement and Concrete Terminology (Report of ACI Committee 116).

C. Comply with the provisions specified in the following:

1. Concrete Plant Manufacturers Bureau: "Concrete Plant Mixer Standards of the Plant Mixer Manufacturers Division", 1970.
2. National Ready Mixed Concrete Association: Check List for Certification of Ready Mixed Concrete Production Facilities, 1967.

## **SECTION 03 30 00 - CAST-IN-PLACE CONCRETE**

3. American Association of State Highway and Transportation Officials, "Standard Specification for Transportation Materials and Methods of Sampling and Testing". (AASHTO T260-78).

### **PART 5: EXECUTION**

#### **5.01 HANDLING**

##### **A. Storage**

1. Store cement in weathertight buildings, bins or silos which will exclude moisture and contaminants.
2. Arrange and utilize aggregate stockpiles in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of like aggregates. To insure that this condition is met, perform any test for determining conformance to requirements for cleanness and grading on samples taken from the aggregates at the point of batching. Do not use frozen or partially frozen aggregates.
3. Allow stockpiles of natural or manufactured sand to drain to ensure a relatively uniform moisture content throughout the stockpile.
4. To prevent excessive variations in moisture content, allow predampened aggregates to remain in the stockpiles for a minimum of 12 hours before use.
5. Store admixtures in such a manner as to avoid contamination, evaporation or damage. For those used in the form of suspensions or non-stable solutions, provide agitating equipment to assure thorough distribution of the ingredients. Protect liquid admixtures from freezing and from temperature changes which would adversely affect their characteristics.

#### **5.02 CONCRETE MIX**

##### **A. General**

1. Concrete for all parts of the work shall be of the specified quality capable of being placed without excessive segregation and, when hardened, of developing all characteristics required by these specifications.

##### **B. Strength**

**SECTION 03 30 00 - CAST-IN-PLACE CONCRETE**

- The minimum compressive strength of the concrete as measured at seven (7) days shall be 5,000 psi, unless otherwise indicated on the drawings.

**Commented [PB1]:** This value is important  
 4500 as per table 4.2.2 in ACI 318, due to our routinely expected exposure condition: exposed to freezing and thawing in moist conditions and exposed to deicing chemicals. Similarly, w/c ratio is capped at .45.  
 Or, in ACI 357R (Offshore structures), 5,000 psi is recommended for splash zone and atmospheric exposure, as well as 0.4 w/c ratio max.

**C. Durability**

- Concrete shall be air-entrained and shall conform to the air content limits of the following table as measured by ASTM C 138 or ASTM C 173 or ASTM C231.

Nominal maximum size of coarse aggregate, in	Size number	Total air content percent by volume
3/8	8	6 - 10
1/2	7	5.5 - 7.5
3/4	67	5 - 7
1	57	4.5 - 6.5
Nominal maximum size of coarse aggregate, in	Size number	Total air content percent by volume
1-1/2	467	4.5 - 6
2	357	4 - 5.5
3	-	3.5 - 4.5

- Concrete of normal weight shall have a water-cement ratio not exceeding 0.40.
- For all concrete in which aluminum or galvanized metal is to be embedded, demonstrate by tests that the mixing water of the concrete, including that contributed by the aggregates and admixture used, will not contain a deleterious amount of chloride ion.

**Commented [PB2]:** See comment above on f'c. Effectively, ACI 357R recommends an exposure class of C2 in ACI 318 Table 4.2.2

**D. Slump**

- Except as specified for floors, proportion and produce concrete to have a slump of 4 in. or less if consolidation is to be by vibration, and 5 in. or less if consolidation is to be by methods other than vibration. A tolerance of up to 1 in. above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may be used provided it is properly placed and consolidated. The slump shall be determined by ASTM C 143.

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2. If concrete slabs are used, proportion and produce concrete to have a slump of 3 inches or less.
3. A slump of 6 to 9 inches is typically used for concrete that will be pumped or tremie-poured.

### **E. Aggregate Size**

1. The nominal maximum size of the aggregate shall be  $\frac{3}{4}$  inch, but shall not exceed one-fifth of the narrowest dimension between sides of forms, one-third of the depth of slabs, or three-fourths of the minimum clear spacing between reinforcing bars.

### **F. Admixtures**

1. Except for air-entraining admixtures, do not use admixtures unless specifically approved by the Engineer.
2. When its use is allowed by the Engineer, the amount of calcium chloride shall not exceed 2 percent by weight of cement. Determine the amount of calcium chloride by the method described in AASHTO T260-78.
3. When their use is permitted, use all admixtures in accordance with the manufacturer's instructions except as otherwise specified herein.

### **G. Proportions**

1. Proportion the ingredients so as to produce a mixture which will work readily into the corners and angles of the forms and around reinforcement by the methods of placing and consolidation employed on the work, but without permitting the materials to segregate or excessive free water to collect on the surface.
2. Use of the proposed mixture proportions shall be subject to approval by the Engineer based on their demonstrated ability to produce concrete meeting all requirements of the specifications. Determine ability to produce the required average strength on the basis of the strength test record of 30 or more tests made during the past 24 months from a similar mix, representing similar materials and conditions to those expected, in accordance with section 5.3 of ACI 318.

The strength test history used to determine standard deviation will be considered to comply with the above requirement for 30

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consecutive strength tests if the tests represent either a group of 30 consecutive batches of the same class of concrete or the statistical average for two groups totaling 30 or more batches. The tests used in establishing the standard deviation shall represent concrete produced for a specified strength or strengths within 1000 psi of that required for the proposed work; changes in materials and proportions within the population of background tests shall not have been more closely restricted than will be the case for the proposed work.

H. Temperature

1. The temperature of concrete to be placed shall not exceed 90 degrees F.
2. The temperature of concrete to be placed in cold weather shall conform to the requirements of the following table.

Nominal Section Size, in	Minimum Concrete Temperature, as placed, F
<12	55
12-36	50
36-72	45
>72	40

3. The temperature of ready-mix concrete shall be determined in accordance with ASTM C 1064.

5.03 PRODUCTION OF CONCRETE

- A. Batch, mix and transport ready-mixed concrete in accordance with ASTM C94, except as otherwise specified herein. Plant equipment and facilities shall conform the "Check List for Certification of Ready Mixed Concrete Production Facilities" of the National Ready Mixed Concrete Association.
- B. Batch and mix concrete produced by on-site volumetric batching and continuous mixing in accordance with and conforming to all requirements of ASTM C 685.
- C. Charge air-entraining admixtures, calcium chloride, and other chemical admixtures into the mixer as solutions and measure by means of an approved mechanical dispensing device. Consider the liquid a part of the mixing water. Admixtures that cannot be added in solution may be weighed or may be measured by volume if so recommended by the manufacturer.

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- D. If two or more admixtures are used in the concrete, add them separately to avoid possible interaction that might interfere with the efficiency of either admixture or adversely affect the concrete.
- E. Complete the addition of retarding admixtures within 1 minute after addition of water to the cement has been completed, or prior to the beginning of the last three-quarters of the required mixing, whichever occurs first.
- F. Mix concrete only in quantities for immediate use. Do not re-tamper concrete which has partially set.
- G. When concrete arrives at the project with slump below that suitable for placing, as indicated by the specifications, water may be added only if neither the maximum permissible water-cement ratio nor the maximum slump is exceeded. Incorporate the water by additional mixing equal to thirty revolutions or more, if necessary, at mixing speed. Water shall not be added to the batch at any later time.
- H. Cold Weather
  - 1. Comply with the applicable requirements of "Cold Weather Concreting", ACI 306.
  - 2. Do not place concrete if temperature is below 40 degrees F, except with specific approval. For concrete placed or cured below 40 degrees F, provide heat, insulation and moisture to maintain concrete temperature and curing conditions as recommended by ACI 306.
  - 3. Do not use frozen materials, or materials containing ice. Do not allow concrete to come into contact with frost.
- I. Hot Weather
  - 1. Comply with the applicable requirements of "Hot Weather Concreting", ACI 305.
  - 2. Cool the ingredients before mixing.
  - 3. Flake ice or well-crushed ice of a size that will melt completely during mixing may be substituted for all or part of the mixing water if, due to high temperature, low slump, flash set or cold joints are encountered.

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4. Reduce concrete temperatures to prevent rapid evaporation of water in hot weather.

### 5.04 PREPARATION BEFORE PLACING

- A. Remove hardened concrete and foreign materials from the inner surfaces of the conveying equipment.
- B. Complete the formwork and remove snow, ice, frost, water, dirt or other foreign materials.
- C. All material that is to come in contact with the fresh concrete, including formwork, reinforcement and inserts, must be at a temperature above 32 Degrees Fahrenheit at the time the concrete is poured, in accordance with ACI 306 "Cold Weather Concreting".
- D. Place all sleeves, inserts, anchors and embedded items including reinforcing bars. Approved bar chairs shall be used where required to vertically position reinforcing bars. The use of large aggregate or brick will not be permitted to provide clearance between the formwork and reinforcing steel.
- E. Give ample notice and opportunity to Engineer before starting to place concrete in any unit of the structure to permit proper inspection of forms and reinforcement by the Engineer.
- F. Give ample notice and opportunity to all other contractors whose work is related to or supported by the concrete to furnish embedded items before the concrete is placed.
- G. Sprinkle semiporous subgrades sufficiently to eliminate suction, and seal porous subgrades in a manner approved by the Engineer.
- H. Do not place concrete on frozen ground or fill material, or on subgrades containing frost.

### 5.05 CONVEYING

- A. Convey concrete from the mixer to the place of final deposit as rapidly as practicable by methods which will prevent segregation or loss of ingredients and in a manner which will assure that the required quality of the concrete is maintained.

### **SECTION 03 30 00 - CAST-IN-PLACE CONCRETE**

- B. Use conveying equipment which is approved by the Engineer and of a size and design such that detectable setting of the concrete does not occur before adjacent concrete is placed.
- C. Clean conveying equipment at the end of each operation or work day.
- D. For truck mixers, agitators and non agitating units, conform to the applicable requirements of ASTM C94.
- E. For belt conveyors, use units which are horizontal or at a slope which will not cause excessive segregation or loss of ingredients. Protect concrete against undue drying or rise in temperature. Use an arrangement approved by the Engineer at the discharge end to prevent apparent segregations. Do not allow mortar to adhere to the return length of the belt. Discharge long runs into a hopper or through a baffle.
- F. For chutes, use metal or metal lined equipment having a slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal. Chutes more than 20 ft. long and chutes not meeting the slope requirements may be used provided they discharge into a hopper before distribution.
- G. For pumping or pneumatic conveying, use equipment of suitable kind with adequate pumping capacity, and pump the concrete directly to the structure with no intermediate transfer points.
  - 1. Do not convey concrete through pipe made of aluminum or aluminum alloy.
  - 2. Control pneumatic placement so that segregation is not apparent in the discharged concrete.
  - 3. When concrete is being conveyed to the pump by delivery trucks, the Contractor shall test the slump and entrained air of the first batch of concrete on each shift in which concrete will be poured. Tests will be conducted on the concrete being discharged from the truck into the pump, and on the concrete being discharged from the end of the pumping line at the point of final placement. These tests shall be performed at no additional cost to the Owner.
    - a. The loss of slump due to the pumping or pneumatic conveying of concrete shall not exceed 3 inches. Concrete exhibiting larger slump losses, or a resulting slump outside the specified range shall not be accepted.

## **SECTION 03 30 00 - CAST-IN-PLACE CONCRETE**

- b. The loss of entrained air due to the pumping or pneumatic conveying of concrete shall not exceed 5%. Concrete with a resulting air entrainment below the specified range shall not be accepted.
- 4. The Contractor shall ensure that pump and pipeline washout-blowout procedures are performed safely and cleanly to prevent personnel injury and to prevent concrete contact with river water or other natural environments.

### **5.06 PLACING CONCRETE**

- A. Deposit concrete continuously, or in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, locate construction joints as shown on the drawings or as approved by the Engineer.
- B. Deposit concrete at such a rate that the concrete which is being integrated with fresh concrete is still plastic.
- C. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
- D. Remove temporary spreaders in forms when the concrete placing has reached an elevation rendering their service unnecessary. They may remain embedded in the concrete only if made of metal or concrete, and if prior approval has been obtained from the Engineer.
- E. Do not begin placing of concrete in supported elements until the concrete previously placed in columns and walls is no longer plastic and has been in place at least two hours.
- F. Deposit concrete as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. Do not subject the concrete to any procedure which will cause segregation.
  - 1. Do not allow concrete to drop free more than four feet. Where greater drops are required use a tremie or "elephant's trunk". Control the discharge of such devices so that the concrete can effectively be compacted in horizontal layers not more than 12 inches thick. Space the devices such that excessive segregation does not occur.
- G. Consolidate all concrete by vibration, spading, rodding or forking so that the concrete is thoroughly worked around the reinforcement, around

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embedded items, and into corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Use international vibrators of the largest size and the most powerful that can be properly used in the work, as described in Table 5.1.4 of ACI 309. They shall be operated by competent workmen. Do not use vibrators to transport concrete within forms. Insert vibrators and withdraw at points approximately 18 in. apart. At each insertion, the duration shall be sufficient to consolidate the concrete but not sufficient to cause segregation, generally from 5 to 15 seconds. Keep a spare vibrator on the job site during all concrete placing operations. Where the concrete is to have an as-cast finish, bring a full surface of mortar against the form by the vibration process, supplemented if necessary by spading to work the coarse aggregate back from the formed surface.

- H. Unless adequate protection is provided, do not place concrete during rain, sleet or snow.
- I. Do not allow rainwater to increase the mixing water or damage the surface finish.
- J. The temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set, or cold joints and should not exceed 90F. When the temperature of the concrete exceeds 90 F, use precautionary measures approved by the Engineer. When the temperature of steel forms is greater than 120 F, spray steel forms and reinforcement with water just prior to placing the concrete.
- K. When required or permitted, deposit concrete under water by an approved method in such a way that the fresh concrete enters the mass of previously placed concrete from within, causing water to be displaced with minimum disturbance at the surface of the concrete.

A tremie pipe (8 to 12 inches in diameter) shall be used to deposit the concrete. The tremie pipe shall be water tight. No water shall be allowed to enter the tremie pipe. The tremie pipe shall be sealed and lowered into the base of the formwork and filled with concrete. The tremie shall be raised no more than 6 inches off the bottom to break the seal and initiate the flow of concrete. The end of the tremie pipe shall remain embedded in the fresh concrete from 3 to 5 feet after pouring is started. The tremie pipe shall be lifted slowly to avoid disturbance to the concrete. Concrete placement shall be as continuous as possible through each tremie.

The tremie pipe must remain fixed horizontally while concrete is flowing. Horizontal movement of the pipe will damage the surface of concrete already in place. Horizontal distribution of the concrete is accomplished by halting placement, moving the pipe, reestablishing the seal and

### SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

resuming placement. A tremie pipe injection point spacing of 2 to 3 times the depth of concrete shall be used.

- L. After the introduction of the mixing water to the cement and aggregates, each batch of concrete will be discharged within 1.5 hours, or before the mixing drum has completed 300 revolutions, whichever comes first.
  - 1. These limitations may be waived by the Owner, or Engineer, if, after the limits stated above, the concrete slump remains sufficient to allow it to be placed without the addition of water to the batch.
  - 2. These limitations may be reduced by the Owner, or Engineer, if hot weather, or other conditions that may contribute to rapid stiffening of the concrete mix, are present.
- M. Provide all material, manpower and equipment necessary for the safe washout and cleaning of all concrete-related equipment, including trucks, pumps, pipes, and forming tools. Dispose of all hardened washout concrete. Rivers and other aquatic environments shall not be used for washout or cleaning.

#### 5.07 CONSTRUCTION JOINTS

- A. Make construction joints only as shown on the Drawings, or as approved by the Engineer.
- B. Locate joints not shown on the Drawings only as approved by the Engineer. Locate those joints as least to impair the strength of the structure. In general, locate construction joints near the middle of the spans of slabs, beams and girders. Locate joints in walls and columns at the underside of floors, slabs, beams or girders and at the tops of footings or floor slabs. Place beams, girders, brackets, column capitals, haunches and drop panels at the same time as slabs. Make joints perpendicular to the main reinforcement.
- C. Continue reinforcement across joints unless shown otherwise on the drawings.
- D. Provide keys and inclined dowels as directed by the Engineer.
- E. For all transverse and longitudinal construction joints, provide a keyway 2 inches deep by 4 inches wide with a rubber dumbbell-type waterstop.
- F. Clean the surface of concrete at all joints and remove all laitance before placing adjoining concrete.

## **SECTION 03 30 00 - CAST-IN-PLACE CONCRETE**

- G. Immediately before new concrete is placed, all construction joints shall be wetted and standing water removed.
- H. Obtain bond by one of the following methods:
  - 1. The use of an approved adhesive. Prepare and apply adhesive to joints receiving an adhesive in accordance with the manufacturer's recommendations.
  - 2. The use of an approved chemical retarder which delays but does not prevent setting of the surface mortar. Remove mortar within 24 hours after placing to produce a clean exposed aggregate bonding surface. Prepare surfaces of joints to be treated in accordance with the manufacturer's recommendations.
  - 3. Roughening the surface of the concrete in an approved manner which will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate or damaged concrete at the surface.
  - 4. Dampen (but do not saturate) the hardened concrete of construction joints and of joints between footings and walls or columns, between walls or columns and beams or floors they support, joints in unexposed walls and all others not mentioned below immediately prior to placing of fresh concrete.
  - 5. For horizontal construction joints in exposed work; horizontal construction joints in the middle of beams, girders, joists and slabs; and horizontal construction joints in work designed to contain liquids, dampen (but do not saturate) the hardened concrete and thoroughly cover the joint with a coat of cement grout of similar proportions to the mortar in the concrete. Place the fresh concrete before the grout has attained its initial set.

### **5.08 EMBEDDED ITEMS**

- A. Expansion Joints - Do not extend reinforcement or other embedded metal items bonded to the concrete (except dowels in slabs bonded on only one side of joints) continuously through any expansion joint.
- B. Position expansion joint material, waterstops and other embedded items accurately, and support them against displacement. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent the entry of concrete into the voids.

### **5.09 SLABS**

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- A. Set edge forms and intermediate screed strips accurately to produce the designated elevations and contours of the finished surface, and construct them sufficiently strong to support vibrating screeds or roller pipe screeds if the nature of the finish specified requires the use of such equipment. Align the concrete surface to the contours of screed strips by the use of strike-off templates or approved compacting type screeds.
- B. Carefully coordinate mixing and placing with finishing. Do not place concrete on the subgrade or forms more rapidly than it can be spread, straightened, and darried or bull floated. These operations must be performed before bleeding water has an opportunity to collect on the surface.
- C. To obtain good surfaces and avoid cold joints, plan the size of finishing crews with due regard for the effects of concrete temperature and atmospheric conditions on the rate of hardening of the concrete.
- D. If saw-cut joints are required or permitted, time cutting properly with the set of the concrete: start cutting as soon as the concrete has hardened sufficiently to prevent aggregates being dislodged by the saw, and complete before shrinkage stresses become sufficient to produce cracking.
- E. Thoroughly consolidate concrete in slabs. Use internal vibration in beams and girders of framed slabs and along the bulkheads of slabs on grade. Obtain consolidation of slabs with vibrating screeds, roller pipe screeds, internal vibrators, or other approved means.

### 5.10 FINISHES

- A. Provide the following finishes as applicable and in accordance with ACI 301 unless specified otherwise herein or shown otherwise on the Drawings:
  - 1. Smooth Form Finish - for all formed concrete surfaces.
  - 2. Broom or Belt Finish - for sidewalks, driveways, ramps and exterior platforms.
  - 3. Provide smooth form finish where type of finish is not certain from above.
- B. Smooth Form Finish - Use form facing materials which produce a smooth, hard, uniform texture on the concrete. it may be plywood, tempered

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concrete-form-grade hardboard, metal, plastic, paper, or other approved material capable of producing the desired finish. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to the practical minimum. Support it with studs or other backing capable of preventing excessive deflection. Do not use material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which will impair the texture of the concrete surface. Patch tie holes and defects. Completely remove all fins.

- C. Broom or Belt Finish - First, float finish the surface as described above. Do not trowel. Give the surface a coarse transverse scored texture by drawing a broom or burlap belt across the surface.

### 5.11 TOLERANCES

- A. Tolerance in finished elevation shall be ¼ inch per 100 feet of length. This tolerance is non additive.
- B. Produce formed surfaces which result in concrete outlines within the tolerances of applicable standards.
- C. Depressions in slabs between high spots shall not be greater than 3/16 in. below a 10 ft. long straightedge.

### 5.12 CURING

- A. Beginning immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury, and maintain the concrete with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete.
- B. For concrete surfaces not in contact with forms, apply one of the following procedures immediately after completion of placement and finishing:
  - 1. Ponding or continuous sprinkling.
  - 2. Application of absorptive mats or fabric kept continuously wet.
  - 3. Application of sand kept continuously wet.
  - 4. Continuous application of steam (not exceeding 150F) or mist spray.
  - 5. Application of waterproof sheet materials conforming to ASTM C171.

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6. River water and other non-potable water sources shall not be acceptable for use in curing.
  7. Application of a curing compound conforming to ASTM C309. Apply the compound in accordance with the recommendations of the manufacturer immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. Do not use on any surface against which additional concrete or other material is to be bonded unless it is proved that the curing compound will not prevent bond, or unless positive measures are taken to remove it completely from areas to receive bonded applications. Minimize moisture loss from surfaces placed against wooden forms or metal forms exposed to heating by the sun by keeping the forms wet until they can be safely removed. After form removal, cure the concrete for at least seven days.
- C. Cold Weather - When the mean daily outdoor temperature is less than 40 F, maintain the temperature of the concrete between 50 and 70 F for seven days. When necessary, make arrangements for heating, covering, insulating, or housing the concrete work in advance of placement and maintain the required temperature without injury due to concentration of heat. Do not use combustion heaters during the first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide.
- D. Hot Weather - When necessary, make provision for windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material in advance of placement, and take such protective measures as quickly as concrete hardening and finishing operations will allow.
- E. Rate of Temperature Change - Keep changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period as uniform as possible and do not exceed 5 F in any 1 hour or 50 F in any 24 hour period.
- F. During the curing period, protect the concrete from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration. Protect all finished concrete surfaces from damage by construction equipment, materials, or methods, by application of curing procedures, and by rain or running water. Do not load self-supporting structures in such a way as to overstress the concrete.
- G. Proper curing methods shall be maintained, including curing methods for side faces once forms are stripped, for a minimum of seven (7) days.

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- H. No external loads shall be applied to the concrete until seven (7) days after concrete is cast.
- I. No piles shall be driven or vibrated within fifty feet (50 ft) of new concrete until seven (7) days after concrete is cast.

#### 5.13 REPAIR OF SURFACE DEFECTS

- A. Repair surface defects, including tie holes immediately after form removal.
- B. Remove all honeycombed and other defective concrete down to sound concrete. If chipping is necessary, form the edges perpendicular to the surface or slightly undercut. No feathered edges will be permitted. Dampen the area to be patched and an area at least 6 in. wide surrounding it to prevent absorption of water from the patching mortar. Prepare a bonding grout using a mix of approximately 1 part cement to 1 part fine sand passing a No. 30 mesh sieve, mixed to the consistency of thick cream, and then well brushed into the surface.
- C. Make the patching mixture of the same materials and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than 1 part cement to 2 1/2 parts sand by damp loose volume. Substitute white portland cement for a part of the gray portland cement on exposed concrete in order to produce a color matching the color of the surrounding concrete as determined by a trial patch. Use no more mixing water than necessary for handling and placing. Mix the patching mortar in advance and allow it to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.
- D. After surface water has evaporated from the area to be patched, brush the bond coat well into the surface. When the bond coat begins to lose the water sheen, apply the premixed patching mortar. Consolidate the mortar.
- E. After cleaning and thoroughly dampening the tie holes, fill them solid with patching mortar.
- F. If permitted or required, proprietary compounds for adhesion or as patching ingredients may be used in lieu of or in addition to the foregoing patching procedures. Use such compounds in accordance with the manufacturer's recommendations.

#### 5.14 TESTING

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- A. Concrete materials and operations will be tested and inspected as the work progresses. Failure to detect any defective work or material shall not in any way prevent later rejection when such a defect is discovered, nor shall it obligate the Engineer for final acceptance.
- B. Additional testing and inspection required by failure to meet specification requirements or by changes in materials or proportions requested by the Contractor shall be paid for by the Contractor.
- C. Testing of concrete for mix design purposes shall be paid for by the Contractor.
- D. All testing agencies shall meet the requirements of ASTM E 329.
- E. Contractor shall engage an independent field and laboratory testing agency to perform all test required by the Contract Documents.
- F. To facilitate testing and inspection,
  - 1. Furnish any necessary labor to assist the designated testing agency in obtaining and handling samples at the project or other sources of materials.
  - 2. Advise the designated testing agency sufficiently in advance of operations to allow for completion of quality tests and for the assignment of personnel.
  - 3. Provide and maintain for the sole use of the testing agency adequate facilities for safe storage and proper curing of concrete test cylinders on the project site for the first 24 hours as required by ASTM C 31.
- G. The first batch of concrete to be poured during a shift shall have its air content, slump and temperature tested, prior to initiating a pour, and will be rejected if values outside accepted ranges are obtained.
- H. One strength test sampling shall be randomly taken from each 50 cu. yds. of concrete poured in a given shift. A minimum of five (5) strength test samplings shall be performed on randomly selected batches for each class of concrete on the project. If fewer than five (5) batches of concrete are used, strength test sampling shall be performed on each batch. If the total quantity of a given class of concrete is less than 50 cu. yds., strength tests may be waived at the engineer's discretion.
- I. A strength test sampling shall consist of enough cylinders to perform a minimum of two strength tests, as defined below in 5.14.1.1. All strength

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test sampling shall be performed in accordance with ASTM C-172. Cylinders will be made and cured in accordance with ASTM C-31 and tested in accordance with ASTM C-39.

1. A valid strength test shall consist of the breaking of a minimum of two (2) 6"x12" concrete cylinders, or three (3) 4"x8" concrete cylinders. At a minimum, strength tests shall be performed after seven (7) days and twenty-eight (28) days.
2. Additional test cylinders may be taken at the time of sampling, at the Engineer's or Contractor's discretion, in order to:
  - a. Perform an additional strength test after less than seven (7) days for consideration of form removal.
    - i. Forms shall not be removed until the concrete has achieved at least 70% of the design strength.
  - b. Perform an additional strength test after fourteen (14) days for evaluation of strength gain.
  - c. Perform an additional strength test after either seven (7) days or twenty-eight (28) days to confirm those strength tests results.
  - d. Perform an additional strength test after forty-five (45) days should the twenty-eight (28) day strength test results be below the specified strength.
  - e. Allow for the discarding of outlying strength results for any strength test, in accordance with ACE 214R.
  - f. Perform strength tests of cylinders cured under field conditions to demonstrate the adequacy of the curing and protection undertaken in the field.
    - i. The strength test results of field-cured cylinders will not be used for evaluation and acceptance of the concrete strength. However, a field-cured strength test that results in less than 85% of the strength of companion laboratory-cured cylinders will necessitate the improvement of field protection and curing procedures. This 85% limitation will not apply if the field-cure strength exceeds the specified compressive strength by more than 500 psi.

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- ii. No additional compensation will be allowed to accommodate the requirement to perform the additional sampling and testing under this provision, and to improve field curing and protection procedures as necessary.
- J. The air content, temperature, and slump of the concrete shall be measured for each strength test sampling performed. All sampling shall be performed in accordance with ASTM C 172.
  - 1. These properties tests may be conducted more frequently than the test strength sampling, and may be performed on every arriving batch prior to its placement, at the Engineers discretion.
  - 2. If the measured slump, or air content, or both are found to be *above* the specified upper limit, a check test shall be immediately performed on a fresh sample. If the check test fails, the concrete shall be considered to have failed the requirements of this specification, and shall be rejected.
  - 3. If the measured slump, or air content, or both are found to be *below* the specified upper limit, adjustments shall be permitted in accordance with ASTM C 94. If the adjusted concrete subsequently fails, a check test shall be immediately performed on a fresh sample. If the check test fails, the concrete shall be considered to have failed the requirements of this specification, and shall be rejected.
- K. All concrete testing, whether properties testing or strength test sampling, shall be conducted on concrete at the point of placement. The Contractor shall take all necessary measures to efficiently and safely allow the representative of the testing agency to take samples at the point of placement. No additional compensation will be allowed to accommodate this requirement.
- L. Representatives of the testing agency will inspect, sample and test the materials and the production of concrete as required by the Engineer. When it appears that any material furnished or work performed by the Contractor fails to fulfill specification requirements, the testing agency will report such deficiency to the Engineer and the Contractor.
- M. The testing agency will report all test and inspection results to the Engineer and Contractor immediately after they are performed. All test reports will include the exact location in the work at which the batch represented by a test was deposited. Reports of strength tests will

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include detailed information on storage and curing of specimens prior to testing.

- N. The testing agency and its representatives are not authorized to revoke, alter, relax, enlarge or release any requirement of the contract documents, nor to approve or accept any portion of the work.

### 5.15 EVALUATION AND ACCEPTANCE

- A. Test results for standard molded and standard cured test cylinders will be evaluated separately for each portion of the structure.
- B. The strength level of the concrete will be considered satisfactory so long as the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 psi, or one tenth the specified strength, whichever is greater.
- C. Completed concrete work which meets all applicable requirements will be accepted without qualification.
- D. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring into compliance will be accepted without qualification.
- E. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance as determined by the Engineer may be accepted or rejected. Remove and replace (at Contractor's expense) all concrete work rejected by the Engineer.
- F. Formed surfaces resulting in concrete outlines smaller than permitted by the allowable tolerances shall be considered potentially deficient in strength and subject to the requirements stated below for concrete of deficient strength.
- G. Formed surfaces resulting in concrete outlines larger than permitted by the allowable tolerances may be rejected and the excess material shall be subject to removal. If removal of the excess material is permitted, it shall be accomplished in such a manner as to maintain the strength of the section and to meet all other applicable requirements of function and appearance.
- H. Concrete members cast in the wrong location may be rejected if the strength, appearance or function of the structure is adversely affected or misplaced items interfere with other construction.

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- I. Inaccurately formed concrete surfaces exceeding the limits of applicable standards and which are exposed to view, may be rejected and shall be repaired or removed and replaced if required.
- J. Finished slabs exceeding the tolerances of this section may be repaired provided that strength, durability or appearance is not adversely affected. High spots may be removed with a terrazzo grinder, low spots filled with a patching compound or other remedial measures performed as permitted.
- K. Concrete with defects which adversely affect the appearance of the specified finish may be repaired, if possible. If, in the opinion of the Engineer, the defects cannot be repaired, the concrete may be either accepted or rejected.
- L. Concrete not exposed to view is not subject to rejection for defective appearance, except in those cases where concrete finish is specified.
- M. The strength of the structure in place will be considered potentially deficient if it fails to comply with any requirements which control the strength of the structure, including but not necessarily limited to the following conditions.
  - 1. Low concrete strength.
  - 2. Reinforcing steel size, quantity, strength, position, or arrangement at variance with the requirements of the contract drawings.
  - 3. Concrete which differs from the required dimensions or location in such a manner as to reduce the strength.
  - 4. Curing less than that specified.
  - 5. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
  - 6. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
  - 7. Poor workmanship likely to result in deficient strength.
- N. Structural analysis and/or additional testing may be required when the strength of the structure is considered potentially deficient.
- O. Core tests may be required when the strength of the concrete in place is considered potentially deficient.

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- P. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be required and their results evaluated in accordance with Chapter 20 of ACI 318.
- Q. Concrete work judged inadequate by structural analysis or by results of a load test shall be reinforced with additional construction if so directed by the Engineer, or shall be replaced at the Contractor's expense.

**- END OF SECTION -**

## SECTION 03 60 00 - GENERAL GROUTING

### **PART 1: GENERAL**

#### 1.01 SCOPE

- A. Provide all labor, materials, equipment, and services necessary to furnish and place all grout as shown and specified in the contract documents or otherwise required for proper completion of the Work.
- B. This specification covers the requirements for the furnishing and installation of non-shrink epoxy grout, sand-cement poured grout and sand-cement drypack grout, unless shown otherwise on the design drawings. The work shall include, but not be limited to the following:
  - 1. Concrete surface preparation
  - 2. Furnishing and installation of all leveling plates, shims, wedges, and other approved adjusting materials.
  - 3. Furnishing and installation of all grout

### **PART 2: PRODUCTS**

#### 2.01 GENERAL REQUIREMENTS

- A. Application of grout types shall be as follows unless noted otherwise on the drawings:
  - 1. Non-shrink Epoxy Grout
    - a. Compressors, generators, blowers, pumps, motors and all other rotating equipment, including grout inside equipment bases.
    - b. Equipment with cast bases.
    - c. Equipment on base frames or skids up to base of skid (space between beams shall be filled with sand-cement grout)
    - d. Anchor bolts and structural elements, especially those mounted into existing concrete elements.
  - 2. Sand-Cement Poured Grout
    - a. Vessels, heat exchangers and other miscellaneous equipment

## **SECTION 03 60 00 - GENERAL GROUTING**

- b. Anchor bolts and structural elements subjected to static loading only.
- 3. Dry-pack Grout
  - a. Structural column base plates
  - b. Small equipment with flat plate bases
- B. Manufacturer's printed instructions accompanying epoxy grout containers and the installation instructions given on vendor equipment drawings shall be reviewed together with this specification prior to commencing any grouting. Any conflict among these three sources of information will be resolved by the Engineer. The Construction Manager will issue a revision to this specification, documenting the resolution.
- C. Work Prior to Setting Base Plates
  - 1. Concrete foundations shall be at least 7 days old prior to surface preparation.
  - 2. Concrete surfaces shall be prepared for grouting or drypacking by chipping back to sound concrete or to a dimension specified by the Engineer. The surface shall be clean with all laitance, grease, oil, dirt or loosened aggregate removed prior to setting the leveling plate and/or equipment to be grouted.
  - 3. Water for surface soaking, mixing and curing cement-based grout or drypack shall be potable.
  - 4. All leveling plates shall be set to the proper elevation prior to grouting. The number and type of leveling plates will be determined by the Construction Manager in accordance with the recommendations of the equipment manufacturer and other project documents. On subcontracted work, the number and type of leveling plates shall be submitted by the Equipment Installation Subcontractor to the Engineer for review two weeks prior to use. Leveling plates shall be removed after grout hardening and before tightening the anchor bolt nuts.
  - 5. Concrete surfaces on which cement-based grout or drypack is to be placed shall be thoroughly soaked with water for 24 hours. Just prior to grouting, the water shall be removed. All standing water shall be removed from anchor bolt sleeves.

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6. Concrete surfaces on which epoxy grout is to be placed shall be completely dry before grouting.
7. Metal surfaces in contact with the grout or drypack shall be clean and free of oil and grease, and foreign substances not associated with the grouting process.

### **D. Grout Formwork**

1. Form work shall be provided for grout and shall be compatible with the method of placing grout specified herein.
2. Forms shall be designed for rapid, continuous and complete filling of space to be grouted. Forms shall be of adequate strength to withstand the forces of the fluid grout, and shall be caulked or sealed with tape to prevent excessive leakage. The forms shall be coated with form oil or heavy wax to prevent grout adherence and absorption.
3. For other than epoxy grout applications, form placement shall allow at least 1 inch (25 mm) of space all around base plates or equipment bases. The top of the forms shall be a minimum of 1 inch (25 mm) above the bottom of the adjacent base plate. Forms shall have a chamfer strip attached to form a chamfered edge at all corners.
4. For all epoxy grout applications, form placement shall be such that the epoxy grout extends 1 ½ inch (38 mm) beyond the outside edge of the foundation, and 4 inches (100 mm) below the top of the poured concrete surface. Grout thickness below the equipment base shall be a minimum of 1 ½ inch (38 mm) for foundations 3 feet (.9m) in width and less, increasing by 1 inch for each additional 3 feet in foundation width. Forms shall have a chamfer strip attached to form a chamfered edge at all corners.
5. For rotating equipment, leveling and alignment shall be performed and witnessed by the Engineer on the same day that the grout is placed.

### **E. Grout Material Storage**

1. Epoxy grout materials shall be stored and handled in accordance with the manufacturer's printed instructions.
2. Cement-based grouting materials which becomes damp or air-set, prior to use, shall not be used.

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3. Epoxy grout aggregate shall be delivered to the jobsite in sound, dry bags and epoxy grout liquids in sealed hardener and resin containers. The Contractor shall be responsible for storing the grout in a dry, weatherproof shelter.

### 2.02 REQUIREMENTS FOR EPOXY GROUT

#### A. Materials

Nonshrink epoxy grout shall be a proportioned, factory packaged product consisting of specially formulated resin, hardener and aggregate. Approved epoxy grouts are HILTI, Carter Waters, Five Star, Sika, and Escoweld. Substitutes shall not be permitted unless specifically approved by the Engineer. Epoxy grout shall be designed for injection in anchor bolt applications.

#### B. Performance Characteristics

1. Epoxy grout shall have a minimum compressive strength of 5000 psi (350 kg/cm<sup>2</sup>) at 24 hours when tested in accordance with ASTM C579.
2. Epoxy grout shall have a minimum working time of 45 minutes at 75° F (24° C).
3. The grout shall show no shrinkage (0.0 percent) and a maximum of 2.5 percent expansion at all ages when tested in accordance with ASTM C827 (modified). The volume change test of epoxy grout, ASTM C827 (modified), requires an indicator ball with a specific gravity between 0.9 and 1.1.
4. The grout shall be flowable, or injectable, depending on the application.

### 2.03 REQUIREMENTS FOR SAND-CEMENT POURED GROUT

#### A. Materials

1. Grout is a mixture of cement and sand with pouring consistency. The mix shall consist of 1 part of Portland cement and 2 parts of sand by volume.

The water-cement ratio shall be limited to 0.45 by weight.

2. Portland cement shall conform to ASTM C150, Types I, II, IV, or V.

## **SECTION 03 60 00 - GENERAL GROUTING**

3. Sand shall conform to ASTM C33.

### 2.04 REQUIREMENTS FOR DRYPACK GROUT

#### A. Materials

1. Drypack shall be a mixture of one part cement and 2 ½ parts of sand by volume proportioned at the jobsite and mixed thoroughly with just enough water to produce a consistency such that when a sample is tightly squeezed in the hand only enough moisture will come to the surface to moisten the hand.
2. Portland cement shall conform to ASTM C150, Types I, II, IV or V.
3. Sand shall conform to ASTM C33.

## **PART 3: SUBMITTALS**

3.01 Contractor shall submit the following in accordance with the Contract:

- A. Submit with the bid, if not otherwise directed, copies of laboratory test reports, including all test data certifying that the selected products will produce grouts of the qualities specified herein. These certification documents shall be forwarded to the Engineer for review and authorization to proceed.
- B. Certify that the grout conforms to the test reports submitted with the bid.

## **PART 4: QUALITY ASSURANCE**

### 4.01 REFERENCE

Comply with the requirements of the latest edition of the following standards.

- A. ASTM Standards
  1. C33 Specification for Concrete Aggregates
  2. C150 Specification for Portland Cement
  3. C191 Test for Time of Setting Hydraulic Cement by Vicat Needle

## **SECTION 03 60 00 - GENERAL GROUTING**

4. C579 Test Method for Compressive Strength of Chemical-resistant Mortars and Monolithic Surfacing
  5. C827 Test Method for Early Volume Change of Cementitious Mixtures
- B. U.S. Army Corp. of Engineers (CRD) Standards
1. CRD-C79-77 Test Method for Flow of Grout Mixtures (Flow Cone Method)

### **PART 5: EXECUTION**

#### 5.01 EPOXY GROUT

A. Mixing

1. All epoxy grout components shall be conditioned to a temperature range between 70° F to 85° F (21° C to 30° C) prior to mixing. The entire hardener component shall then be added to the entire resin component and thoroughly mixed for 2 to 3 minutes with a low speed mixer. Mixed resin and hardener shall then be put into a clean mortar mixer or wheelbarrow and the entire bag of aggregate added. The combination shall be mixed until aggregate is completely wetted. Nothing else shall be added to the mixture.
2. Mixing shall be adjacent to area being grouted, with sufficient manpower and equipment available for rapid and continuous mixing and placing.
3. Grout shall not be mixed in quantities larger than that which can be placed during the working time specified herein.

B. Placing

1. Epoxy grout has a limited working time after mixing. This working time shall be specified by the grout manufacturer. The placing of grout shall be performed only during this specified working time and any unused grout remaining beyond this time shall be discarded.
2. Epoxy grout shall be injected for anchor bolt applications. In top-down vertical anchor bolt applications, grout may be gravity-poured with the Engineer's approval. Anchors shall be temporarily supported to prevent sagging until the grout is fully cured.

## **SECTION 03 60 00 - GENERAL GROUTING**

3. When placing epoxy grout, the temperature of the foundation, base plate and grout material shall be within the temporary range of 40° F to 90° F (5° C to 32° C) or as recommended by the manufacturer, determined by a surface thermometer.
4. Epoxy grout shall be placed from one long side of an equipment base to the other, in one direction only. The grout shall be poured into movable head box having an inclined plane to direct the grout beneath the equipment base in a manner which minimizes trapped air and bubble formation. The head box should be about a 3 foot (1 m) cube to allow large volumes of grout to be poured continuously. The use of vibrators is not permitted. The use of steel straps is permitted to move grout into position but chaining is not permitted because of air entrapment between the links.
5. Pumping epoxy grout is permitted and may eliminate the requirement for a head box.
6. Epoxy grout placing shall be continued until it oozes out along the entire perimeter and up through every interior air relief hole and grout hole. An exception occurs when grouting such equipment as pumps having an elevated interior base plate. In these situations, grout shall be placed under the entire equipment base to the top of the exterior base plate and then the grouting stopped for a short period of time to allow the grout to seal the periphery and then the grouting completed through one of the interior grout holes.
7. Expansion joints shall be installed as indicated on the design drawings for epoxy grout placements of long length or large area. In no case shall the poured length in any direction exceed 10 feet (3m) without an expansion joint.

### **C. Finishing and Curing**

1. Finishing and curing shall be in strict accordance with the manufacturer's printed instructions.
2. Epoxies cannot be trimmed after set. They must be left at the finished level with required chamfer strips built into the forms. Top surfaces may be trowelled with a steel trowel moistened with oil. Further finishing will require grinding.
3. The epoxy grout shall be maintained within the placing temperature range for a minimum of 24 hours after placing.
4. Epoxy grout shall not be wet-cured.

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5. After 24 hours, the juncture between the equipment base or sole plate and the epoxy grout, and between the epoxy grout and the concrete foundation shall be sealed with a silicon such as R.T.V., as approved by the Engineer.

### 5.02 SAND-CEMENT POURED GROUT

#### A. Mixing

1. Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 to 5 minutes.
2. Batches shall be sized to allow continuous placement of freshly mixed grout. Grout not used within one hour or in accordance with manufacturer's recommendation, whichever is less, after mixing, shall be discarded.

#### B. Placing

1. When placing grout the temperature of the foundation, base plate and grout shall be within the temperature range of 40° F to 90° F (5° C to 32° C) or as recommended by the manufacturer, determined by a surface thermometer. This temperature shall be maintained for 3 days following grouting. Preparations for maintaining this temperature shall be submitted to the Engineer.

### 5.03 DRYPACK GROUT

#### A. Mixing

1. Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 to 5 minutes. Batches shall be sized to allow continuous placement of freshly mixed drypack. Drypack grout not used within one hour, or in accordance with manufacturer's recommendation whichever is less, after mixing shall be discarded. Re-tampering will not be allowed.

#### B. Placing

1. The space between the top of the flange of steel beam and the bottom of the concrete slab shall be filled with drypack grout by tamping with a bar until the voids are eliminated.

## **SECTION 03 60 00 - GENERAL GROUTING**

2. When placing drypack grout, the temperature of the concrete, steel, and drypack grout shall be within the temperature range of 40° F to 90° F (5° C to 32° C) or as recommended by the manufacturer, determined by a surface thermometer. This temperature shall be maintained for 3 days following grouting.

### **5.04 INSPECTION AND QUALITY CONTROL**

- A. For epoxy grouts, a manufacturer's technical representative shall be called to the field office for a pre-grouting conference to assure that all grouting steps are followed in accordance with the manufacturer's instructions. The representative should remain at the jobsite until the Construction Manager is assured that the correct procedures are being followed and the warranty is not in jeopardy. The Structural Engineer shall be advised if the manufacturer's representative recommends anything contrary to this specification.
- B. The Construction Manager and Contractor shall implement contract document procedures for inspection, testing, and documentation. These procedures shall define the documentation that will be employed to assure that the certifications, examinations, tests and approvals required by the contract specifications are accomplished.
- C. Vertical support for equipment having a structural steel base frame and a stiffened cover plate is provided by grouting under the base frame. Compliance with the installation procedure established herein will preclude unacceptable voids. Incidental voids under the cover plate may not be detrimental or witnessed and approved by the construction engineer. It is important that the cover plate is sealed by grout against foreign elements.

**- END OF SECTION -**

## SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK

### **PART 1: GENERAL**

#### 1.01 SCOPE

- A. The provisions of this section are applicable to all the structural steel, miscellaneous metal work, and steel items required to complete the work as shown and specified in the contract documents.

### **PART 2: PRODUCTS**

#### 2.01 MATERIALS

- A. Plates, Shapes and Bars
  - 1. All structural steel shapes and bars, except wide flange and HP shapes, shall be purchased under the requirements of ASTM A36 "Standard Specification for Structural Steel," unless noted otherwise. Wide flange shapes shall conform to ASTM A992, GR-50. HP shapes shall conform to ASTM A572, GR-50.
  - 2. Plates shall be produced from cut lengths of flat product. Plates produced from coil are specifically disallowed. Plates shall be purchased oversized and cut to fabricated dimensions or purchased with sheared, gas, or plasma cut edges in exact sizes. Mill edge plates are not to be used in fabrication. Plates, shapes, and bars shall meet the dimensional requirement of ASTM A6.
- B. Structural Steel Tubing
  - 1. Structural Steel tubing shall be purchased under the requirement of ASTM A 500. Tensile requirements for square and rectangular tubing shall meet the requirements of Grade B (46 ksi minimum yield).
- C. Pipe
  - 1. Structural steel pipe shall be purchased under the requirements of ASTM A 53 Grade B, unless otherwise noted on the drawings.
- D. Grating.
  - 1. Bar Grating
    - a. Grating shall be welded galvanized steel bar grating, Irving type IWA or equal, with 1 ¼ in. x 3/16 in. bearing bars space

## SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK

1-3/16 in. on centers, unless noted otherwise on Contract Drawings. Grating shall be serrated.

- b. Banding of grating edges not required, unless noted on Contract Drawings. However, provide load-carrying bands at all openings through grating. Grating panels shall be attached to the supporting structure by welding or using anchor and/or clamp assemblies. If welded, use 2 in. of 3/16-in. fillet weld at maximum 12 in. on centers. If using clips, the spacing of attachment clips shall not exceed two (2) feet and there shall be no less than six (6) clip assemblies in any one piece of grating.

### E. Ladders

1. Unless otherwise noted on Contract Drawings, vertical ladders shall be fabricated using 3 1/2"x 1/2" side rails (with eased edges) spaced on eighteen (18) inch centers with 1" round bar rungs spaced on twelve (12) inch centers. Vertical ladders of more than twenty-four (24) feet in height shall have back cages installed beginning between seven and eight feet above the walkway or base elevation and extending to the upper extent of the vertical ladder stringers. The back cages shall be of form and construction to meet applicable OSHA requirements. Stringers shall extend above the top rung of the vertical ladders at least forty-two (42) inches to provide an adequate hand hold for entry and exit from the ladder, unless noted otherwise. Where required for safety, additional 1" square bar grip rungs shall be provided on adjacent structure to facilitate safe and convenient access to the vertical ladder. Support each ladder at top and bottom and at intermediate points where shown by means of welded or bolted steel brackets clear of the wall surface by not less than seven (7) inches.

### F. Handrails

1. Handrails are to be of the two-tier type with toe guard attached at grating level. Unless otherwise noted on Contract Drawings, handrail stanchions shall be 1 1/2" O.D. schedule 80 structural steel pipe with a maximum spacing of six (6) feet on centers and where possible shall be aligned with the transverse supporting framing below the grating for increased rigidity. The top tier of horizontal rail is to be 1 1/2" O.D. schedule 40 structural steel pipe. The intermediate tier of horizontal rail shall be 1 1/2" O.D. schedule 40 structural steel pipe and shall be equidistant from the top rail, and walkway finished surface. For steel walkways, a galvanized L-6"x3 1/2"x3/8" angle toe board is to be installed continuously between

## SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK

handrail stanchions with the bottom of the angle welded to the walkway stringer. For concrete installations, a four inch by one-quarter inch (4" x 1/4") painted flat bar kick plate is to be installed continuously between handrail stanchions with the bottom of the bar not more than one quarter inch (1/4") above the top of the finished surface.

2. Portable safety chain type rails are to be installed at all openings in the handrail perimeter. The chain rails are to be fabricated of 1/4" hot dipped galvanized chain. Attachments are to be welded 1/4" round bar eyelets at one end, and fitted with chain hooks with spring loaded safety clasp at the other end. Chain hooks and clasps are to be hot dipped galvanized. The chain hooks are to attach to 1/4" round bar eyelets welded to the handrail stanchion.

### G. Bolts, Threaded Rods, Nuts, and Washers

1. All bolts, anchors, and threaded rods that are not a portion of vendor-furnished equipment packages shall be purchased under the following ASTM Designations, as indicated in the design drawings: ASTM A307, ASTM A325, ASTM A449, ASTM A490, ASTM A193, or ASTM F1554. Nuts shall conform to ASTM A563, and washers shall conform to ASTM F436, unless the grade of bolt, anchor or threaded rod calls for matching nuts and washers from another specification. Where necessary, bolts may be purchased under the equivalent SAE specification of grade eight (8) if mechanical properties are shown to be equivalent. Bolts that are a part and/or accessory to vendor-purchased items shall meet the manufacturer's requirements as modified by special protective coating stipulations in this specification.
2. All bolts shall be of the size indicated on the contract and detail drawings and shall be UNC coarse thread series. Nuts shall be heavy hex series and fitted with hardened washers, lock washers, and/or other washers as indicated on the drawings.
3. All bolts nuts, and threaded holes in structural steel shall be thoroughly cleaned of any foreign matter including machining chips and oil before the bolts are installed. The threaded portion of the bolt to engage with the nut and/or the threaded steel shall be coated with a thread locking compound suitable for disassembly with hand tools
4. All bolts in slip-critical connections shall be tensioned to seventy (70) percent of the minimum tensile strength of the bolts using the turn of the nut method, or an accurately calibrated torque wrench.

## **SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK**

Torque shall be applied to the bolts immediately after the application of the thread-locking compound. Bolts that are found to be under the required torque value shall be removed, thoroughly cleaned, and reinstalled with another application of thread locking compound.

5. Impact wrenches, or other tools whose torque is not easily controlled, shall not be used without the written permission of the engineer.
6. Bolts that have been torqued with a calibrated wrench shall be marked with a semi-permanent marker to indicate that they have been tightened to specified value.
7. The bolts, nuts, and washers are to receive the same surface preparation and protective coating systems as the surrounding steel unless otherwise noted on the drawings or in the specification. Note that hot dipped galvanized bolts, nuts, washers, screws, and other similar items are to be used in conjunction with grating, and sheet metal that is specified to be hot dipped galvanized.

### **PART 3: SUBMITTALS**

3.01 The Contractor shall submit the following items in accordance with Section 01330, Submittal Procedures.

#### **A. SUBMITTALS FOR REVIEW**

1. Shop Drawings: Submit shop drawings for review prior to fabrication. Do not start fabrication until review of shop drawings by the engineer is complete. Prepare drawings in accordance with the latest edition of the AISC manual "Structural Steel Detailing" and including complete details, sections, materials, fabrication, assembly, and erection requirements, procedures and diagrams.
  - a. Indicate welds by standard AWS A2.1 and A2.4 symbols, and show size, length and type of each weld.
  - b. Provide setting drawings, templates and directions for installation of anchor bolts or other anchorages.
  - c. Include diameters of bolt holes, types, sizes and strengths of bolts; yield strength of steel; shop and field welding details; arc-welding electrode designation; and manufacturer's name, color, and number of coats of shop paint.

## SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK

- d. Include erection diagrams showing elevations and cross sections which will locate all members by piece mark and provide essential dimensions and necessary erection information.
  - e. Design all connections not shown on the contract drawings as per the AISC manual. Account for eccentricity in all connection designs.
  - f. Prohibit direct reproduction of the Contract Drawings for use as Shop drawings.
2. Test Reports: Assist independent testing agency in submitting reports of inspections and testing of structural steel.
    - a. Furnish the testing agency with the fabrication plant's schedule, in order for appropriate inspections to be accomplished.
    - b. Request the testing agency to conduct both visual inspections and torque sampling of mill-fabricated connections, at the rate of one test and sampling for each 50 tons of steel fabricated.
  3. Manufacturer's Mill Certificate: The Fabricator is required to obtain mill certificates from the supplier for all structural steel and furnish copies of the certificates to the Construction Manager and/or Engineer prior to fabrication. Mill Certificates shall properly account for all project steel, and shall be accompanied by an inventory list that provides the quantities and lengths of the steel in each supplied heat.
  4. Weld & Welder Qualification Documents (See Section 5.06 of this specification for more details):
    - a. Only AWS (American Welding Society) qualified welders shall be employed for welding. Submit a Welding Personnel Qualification Record (WPQR), to the Engineer for review at least three (3) weeks prior to using the welder.
    - c. For each anticipated class of weld, submit Weld Procedure Specifications (WPS) to the Engineer for review at least three (3) weeks prior to welding.

## **SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK**

5. Bolt tensioning procedures for snug, pretensioned, and slip-critical bolts, including methods, equipment, and torque values.
6. Submit samples of materials as requested by the engineer, including names, sources, and description.

### **PART 4: QUALITY ASSURANCE**

#### **4.01 REFERENCE**

- A. Comply with the requirements of the latest edition of the following standards (including all supplements and addenda), unless noted otherwise:
  1. AISC (American Institute of Steel Construction):  
"Steel Construction Manual"  
"Specification for Structural Joints Using High-Strength Bolts"  
"Code of Standard Practice for Steel Buildings and Bridges".
  2. AWS (American Welding Society):  
"Structural Welding Code-Steel" (AWS D1.1)  
"Welding Zinc-Coated Steel" (AWS D19.0)  
Other Applicable Standards
  3. BOCA (Basic Building Code)
  4. ASTM (American Society for Testing and Materials):  
Applicable Referenced Specifications.
  5. OSHA (Occupational Safety and Health Administration):  
As required by State and Federal Regulations.
- B. Where provisions of pertinent codes and standards conflict with these specifications, more stringent provisions shall govern.

#### **4.02 QUALIFICATIONS**

- A. Steel Fabricator shall be a member of the American Institute of Steel Construction or can further demonstrate at least ten (10) years of qualified experience, subject to the approval of the Engineer.

## **SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK**

- B. Qualify welding procedures, welders and welding operators in accordance with AWS D1.1. See Section 5.06 of this specification for further details.
- C. Fabricate structural steel members in accordance with AISC Code of Standard Practice.
- D. Maintain one copy of each document on site.
- E. Erector: Company specializing in performing the work of this section with a minimum of 5 years documented experience.
- F. Design connections not detailed on the drawings under direct supervision of a professional structural engineer experienced in design of this work and licensed in the Commonwealth of Pennsylvania.
- G. An independent testing laboratory may be employed by the Owner for the final detailed inspection of the work under this section. The Engineer may also elect to undertake this work. In either case, the following items apply:
  - 1. The testing agency (or Engineer) will inspect materials, workmanship, field welds, bolts and bolt tension and projection of bolt threads. The testing agency will follow specified and applicable AISC criteria and the inspection procedures specified in the "Specifications For Structural Joints Using ASTM A-325 or A-490 Bolts" for checking Hi-Tensile Bolt installation. Materials and workmanship not conforming to drawings and established standards of these specifications and/or references will be rejected by the Owner and shall be corrected at Contractor's expense.
  - 2. The Contractor shall allow access for such testing at all times.
  - 3. Testing on behalf of the Owner shall not relieve the Contractor of responsibility to comply with the provisions of these specifications.
- H. Inspection of material and workmanship in mill and shop, if required, will be performed by the Owner without expense to the Contractor, except as otherwise described in these Specifications. Contractor shall provide access to all areas of work to allow inspection as may be determined necessary by the Owner and Engineer. In either case, whether the Owner decides to require or omit Laboratory inspection in the shop, this shall not relieve the Contractor of the responsibility of providing and erecting steel in full accordance with the Specifications. Any steel not conforming may be rejected by the Engineer at any stage of construction, and shall be repaired or replaced by the Contractor, as

## SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK

required to satisfy all Contract requirements, all without additional cost to the Owner.

### **PART 5: EXECUTION**

#### **5.01 FABRICATION**

- A. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on the approved Shop Drawings. Provide camber in structural members as shown.
- B. Properly mark and match-mark materials for field assembly and for identification as to structure and site for which intended. Fabricate for delivery sequence, which will expedite erection and minimize field handling of materials.
- C. All fabricated members shall have shop marks matching the member designations on the approved shop drawings. Any finished members arriving onsite that are unlabeled, or do not match the approved shop drawings, shall be rejected.
- D. Furnish main steel members in one piece without splicing, unless otherwise noted on Contract Drawings or approved by the Construction Manager.
- E. Exclude bolt threads from shear planes in bearing type connections using high-strength bolts.
- F. Provide either welded or bolted shop connections, except as noted on Contract Drawings. Provide bolted or welded field connections at contractor's option, except as noted on Contract Drawings.
- G. Remove all cracks, porosities, spatter, slag inclusions, incomplete fusions, and incomplete penetrations over ½ in. long in any 12 in. length of weld, and reweld as required.
- H. Mill ends of columns and other members in direct bearing.
- I. Contractor to verify all existing dimensions and elevations before fabrication. The completed structure shall be dimensionally accurate to the extent that parts shall move and function freely without unnecessary strain, wear, vibration or deflections.
- J. In regard to items not indicated on the drawings or referenced in the specifications or contract, the requirements of the Code of Standard

## **SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK**

Practice for Steel Buildings and Bridges as contained in the AISC Manual of Steel Construction – Thirteenth Edition shall be applicable.

- K. General dimensional tolerances not specified on the drawings shall meet the requirements of the Code of Standard Practice referenced above. Dimensional tolerances for fitting at joints to be welded shall meet the requirements of AWS D1.1 for pre-qualified and/or Fabricator-qualified welding procedures.
- L. All workmanship must be first-class in all respects, and any exposed members not presenting a finished and workmanlike appearance will be rejected. All finished members shall be free from twist, bends or open joints.
- M. All members shall be true to length so that assembling may be done without fillers, except where same are required as detailed. There shall be no projecting edges or corners where different members are assembled.
- N. All coping, blocking and mitering shall be done with care.
- O. All welds on exposed surfaces shall be ground smooth and flush with the adjacent surfaces.
- P. All details and connections shall be carefully made and fitted and special care shall be exercised to produce a thoroughly neat and workmanlike appearance. All detail pieces shall be made in exact accordance with detail drawings and all projecting corners clipped and all filler pieces made flush.
- Q. Provide all lugs, clips, connections, bolts and the like, necessary for complete fabrication and erection, and to engage with the adjacent construction. Provide setting diagrams for loose items to be built into concrete work indicating location, elevation and projection of loose items. All bolts remaining in the finished, exposed work shall be hexagon head bolts with hexagon nuts. Bolts shall be of proper length to permit full thread in the nut, but shall not project more than 1/4" beyond the face of the nut.
- R. Burning shapes to length in the shop with a standard flamecutting machine will be permitted. There shall be no burning in the field without the consent of the Owner. If consent is given, burned members shall be finished to an acceptable appearance which shall be the equal of a sheared finish. Burning of holes will not be permitted in the shop or in the field.

## SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK

- S. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.

### 5.02 MATERIAL HANDLING

- A. Where possible, material shall be handled with slings, straps, and/or plate clamps to minimize the attachment of welded plate clips and lifting lugs to the structure. Where necessary, lifting clips, eyes, and lugs may be fitted on a temporary basis and removed after member erection. Where this course is followed, the base material shall be refinished to original surface condition by welding gouges and grinding surface irregularities to a flush finished condition.
- B. In areas where lifting lugs may be left on the structure without detriment to the function or appearance to the structure, the Fabricator shall be permitted to leave the lifting attachments permanently in place. Where this course is followed, the lugs shall be fabricated using optical or numerically controlled burning equipment and shall have smooth finishes on all cut surfaces. In addition, the attachments shall be welded continuously and shall receive surface preparation and protective coating systems identical to the surrounding structure to which they are attached.
- C. Material shall be stored so as to avoid contact with the ground, and shall be protected against weathering. Material shall be stored in a manner to insure that no members, protruding flanges, stiffeners, gussets plates, and other attachments are bent or otherwise damaged during storage. During transport, material shall be similarly secured so as to protect it from excessive vibration, abrasion, impact, weather, and anything else which could damage the material or coating.
- D. If such defects or damage in material cannot be corrected in the field to the entire satisfaction of the Engineer, the material shall be returned to the shop, or new parts furnished, as the Engineer will direct. The Contractor shall pay all expenses for such actions.
- E. Material determined unacceptable by the Engineer shall be corrected or replaced as required, all at Contractor's expense.

### 5.03 MATERIAL PREPARATION

- A. Material shall be carefully cut to length and dimensioned using optical or numerical burning equipment, saws, shears, etc. where possible. Material that is cut using hand torches shall be carefully ground to finished dimensions and to remove any edge irregularities prior to fabrication.

## **SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK**

- B. Holes for bolts, pins, and miscellaneous attachments shall be drilled or bored. Flame burning is not allowed to prepare holes in structural steel with the exception of using flame burning to remove excessive material prior to finishing the parts with machine tools.
- C. Where special grades of steel are required, those being steel grades other than ASTM A 36, the individual parts are to be clearly marked with semi-permanent markers to indicate the steel grade from which the part has been fabricated.
- D. The Fabricator shall protect all material from extended ground contact, exposure to corrosive environment, weld spatter, or other conditions that will adversely affect the milled surface finish on the material to be used in fabrication.

### 5.04 CLEANING AND PAINTING

- A. Clean and paint all structural steel as outlined in Sections 099000 and 099626, unless noted otherwise. If a structural steel section is designated to be hot-dip galvanized, galvanize in accordance with Section 099110.
- B. Do not shop coat:
  - 1. Surfaces within 2 in. of field welds.
  - 2. Contact surfaces of slip-critical high-strength bolted connections.
- C. After erection and inspection, erection contractor shall field paint all unpainted surfaces and abraded spots with primer and finish coats as outlined the appropriate Section.
- D. For galvanized steel that will be welded after galvanizing, refer to Section 051200.5.06.

### 5.05 ERECTION

- A. Brace and maintain all steel in alignment until other parts of construction necessary for permanent bracing or support are completed.
- B. Install temporary guys and bracing to safely resist wind loading designated in applicable building code.
- C. Set threads of machine bolts to prevent loosening.

## **SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK**

- D. Tighten bolts in slip-critical connections by the "turn-of-nut" or calibrated wrench methods as specified in the Specification for Structural Joints Using ASTM A325 or A490 Bolts.
- E. Contact surfaces of slip-critical connections shall be free of oil, grease, rust, mill scale, etc.
- F. After erection and inspection, paint with shop paint all unpainted surfaces, abraded spots, and bolt heads and nuts.
- G. Base plates, complete with anchor bolts shall be accurately located and leveled with instruments. When leveling bolts are not required by the drawings, proper steel shims shall be provided for leveling the base plates. Wood shims will not be permitted to be used for leveling steel base plates or masonry plates. Provide grout holes in base plates as shown on drawings.
- H. No shims will be allowed between compression/tension members and base plates.
- I. Compression members shall not be spliced except as shown on drawings or as authorized in writing by Engineer.
- J. Erect compression and tension members plumb and true, in positions indicated. All work shall be formed, fabricated and erected or installed true to lines, levels, and dimensions, plumb and square. Level and plumb individual members of the structure within specified AISC tolerances.
- K. All beams shall be fabricated with crown of mill camber at top.
- L. Do cutting, punching, drilling and tapping as required for attachment of other work coming in contact with miscellaneous metal work where so indicated or where directions for same are given prior to or with approval of shop drawings. Do necessary cutting, drilling and fitting required for installation of miscellaneous metal work. Execute drilling, cutting, fitting carefully and where required, fit work at job before finishing. Flame cutting or hole burning will not be accepted, unless specifically approved.
- M. Form all work true to detail, with clean, straight, sharply defined profiles. Metals shall have smooth finish surfaces except where otherwise specified. Finish curved work to true radii, using easy curves.
- N. Wherever exposed, welds shall be ground smooth and polished to match finish to adjacent metals using filler metal compatible with base metal.

## **SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK**

- O. Install all supporting members, fastenings, framing, hangers, bracing brackets, straps, bolts, angles as required to set, connect work rigidly and properly to steel, masonry or other construction.
- P. Finished work shall be free from warp, twists, bends or open joints and shall present a clean and workmanlike appearance.
- Q. Faulty work shall be immediately corrected at no additional expense to the Owner.
- R. Unless shown on drawings, Anchorage to concrete shall be accomplished by use of built-in anchors or expansion bolts. Expansion bolts or cartridge driven stud anchorage will be allowed only for fastening to concrete, but will not be permitted for fastening to masonry. Wood plugs will not be permitted for fastening in any walls.

### 5.06 WELDING

#### A. General

1. Welding details shall conform to the size and configurations indicated on the contract and Fabricator-prepared detail drawings. Unless otherwise noted and approved by the Engineer, all exterior welding shall be continuous.
2. All welding shall fully comply with the requirements of AWS D1.1 Structural Welding Code – Steel. Other welding procedures may be considered by the Engineer on a per case basis; however, requests for variance from AWS code requirements will normally be denied.
3. Welds shall not be water quenched. For field welding to be performed in the tidal zone, the base metal within 3" of the proposed weld shall be preheated to fully dry the material prior to welding.
4. In general, electrodes shall be new, or reconditioned, at the start of each work shift. The Contractor shall strictly adhere to the atmospheric exposure and baking requirements of Clause 5 of AWS D1.1, and shall provide suitable holding and conditioning ovens onsite, as necessary.

#### B. Welding Procedures

1. Formal written welding procedure specifications (WPS) shall be prepared by the Contractor and submitted to the Engineer for review prior to the commencement of fabrication. All WPS shall be either

## SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK

prequalified in accordance with AWS, or qualified by the Fabricator on a case-by-case basis.

2. The formal WPS shall contain all variables listed in AWS Table 3.8, including: sketches indicating joint geometry and access or backing holes; welding process; base material specification and thickness limits; backing material specification and dimensions; groove preparation dimensions and tolerances, permitted welding positions; electrode rod, wire, flux and gas shield information; current type, range and polarity; and preheat and interpass temperature ranges.
3. Welding procedures that are not pre-qualified by AWS D1.1, and are to be qualified by the Fabricator, shall be qualified in accordance with AWS D1.1 in the presence of the Engineer and/or his designated representative.
4. Allowable welding processes are shielded metal arc welding (SMAW), gas metal arc welding (GMAW), flux core arc welding (FCAW), and submerged arc welding (SAW). As such, the following filler material requirements are to be used on all grades of steel used on this project:

SMAW	E70X5(-X), E70X6(-X), E70X8(-X)
SAW	F7X-EXXX-X
GMAW	ER70S-X
FCAW	E7XTX-X (Except -2, -3, -1-, -GS)

Higher filler metal strengths may be required when welding materials in groups III and IV of AWS D1.1 Table 3.1.

5. Submerged arc welding, while being very efficient on thick material, sometimes produces excessive distortion on light gauge materials. Where the Fabricator desires to use submerged arc welding on material of less than one-half (1/2) inch in thickness, it shall be demonstrated to the Engineer that excessive distortion of the material can be effectively controlled.
6. Short circuiting transfer (short arc) welding produces low heat input into parent material and is useful for preventing excessive distortion when welding relatively thin steel shapes and plate. Penetration produced by short arc welding is minimal and often times insufficient for highly stressed parts. Short arc welding will only be considered on certain thin plate structures where stress levels are relatively low. Specific written approval of the engineer is required for the use of short arc welding.

## **SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK**

7. All bevel welds shown without penetration size shall be complete joint penetration welds.
8. Backing bars shall be removed from all accessible complete joint penetration welds.
9. When the 'all-around" welding symbol is used at an end connection of a rolled shape, the Contractor shall terminate the weld at each of the flange edges, and one weld thickness away from each intersection of the web and flange, unless noted otherwise.
10. Parts to be joined by fillet welds shall be brought into close contact, and the root opening shall not be permitted to exceed 3/16 in, unless written permission is granted by the Engineer. If the root opening separation is greater than 1/16 in, the legs of the fillet weld shall be increased by the size of the root opening.

### **C. Welders and Welding Operator Qualifications**

1. Each welder or welding operator shall be qualified in accordance with AWS D1.1. Welding Personnel Qualification Records shall be submitted to the Engineer for review.
2. WPQRs shall contain all of the variables listed in AWS Table 4.12, and shall be applicable to the welds that a given welder proposes to perform on the project.
3. If the qualification test listed on the WPQR is more than six (6) months old, a detailed employment history and letter must accompany the WPQR to certify that the welder has been engaged in the welding process in question since the date of original qualification.

### **D. Welding Galvanized Steel**

1. Prior to welding surfaces that have been previously hot dip galvanized, all zinc coating must be removed from either side of the intended weld zone, and on both sides of the piece.
2. Zinc coating may be removed by grinding or burning. If the coating is removed by burning, the surface shall be further ground or cleaned to remove combustion byproducts and other impurities.
3. Welding shall be performed in Accordance with AWS D19.0.

## **SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK**

4. In order to prevent excessive heat that could damage the adjacent galvanized coating, weave beads shall not be permitted.
5. Recoat areas after the completion of welding in accordance with the Contract Drawings and Section 099110.

### **5.07 REWORK AND FAIRING**

- A. Fabricated steel that is out of dimensional tolerances and/or not fair to the eye may be replaced and/or repaired by the Fabricator. If heat fairing is to be used, the material shall not be heated to more than twelve hundred (1200) degrees Fahrenheit. During heat fairing procedures, the Fabricator shall monitor the material temperature with temp sticks or lacquer, surface applied thermocouple gauges, or some other suitable form of temperature measuring system.

### **5.08 WELD INSPECTION**

- A. Inspection of welded splices of main material and all complete penetration welds selected by the Engineer shall be by a testing laboratory selected by the Engineer and paid by the Owner, unless noted otherwise. All weld testing shall be in accordance with the AWS, unless otherwise modified hereinafter.
- B. The Contractor shall cooperate with and assist the Owner with the inspection of welds.
- C. Unless noted otherwise, visual inspection of all welds will be made by the Contractor. A record of this inspection shall be maintained by the Contractor.
- D. The Contractor shall correct improper workmanship and remove, replace or correct as instructed all welds found unacceptable or deficient by the Engineer. The Contractor shall pay for all corrections.
- E. Send five copies of reports on all required testing directly to the Engineer.

### **5.09 COMPLETION**

- A. Upon Completion or when directed, conduct careful inspection and correct all defective work.

**SECTION 05 12 00 - STRUCTURAL STEEL & METAL WORK**

- B. Remove scrap, litter and debris resulting from operations specified herein, and leave work and the premises in clean satisfactory condition, ready to receive subsequent work.

**- END OF SECTION -**

## **SECTION 09 90 00 - PAINT & COATINGS**

### **PART 1: GENERAL**

#### 1.01 SCOPE

##### A. Work Included

Paint and finish all surfaces listed in the Painting Schedule, Part Five of this Section. Provide all touch up and remedial painting as required until the work is accepted by the Engineer.

##### B. Work Not Included

1. Painting specified under other sections.
2. Unless otherwise indicated, painting is not required on surfaces in concealed areas and inaccessible areas.
3. Metal surfaces of anodized aluminum, stainless steel, chromium plate, copper, bronze, and similar finished materials will not require painting under this Section except as may be specified herein.
4. Do not paint any moving parts of operating units; mechanical or electrical parts such as valve operators, linkages, sensing devices, and motor shafts, unless otherwise indicated.
5. Do not paint over any required labels or equipment identification, performance rating, name, or nomenclature plates.

##### C. Definitions

The term "paint", as used herein, means all coating systems materials including primers, emulsions, epoxy, enamels, sealers, fillers, and other applied materials whether used as prime, intermediate, or finish coats.

### **PART 2: PRODUCTS**

#### 2.01 MATERIAL

##### A. Design

Design is based on use of paint products manufactured by Glidden or Rustoleum, and the materials of those manufacturers are named in the Painting Schedule. Equal products of Sherwin-Williams or other manufacturers may be used if approved by Engineer.

## SECTION 09 90 00 - PAINT & COATINGS

### B. General

Provide the best quality grade of the various types of coatings as regularly manufactured by paint materials manufacturers approved by Engineer. Materials not displaying the manufacturer's identification as a standard best-grade product will not be acceptable.

### C. Durability

Provide paints of durable and washable quality. Do not use paint materials which will not withstand normal washing as required to remove pencil marks, ink, ordinary soil, and similar material without showing discoloration, loss of gloss, staining, or other damage.

### D. Colors and Glosses

Paint colors shall be as specified below, or Owner approved equal, unless noted otherwise on the Contract Drawings:

- Handrail - Sherwin Williams Safety Yellow (SW 4084)
- Cleats - Sherwin Williams Safety Yellow (SW 4084)
- Bollards - Sherwin Williams Safety Yellow (SW 4084)
- Walkway Stringers- Sherwin Williams Blueprint (SW 4058)
- All other structural steel - Primer only.

The Construction Manager will be the sole judge of acceptability of the various glosses obtained from the materials supposed to be used in the Work.

### E. Undercoats and Thinners

Provide undercoat paint produced by the same manufacturer as the finish coat. Use only the thinners recommended by the paint manufacturer, and use only to the recommended limits. Insofar as practicable, use undercoat, finish coat, and thinner material as parts of a unified system of paint finish.

### F. Standards

Provide paint materials, which meet or exceed the standards listed for each application in the Painting Schedule in Part Five of this Section.

## **SECTION 09 90 00 - PAINT & COATINGS**

### 2.02 APPLICATION EQUIPMENT

#### A. General

For application of the approved paint, use only such equipment as is recommended for application of the particular paint by the manufacturer of the particular paint, and as approved by Engineer.

#### B. Compatibility

Prior to actual use of application equipment, use all means necessary to verify that the proposed equipment is actually compatible with the material to be applied and that the integrity of the finish will not be jeopardized by use of the proposed application equipment.

### 2.03 OTHER MATERIALS

- A. All other materials, not specifically described but required for a complete and proper installation of the work of this Section, shall be new, first-quality of their respective kinds, and as selected by the Contractor subject to the approval of the Engineer.

## **PART 3: SUBMITTALS**

- 3.01 Contractor shall submit the following in accordance with Section 013300, Submittal Procedures:

- A. Submit recommended color, paint specifications, proposed application procedure, and manufacturer contact number three weeks prior to painting.

## **PART 4: QUALITY ASSURANCE**

### 4.01 QUALIFICATIONS

- A. Qualification of Manufacturer  
Products used in the work of this Section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production acceptable to the Engineer.
- B. Qualifications of Workmen

## **SECTION 09 90 00 - PAINT & COATINGS**

1. Provide and identify by name, at least one person who shall be present at all times during execution of the work of this Section, who shall be thoroughly familiar with the specified requirements and the materials and methods needed for their execution, and who shall direct all work performed under this Section.
2. Provide adequate numbers of workmen skilled in the necessary crafts and properly informed of the methods and materials to be used.
3. In acceptance or rejection of the work of this Section, the Engineer will make no allowance for lack of skill on the part of workmen.

### **C. Paint Coordination**

1. Provide finish coats, which are compatible with the prime coats used.
2. Review other Sections of these Specifications as required, verifying the prime coats to be used and assuring compatibility of the total coating system for the various substrata.
3. Upon request, furnish information on the characteristics of the specific finish materials to ensure that compatible prime coats are used.
4. Provide barrier coats over non-compatible primers, or remove the primer and reprime as required.
5. Notify the Engineer in writing of anticipated problems in using the specified coating systems over prime coating supplied under other Sections.

### **D. In addition to complying with all pertinent codes and regulations, comply with all pertinent recommendations contained in the latest revision of the following publications of the Steel Structures Painting Council:**

1. SSPC-SP-1 Solvent Cleaning
2. SSPC-SP-2 Hand Tool Cleaning
3. SSPC-SP-3 Power Tool Cleaning
4. SSPC-SP-4 Flame Cleaning
5. SSPC-SP-5 White Metal Blast Cleaning

## **SECTION 09 90 00 - PAINT & COATINGS**

6. SSPC-SP-6 Commercial Blast Cleaning
7. SSPC-SP-7 Brush Off Blast Cleaning
8. SSPC-SP-8 Pickling
9. SSPC-SP-9 Weathering Blast Cleaning
10. SSPC-SP-10 Near White Metal Cleaning

### **PART 5: EXECUTION**

#### **5.01 PRODUCT HANDLING**

##### **A. Delivery of Materials**

Deliver all materials to the painting site in original, new, and unopened containers bearing the manufacturer's name and label showing at least the following information:

1. Name or title of the material
2. Fed. Spec. number, if applicable
3. Manufacturer's stock number
4. Manufacturer's name
5. Contents by volume for major constituents
6. Thinning instructions
7. Application instructions

##### **B. Do not bring to the job site any paint or solvent containers bearing the name of a material that has not been specified.**

##### **C. Storage of Materials**

Provide proper storage to prevent damage to and deterioration of, paint materials in accordance with manufacturer recommendations.

##### **D. Protection**

## SECTION 09 90 00 - PAINT & COATINGS

Use all means necessary to protect the materials of this Section before, during, and after installation and to protect the work and materials of all other trades.

### E. Replacements

In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

## 5.02 JOB CONDITIONS

### A. Surface Temperatures

Do not apply any paints when the temperature of surfaces to be painted or the surrounding air temperature are below 45 degrees F, unless otherwise permitted by the manufacturer's printed instructions as approved by the Engineer. Do not apply any paints when the temperature of the surfaces to be painted or the surrounding air temperature is above 99 degrees F.

### B. Weather Conditions

Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85%; or to damp or wet surfaces; unless otherwise permitted by the manufacturer's printed instructions as approved by the Engineer. Applications may be continued during inclement weather within the temperature limits specified by the paint manufacturer during application and drying periods.

## 5.03 SURFACE CONDITIONS

### A. Inspection

Prior to installation of the work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence. Verify that painting may be completed in strict accordance with the original design and with the manufacturer's recommendations as approved by the Engineer.

### B. Discrepancies

Do not proceed in areas of discrepancy until all such discrepancies have been fully resolved.

## SECTION 09 90 00 - PAINT & COATINGS

### 5.04 MATERIALS PREPARATION

#### A. General

1. Mix and prepare painting materials in strict accordance with the manufacturer's recommendations as approved by the Engineer.
2. Store materials not in actual use in tightly covered containers.
3. Maintain containers used in storage, mixing, and application of paint in a clean condition, free from foreign materials and residue.

#### B. Stirring

Stir all materials before application to produce a mixture of uniform density, and as required during the application of materials. Do not stir into the material any film, which may form on the surface. Remove the film and, if necessary, strain the material before using.

### 5.05 SURFACE PREPARATION

#### A. General

1. Perform all preparation and cleaning procedures in strict accordance with the paint manufacturer's recommendations, federal, state, local environmental regulations and as approved by the Engineer.
2. Remove all removable items, which are in place and not scheduled to receive paint finish, or provide surface-applied protection prior to surface preparation and painting operations.
3. Following completion of painting in each space or area, reinstall the removed items by using workmen skilled in the necessary trades.
4. Clean each surface to be painted prior to applying paint or surface treatment.
5. Remove oil and grease with clean cloths and cleaning solvents. Change rags as they become dirty. Unless otherwise specified, the general purpose solvent to be used for cleaning under normal conditions shall be aliphatic or aromatic solvents, alcohol esters, chlorinated hydrocarbons, or mixtures of these substances, with a minimum flash point of 100 F. In hot weather (temperatures between 80 and 95 F) a solvent that has a minimum flash point of

## SECTION 09 90 00 - PAINT & COATINGS

120 F shall be used. In very hot weather (temperatures over 95 F) solvent with a flash point over 140 F shall be used.

6. Schedule the cleaning and painting so that dust and other contaminants from the cleaning process will not fall onto wet newly painted surfaces.

### B. Preparation of Wood Surfaces

Not applicable

### C. Preparation of Metal Surfaces

1. Thoroughly clean all surfaces until they are completely free from dirt, oil, and grease.
2. On galvanized surfaces, use solvent for the initial cleaning and then treat the surface thoroughly with phosphoric acid etch. Remove all etching solution before proceeding.
3. Allow to dry thoroughly before the application of paint.
4. Before sandblasting, remove all deposits of oil and grease by the methods described in SSPC-SP-1.
5. Clean in compliance with the provisions of SSPC-SP-10.

## 5.06 PAINT APPLICATION

### A. General

1. Slightly vary the color of succeeding coats. Do not apply additional coats until the completed coat has been inspected and approved. Only the inspected and approved coats of paint will be considered in determining the number of coats applied.
2. Sand and dust between enamel coats to remove all defects visible to the unaided eye from a distance of five feet.
3. On all removable panels and all hinged panels, paint the back sides to match the exposed sides.
4. Prime all blasted surfaces as soon as possible within the same working day and before any visual rusting, blushing, or blooming occurs. Should any of these conditions develop before the paint is applied, these areas must be reblasted.

## SECTION 09 90 00 - PAINT & COATINGS

### B. Drying

1. Allow sufficient drying time between coats. Modify the period as recommended by the material manufacturer to suit adverse weather conditions.
2. Oil-base and oleo-resinous solvent-type paints shall be considered dry for recoating when the paint feels firm, does not deform or feel sticky under moderate pressure of the thumb, and the application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

### C. Brush Application

Brush out and work all brush coats onto the surfaces in an even film. Cloudiness, spotting, laps, brush marks, runs, sags, and other surface imperfections will not be acceptable.

### D. Spray Application

1. Confine spray application to metal framework and similar surfaces where hand brush work would be inferior.
2. Wherever spray application is used, apply each coat to provide the equivalent hiding of brush applied coats. Do not double back with spray equipment for the purpose of building up film thickness of two coats in one pass.

### E. Completed Work

Shall match the approved Samples for color, texture, and coverage. Remove, refinish, or repaint all work not in compliance with specified requirements.

### F. Finish Paint

Finish paint on all structural steel shall be accomplished in the shop prior to shipment to the job site. Touch up all abrasions, welds, connections and other bare metals with primer and finish coats after erection.

### G. Overspray

Overspray will not be permitted. Should overspray occur, remove the overspray with a stiff wire brush or by sanding. Air-blow the affected area to remove all traces of overspray and repaint as necessary.

## **SECTION 09 90 00 - PAINT & COATINGS**

### 5.07 PAINTING SCHEDULE

- A. Provide a three coat system, prime coat of compatible Zinc Primer, 3 to 5 mils total dry thickness.
- B. Provide an Intermediate epoxy coat of 3 to 5 mils total dry thickness.
- C. Provide a finish coat of acrylic urethane with a minimum total dry film thickness of 2 to 4 mils.
- D. Color Chart

The color of the coatings shall be per Owner's requirements. The contractor shall obtain Owner's approval of the color two weeks prior to the purchase of the coatings. The handrail and guardrail shall be painted safety yellow.

### 5.08 PAINTED PRODUCT HANDLING

- A. After a product is painted, the Contractor and painting Subcontractor shall protect the coating from chipping, abrasion, or other damage during storage, transport, placement, and subsequent construction. Any damage to the coating system shall be repaired at the Contractor's expense.

**- END OF SECTION -**

## SECTION 09 91 10 – HOT DIP GALVANIZING

### **PART 1: GENERAL**

#### 1.1 SCOPE

This specification covers iron and steel materials to be hot dip galvanized after manufacturing or fabrication.

##### A. Work Included

All structural steel members and miscellaneous metal work including bolts, washers, nuts, angles, inserts, plates, and other fabrications shall be hot-dip galvanized.

##### B. Work not included

Do not hot-dip galvanize items which are specified under other sections to be painted or coated.

### **PART 2: PRODUCTS**

#### 2.1 STEEL MATERIALS

A. Material for galvanizing to be geometrically suitable for galvanizing as described in ASTM A384 and A385. Steel materials suitable for galvanizing include structural shapes, pipes, sheet, fabrications, and assemblies.

B. Material to be chemically suitable for galvanizing.

### **PART 3: SUBMITTALS**

3.1 The Contractor shall submit the following in accordance with Section 013300, Submittal Procedures:

A. The Contractor shall submit the coating applicator's notarized Certificate of Compliance that the hot dip galvanized coating meets or exceeds the specified requirements of ASTM A123, A767 or A153 (as applicable).

### **PART 4: QUALITY ASSURANCE**

#### 4.1 REFERENCES

A. Publications

## SECTION 09 91 10 – HOT DIP GALVANIZING

1. American Galvanizers Association (AGA)
  - a. Inspections of Products Hot Dip Galvanized After Fabrication
  - b. The Design of Products to be Hot Dip Galvanized After Fabrication
  - c. Recommended Details for Hot Dip Galvanized Structures
2. Research Council on Structural Connections of the Engineering Foundation:
  - a. Specification for Structural Joints Using ASTM A325 or A490 bolts.

### B. Reference Standards

1. American Society for Testing and Materials (ASTM):
  - a. A123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  - b. A143 Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
  - c. A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  - d. A384 Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Articles
  - e. A385 Providing High-Quality Zinc Coatings (Hot-Dip)
  - f. A767 Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
  - g. A780 Repair of Damaged Hot-Dip Galvanized Coatings
2. Federal Specifications
  - a. DOD-P-21035, Paint, High Zinc Dust Content, Galvanizing Repair
  - b. MIL-P-26915, Primer Coating, Zinc Dust Pigmented

## SECTION 09 91 10 – HOT DIP GALVANIZING

### 4.2 QUALIFICATIONS

#### A. Acceptable Coating Applicators

1. Coating Applicator: Company specializing in hot dip galvanizing after fabrication and following the procedures of the Quality Assurance Manual of the American Galvanizers Association.

## **PART 5: EXECUTION**

### 5.1 FABRICATION REQUIREMENTS

- A. Fabricate structural steel in accordance with Class (I), (II), or (III) guidelines, as described in the American Galvanizers Association (AGA) *Recommended Details for Hot Dip Galvanized Structures*.
- B. Fabrication practices for products shall be in accordance with the applicable portions of ASTM A143, A384, and A385, except as specified herein. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.
- C. The Fabricator shall consult with the Engineer and hot dip galvanizer regarding potential problems or potential handling problems during the galvanizing process which may require modification of design before fabrication proceeds.
- D. Remove all welding slag, splatter, anti-splatter compounds and burrs prior to delivery for galvanizing.
- E. Provide holes and / or lifting lugs to facilitate handling during the galvanizing.
- F. Avoid unsuitable marking paints. Consult with the galvanizer about removal of grease, oil paint and other deleterious material prior to fabrication.
- G. Remove by blast cleaning or other methods surface contaminants and coatings which would not be removable by the normal chemical cleaning process in the galvanizing operation.

### 5.2 APPLICATION OF COATING

- A. Galvanize steel members, fabrications, and assemblies after fabrication by the hot dip process in accordance with ASTM A123.

## SECTION 09 91 10 – HOT DIP GALVANIZING

- B. Galvanize bolts, nuts and washers, and iron and steel hardware components in accordance with ASTM A153.
- C. Safeguard products against steel embrittlement in conformance with ASTM A143.
- D. Handle all articles to be galvanized in such a manner as to avoid any mechanical damage and to minimize distortion.

### 5.3 COATING REQUIREMENTS

- A. Coating Weight: Conform to paragraph 5.1 of ASTM A123, Table 1 of A767, or Table 1 of ASTM A153, as appropriate.
- B. Surface Finish: Continuous, adherent, as smooth and evenly distributed as possible and free from any defect detrimental to the stated end use of the coated article.
- C. Adhesion: Withstand normal handling consistent with the nature and thickness of the coating and normal use of the article.

### 5.4 TESTS

- A. Inspection and testing of the hot dip galvanized coatings shall be done under the guidelines provided in the AGA publication *Inspection of Products Hot Dip Galvanized After Fabrication*.
- B. Include visual examination and tests in accordance with ASTM A123, A767 or A153 as applicable to determine the thickness of the zinc coating on the metal surface.
- C. Furnish Notarized Certificate of Compliance with ASTM Standards and Specifications herein listed. The Certificate must be signed by the galvanizer and contain a detailed description of the material processed. The Certificate shall include information as to the ASTM standard used for the coating.

### 5.5 REPAIR OF DAMAGED COATING

- A. The maximum area to be repaired is defined in accordance with ASTM A123 Section 4.6 current edition.
  - 1. The maximum area to be repaired in the field shall be determined in advance by mutual agreement between parties.

## **SECTION 09 91 10 – HOT DIP GALVANIZING**

- B. Repair areas where the coating has been damaged or removed by welding, flame cutting or during handling, transport or erection by one of the approved methods in accordance with ASTM A780 whenever damage exceeds 3/16" in width. Minimum thickness requirements for the repair are those described in the current edition of ASTM A123, section 4.6.

**END OF SECTION**

## **SECTION 09 96 26 - COATING OF STEEL WATERFRONT STRUCTURES**

### **PART 1: GENERAL**

#### 1.1 SCOPE

This section covers coating of steel waterfront structures construction requirements for marine structures located within or forming part of Owner's operating units.

##### A. Work Included

All hot rolled steel piles as shown and specified in the contract documents are included under this section.

##### B. Work not included

Do not include items that are specified under other sections to be painted or coated.

### **PART 2: PRODUCTS**

#### 2.1 COATING SYSTEM

##### A. Coal Tar Epoxy

1. Provide SSPC Paint 16 Coal Tar Epoxy in prime coat and top coat.

### **PART 3: SUBMITTALS**

#### 3.1 The Contractor shall submit the following in accordance with Section 013300, Submittal Procedures:

- A. The Contractor shall submit a description of the coating system to the Engineer for review. Authorization to proceed shall be obtained at least two weeks prior to coating steel structures.

### **PART 4: QUALITY ASSURANCE**

#### 4.1 REFERENCE

- A. All specifications, standards, and codes referred to in this specification shall be the latest revision of the same and considered a part of this specification to the extent referenced.

## SECTION 09 96 26 - COATING OF STEEL WATERFRONT STRUCTURES

### **PART 5: EXECUTION**

#### 5.1 ENVIRONMENTAL CONDITIONS

- A. Start work only when ambient and curing temperatures are within limits of coating manufacturer's recommendations. All coating shall be accomplished in accordance with federal, state, and local codes and regulations.

#### 5.2 SAFETY AND HEALTH PRECAUTIONS

- A. Materials listed in this section contain coal tar pitch volatiles, which are toxic. Follow safety procedures as recommended by manufacturer. Work in a well ventilated area. Provide, and require workers to use, impervious clothing, gloves, face shields (8-inch minimum), and other appropriate protective clothing necessary to prevent eye and skin contact with coating materials. Keep coatings away from heat, sparks and flame.

#### 5.3 CLEANING AND PREPARATION OF SURFACES

##### 5.3.1 Solvent Cleaning

SSPC SP. 1. Remove visible oil, grease, and drawing and cutting compounds by solvent cleaning.

##### 5.3.2 Blast Cleaning

SSPC SP 10. After solvent cleaning, complete surface preparation by near-white blast cleaning. Remove residual dust from blasted surface by blowing with dry, oil-free air, vacuuming, or sweeping. Provide surface profile of at least 1 ½ to 2 ½ -mil thickness.

#### 5.4 PROPORTIONING AND MIXING OF COATING SYSTEM

##### 5.4.1 Proportioning of Coal Tar Epoxy System

Proportion components as dictated by the product manufacturer.

##### 5.4.2 Mixing of Epoxy-Polyamide System

Mix components of coating by power stirring until a smooth, uniform consistency results, or as dictated by the product manufacturer. Stir coating periodically during its induction period. Follow Table 1 for induction time and pot life of mixed batches.

## **SECTION 09 96 26 - COATING OF STEEL WATERFRONT STRUCTURES**

### 5.4.3 Temperatures

Follow all manufacturer guidelines for allowable application temperatures and induction times.

## 5.5 COATING APPLICATION

### 5.5.1 General

Apply primer coating to dry surfaces not more than 4 hours after near-white blast cleaning. Apply coats of each system so that finished surfaces are free from runs, sags, brush marks and variations in color.

### 5.5.2 Application Method for Coal Tar Epoxy System

Allow previous coat to dry to tack-free condition but not more than 72 hours before applying next coat. If more than 72 hours elapses between coats, clean surface, apply a 2 mil wet film thickness of previous coat, allow to cure to a tacky film, and apply a full thickness of next coat.

### 5.5.3 Repair of Defects

Repair detected coating holidays, thin areas, and exposed areas damaged prior to or during installation by surface treatment and application of additional coating or by manufacturer's recommendations. Allow a period of at least 72 hours to pass following final coat before placing in immersion service.

### 5.5.4 Two-Coat Coal Tar Epoxy System

Apply each coat at a dry film thickness of between 8 mils and 10 mils. Where product manufacturer recommends that the product be applied in three coats, apply each coat at a dry film thickness of between 5 mils and 8 mils.

### 5.5.5 Dry Film Thickness

Provide total system minimum dry film thickness of 16 mils to 20 mils. Measure using a magnetic gage.

### 5.5.6 For HP or pipe piles, leave 6 inches of one end of each pile section uncoated for field splices. Further leave the top 2 feet of each pile uncoated for vibratory hammer grip.

## 5.6 FIELD TESTS

## **SECTION 09 96 26 - COATING OF STEEL WATERFRONT STRUCTURES**

Conduct testing in presence of the Engineer.

### **5.6.1 Holiday Testing**

Prior to installation, test for holidays in total coating system. Use a low-voltage holiday detector of less than 90 volts in accordance with manufacturer's instructions. After repair of holidays by surface treatment and application of additional coating or by manufacturer's recommendation, retest with a low-voltage holiday detector.

### **5.6.2 Dry Film Thickness**

After repair of holidays, measure dry film thickness using a magnetic dry film thickness gage in accordance with ASTM D 1186 and ASTM E 376. Re-measure after an additional coat is applied, and add it to meet minimum thickness requirements.

**- END OF SECTION -**

## SECTION 31 00 00 - EARTHWORK

### **PART 1 : GENERAL**

#### 1.1 WORK SPECIFIED

- A. Excavation, embankment, and backfilling, including the loosening, removing, refilling, transporting, storage, and disposal of all materials classified as "earth" necessary for the construction and completion of all waterfront work under the Contract.
- B. Excavation to the widths and depths shown on the Drawings or as specified.
- C. Dewatering excavation, removal, and discharge of water.

#### 1.2 DEFINITIONS

##### A. Excavation

1. Removal of materials of whatever nature encountered, whether natural or manmade, wet, frozen, or otherwise, including dense tills, hardpan, cemented materials, concrete fragments, asphalt pavement, boulders or rock fragments, and weathered rock which can be removed by ripping or excavating with heavy-duty mechanical construction equipment without drilling and blasting.
2. Grubbing, stripping, removing, storing and rehandling of all materials of every name and nature necessary to be removed for all purposes incidental to the construction and completion of all the Work under construction.
3. All sheeting, sheet piling, bracing and shoring, and the placing, driving, cutting off, and removing of the same.
4. All diking, ditching, fluming, cofferdamming, pumping, bailing, draining, well pointing, or otherwise disposing of water.
5. The removing and disposing of all surplus materials from the excavations in the manner specified.
6. The supporting and protecting of all tracks, rails, buildings, curbs, sidewalks, pavements, overhead wires, poles, trees, vines, shrubbery, pipes, sewers, conduits, or other structures or property in the vicinity of the Work, whether over or underground, or which appear within or adjacent to the

## SECTION 31 00 00 - EARTHWORK

excavations, and the restoration of the same in case of settlement or other injury.

7. All temporary bridging and fencing and the removing of same.

### B. Earth

1. All materials such as sand, gravel, clay, loam, ashes, cinders, pavements, muck, roots, or pieces of timber, soft or disintegrated rock, not requiring blasting, barring, or wedging from their original beds, and specifically excluding all ledge or bedrock and individual boulders or masonry larger than 1/2 cubic yard (cy) in volume.

### C. Backfill

1. The refilling of excavation and trenches to grades shown on the Drawings, or as otherwise required to complete the Work, using suitable materials which have physical properties that match the requirements of this Specification for use in refilling of excavations and trenches; and the compacting of all materials used in filling or refilling by rolling, ramming, or as may be required and approved by the Construction Manager.

### D. Spoil

1. Surplus excavated materials not required or excavated materials which have physical properties that limit their suitability for use as backfill or placement for embankments.

### E. Embankments

1. The placement of general fill material above the original grade or such other elevation as specified or directed.

### F. Limiting Subgrade

1. The underside of the pipe barrel for pipelines.
2. The underside of footing lines for structures.
3. The bottom of the lowest course for pavement sections.

### G. Excavation Below Subgrade

## **SECTION 31 00 00 - EARTHWORK**

1. Excavation below the limiting subgrades of structures, pipelines, or pavements.
2. Where materials encountered at the limiting subgrades are not suitable for proper support of structures, pipelines, or pavement the Contractor shall excavate to such new lines and grades as required.

### **PART 2 : PRODUCTS**

#### **2.1 MATERIALS**

##### **A. Wood Sheeting and Bracing**

1. Shall be sound and straight; free from cracks, shakes, and large or loose knots; and shall have dressed edges where directed.
2. Shall conform to National Design Specifications for Stress Grade Lumber having a minimum fiber stress of 1,200 pounds per square inch (psi).
3. Sheeting and bracing shall be removed, except where specifically approved in writing by the Construction Manager to remain.

##### **B. Steel Sheeting and Bracing**

1. Shall be new or in excellent condition.
2. Shall conform to ASTM A328 with a minimum thickness of 3/8 inch.
3. Shall conform to OSHA Subpart P, Excavations Section 1926.652(C) Design of Support Systems, Shield Systems, and Other Protective Systems.
4. Sheeting and bracing shall be removed, except where specifically approved in writing by the Construction Manager to remain.

##### **C. General Fill Material**

## **SECTION 31 00 00 - EARTHWORK**

1. Free of rocks or lumps larger than 3 inches, loam, organic matter, very soft clays, swelling clays, or fine uniform sands that may be difficult to compact.
2. General fill may be obtained from existing onsite areas designated for excavation or from an offsite source to be approved by the Construction Manager.
3. General fill may be composed of soils with any ASTM D2487 Group Symbol except CH, MH, OL, and OH.

### **PART 3 : SUBMITTALS**

- 3.1 The Contractor shall submit a plan, two (2) weeks prior to the start of the field operations, showing the safeguards, barriers, fences, bridges, planks, and warning signs required for a safe excavation.
- 3.2 All falsework, shoring and structural support plans and calculations shall be submitted to the Owner, for review, two (2) weeks prior to the use. Calculations shall be performed and sealed by a professional engineer registered in the Commonwealth of Pennsylvania.
- 3.3 The Contractors shall submit, at least two (2) weeks prior to the start of backfilling operations, lab test results for gradation and modified proctor density tests for all backfill material. If the contractor proposes to reuse excavated material as backfill, the lab tests shall be performed on the excavated material stockpile.
  - A. Moisture and Density relationships for the modified proctor density tests shall be determined in accordance with ASTM D 1557, Method C.
- 3.4 The Contractor shall submit reports of the field density testing of compacted backfill at the end of each work shift in which backfilling was performed.

### **PART 4 : QUALITY ASSURANCE**

#### **4.1 REFERENCES**

- A. American Society for Testing and Materials (ASTM).
- B. PennDOT Publication 408: Specifications

## SECTION 31 00 00 - EARTHWORK

- C. Subpart P, "Excavations" of United States Department of Labor OSHA Regulations for Construction.
- D. Quality of Life Performance Standards (QoLPS).

### **PART 5 : EXECUTION**

#### 5.1 REMOVAL OF WATER

##### A. General

1. At all times, provide and maintain proper and satisfactory means and devices for the removal of all water entering the excavations, and remove all such water as fast as it may collect, in such manner as to not interfere with the prosecution of the Work or the proper placing of pipes, structures, or other Work. Removal of water which enters excavations shall be coordinated with the Construction Manager.
2. Unless otherwise specified, all excavations which extend down to or below the static groundwater elevations shall be dewatered by lowering and maintaining the groundwater beneath such excavations at all times when Work thereon is in progress, during subgrade preparation, and placing of the structure or pipe thereon.
3. Water shall not be allowed to rise over or come in contact with any new masonry, concrete, or mortar until at least 48 hours after placement, and authorized by the Construction Manager.
4. Where the presence of fine-grained subsurface materials and a high groundwater table may cause the upward flow of water into the excavation with a resulting quick or unstable condition, install and operate an approved well point system designed by a licensed Professional Engineer (P.E.) registered in the Commonwealth of Pennsylvania to prevent the upward flow of water during construction. Services for the design of a dewatering system shall be obtained by the Contractor at no addition cost to the Owner.
5. Water pumped or drained from excavations, or any sewers, drains, or water courses encountered in the Work, shall be disposed of in a suitable manner without injury to adjacent property, the Work under construction or to pavement,

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roads, drives, and water courses. All water discharge points shall be approved by the Construction Manager. No water shall be discharged to sanitary sewers, waters or wetlands of the Commonwealth.

6. Provide filtration and erosion control at all water discharge points in accordance with all applicable environmental regulations.
7. Any damage caused by or resulting from dewatering operations shall be the sole responsibility of the Contractor and shall be repaired at no additional cost to the Owner.

### **B. Work Included**

1. Construction and removal of cofferdams, sheeting, and bracing and the furnishing of materials and labor necessary therefore.
2. Excavation and maintenance of ditches and sluiceways.
3. Furnishing and operation of pumps, well points, and appliances needed to maintain thorough drainage of the Work in a satisfactory manner.

### **C. Well Point Systems**

1. Installation
  - a. The well point system shall be designed and installed by or under the supervision of an organization whose principal business is well pointing, and which has at least five consecutive years of similar experience and can furnish a representative list of satisfactory similar operations.
  - b. Well point headers, points, and other pertinent equipment shall not be placed within the limits of the excavation in such a manner or location as to interfere with the laying of pipe or trenching operations or with the excavation and construction of other structures.
  - c. Detached observation wells of similar construction to the well points shall be installed at intervals of not less than 50 feet along the opposite side of the excavation

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from the header pipe and line of well points, to a depth of at least 5 feet below the proposed excavation. In addition, one well point in every 50 feet shall be fitted with a tee, plug, and valve so that the well point can be converted for use as an observation well. Observation wells shall be not less than 1½ inches in diameter.

- d. Standby gasoline or diesel-powered equipment shall be provided so that in the event of failure of the operating equipment, the standby equipment can be readily connected to the system. The standby equipment shall be maintained in good order and actuated regularly, not less than twice a week. Standby gasoline or diesel equipment selected shall comply with Noise QoLPS.

### 2. Operation

- a. Where well points are used, the groundwater shall be lowered and maintained continuously (day or night) at a level not less than 2 feet below the bottom of the excavation. Excavation will not be permitted at a level lower than 2 feet above the water level as indicated by the observation wells.
- b. The effluent pumped from the well points shall be examined periodically by qualified personnel to determine if the system is operating satisfactorily without the removal of fines.
- c. The water level shall not be permitted to rise until construction in the immediate area is completed as determined by the Construction Manager, and the excavation backfilled.

### 5.2 EXAMINATION

- A. Verify that survey benchmarks and existing elevations are as shown on the Drawings.
- B. The Contractor shall locate and mark locations of monitoring wells requiring protection prior to commencement of excavation. Protect existing monitoring wells from damage during performance of the Work. Damage to existing monitoring wells resulting from Contractor activities shall be repaired by the Contractor, to the

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satisfaction of the Construction Manager, at no additional cost to the Owner.

- C. Existing installations: Installations that require protection shall be protected by the Contractor during the entire duration of the Project. Any damage to existing installations resulting from Contractor activities shall be repaired by the Contractor, to the satisfaction of the Construction Manager, at no additional cost to the Owner.
- D. For the purpose of obtaining detailed locations of underground obstruction, make excavations in advance of the Work. Advance the excavation sufficiently to allow re-alignment of the Work without impact to the schedule should obstructions be encountered. Consider such Work as incidental to the Work involved, and no separate payment will be made for such Work.

### 5.3 PREPARATION

- A. Site excavation permit must be completed and submitted to CM for approval prior to initiating excavation.
- B. Prepare Site for excavation Work including clearing and grubbing; inspection and sealing of permanent structures; and establishment of property boundaries, excavation limits, and pre-excavation elevations.
- C. Demolish and dispose of all remaining non-permanent structures/items scheduled for removal or removal and replacement in-kind, as shown on the Drawings.
- D. Identify required lines, levels, contours, and datum locations.
- E. Locate, identify, and protect utilities from damage. Confirm locations of buried utilities and structures (if any) by suitable means.
- F. Arrange for Dig Safe to identify and stake out utilities prior to beginning Work.
- G. Protect plant life, trees, and other features not scheduled for removal. Trees must be approved by Construction Manager.
- H. Maintain and protect from damage benchmarks and survey control points, monitoring wells, utilities, buildings, building foundations, surface features, and any other structures encountered not designated for demolition or removal. In the event of disturbance of

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or damage to any such structures, immediately notify Construction Manager. Any damage or disturbance to such structures resulting from Contractor activities shall be repaired by the Contractor, to the satisfaction of the Construction Manager, at no additional cost to the Owner.

- I. Install sediment and erosion control devices.

### 5.4 SHEETING AND BRACING

#### A. Installation

1. Furnish, place, and maintain such sheeting, bracing, and shoring as may be required to support the side and ends of excavations in such manner as to prevent any movement which could, in any way, injure the pipe, structures, or other Work; diminish the width necessary for construction; otherwise damage or delay the Work of the Contract; endanger existing structures, pipes or pavements; or cause the excavation limits to exceed the right-of-way limits.
2. In no case will bracing be permitted against pipes or structures in trenches or other excavations.
3. Sheeting shall be driven as the excavation progresses and in such manner as to maintain pressure against the original ground at all times. The sheeting shall be driven vertically with the edges tight together, and all bracing shall be of such design and strength as to maintain the sheeting in its proper position.
4. The Contractor shall be solely responsible for the adequacy of all sheeting and bracing. The Contractor shall hire a Professional Engineer licensed in the Commonwealth of Pennsylvania to design all excavation support.

#### B. Removal

1. In general, all sheeting and bracing, whether of steel, wood, or other material, used to support the sides of trenches or other open excavations, shall be withdrawn as the trenches or other open excavations are being refilled. That portion of the sheeting extending below the top of a pipe or structural foundation shall not be withdrawn, unless otherwise directed, before more than 6 inches of earth is placed above the top of the pipe or structural foundation and before any bracing is

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removed. The voids left by the sheeting shall be carefully refilled with selected material and rammed tight with equipment especially adapted for the purposes.

2. Do not remove sheeting and bracing until the Work has attained the necessary strength to permit placing of backfill.

### C. Left in Place

1. If the Contractor files a written request for permission to leave sheeting or bracing in the trench or excavation, the Construction Manager may grant such permission, in writing, on condition that the cost of such sheeting and bracing be assumed and paid by the Contractor, at no additional cost to the Owner.
2. In case sheeting is left in place, it shall be cut off or driven down as directed so that no portion of the same shall remain within 12 inches of the street subgrade or finished ground surface. The locations and depth elevations of all sheeting left in place shall be marked on the Drawings and submitted to the Construction Manager at Project completion.

## 5.5 EXCAVATION

- A. General Requirements: Excavation shall include the removal of all types of materials encountered without exception. Excavated material approved for backfill may be stored at an approved convenient site for reuse. All excavation shall be made to the lines and grades indicated on the drawings or as specified herein.
- B. Upon reaching the required subgrade, all loose dirt and debris shall be removed from the excavation.
- C. After completion of excavation work, and prior to commencement of work on the structures, fill or backfill, the excavation shall be inspected by the Contractor to ensure that suitable foundation elevations have been reached and the surfaces have been properly prepared. The excavation shall be protected from wash by tide, storm, and surface run-off.
- D. Shoring and Bracing: The Contractor shall provide all shoring, bracing, and sheeting of excavations required to properly and safely complete the work as shown on the drawings and in accordance with current OSHA guidelines. Shoring, bracing, and sheeting shall be removed as the excavations are backfilled in a

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manner to prevent caving. Dikes shall be employed to prevent surface run off from entering the excavation.

- E. Bailing and Pumping: The Contractor shall perform all bailing and pumping necessary to drain and keep all excavation, pits, trenches, foundations and the entire site free of water during the progress of the work. Proposed methods and equipment for dewatering shall be submitted to the Engineer, prior to use, and be suitable for the conditions.
- F. Over-Excavation: Over-excavation shall be corrected by placing and compacting suitable backfill material to a density of 95% Modified Standard Procedures for dry density as determined by ASTM 1557. Contractor shall perform field test using nuclear gauges to determine in-place density of moisture content (PA Test Method No. 402) and submit results to the Engineer.
- G. Make excavations to such angles of repose as may be required by OSHA guidelines and to keep the base area of excavations free from sliding or falling debris, as required for the safety of personnel working within the excavation as permitted by prior consent of the Owner.
- H. Dispose and record all excavated material not suited for backfill off the site. Suitable material for backfill may be retained and stockpiled adjacent to the excavation with prior approval of the Owner.
- I. Do not stockpile backfill in any area that can hinder dock operations or which shall prevent the free runoff of surface water, or slope excavation to prevent free runoff, and provide embankments, as shall be required to prevent the entry of surface water into any excavation.
- J. Keep the excavations free of standing or running water, and provide all equipment and perform all work to permit the work to be carried on therein. Take care that removed water does not cause washing or injury to the work.

### 5.6 STORAGE & DISPOSAL OF MATERIALS

#### A. Topsoil

- 1. Topsoil suitable for final grading shall be removed and stored for future reuse separately from other excavated material.

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2. All topsoil which is planned to be stored for longer than 30 days shall be hydroseeded within 5 days of being stockpiled.

### B. Excavated Materials

1. All excavated materials shall be stored in locations approved by the Construction Manager so as not to endanger the Work and so that easy access may be had at all times to all parts of the excavation. Stored materials shall be kept neatly piled and trimmed.
2. Special precautions must be taken to permit and not restrict emergency services access to all areas of the Site and at all times.
3. Topsoil and excavated material shall not be removed from the Site unless otherwise directed by the Construction Manager.

### C. Spoil Material

1. Spoil material shall be placed at pre-approved stockpile locations, as directed by the Construction Manager. Locating, maintaining, and transporting to the stockpiles shall be the responsibility of the Contractor at no additional cost to the Owner.
2. Unsuitable spoil material shall be disposed of at a location on site, identified by the Construction Manager. Locating, maintaining, and transporting to such Sites shall be the responsibility of the Contractor at no additional cost to the Owner.
3. When it is necessary to haul material over the streets or pavement, provide suitable tight vehicles so as to prevent deposits on the street or pavements. In all cases where any materials are dropped from the vehicles, clean same as often and as continuous as required to keep the crosswalks, streets, and pavements clean and free from dirt, mud, stone, and other hauled material.

## 5.7 BACKFILLING

### A. General

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1. All excavations shall be backfilled to original grade or to such other grades as may be shown, specified, or directed.
2. Backfilling shall be done with suitable excavated materials which can be satisfactorily compacted during refilling of the excavation. In the event the excavated materials are not suitable, the Owner will provide a stockpile of suitable material from off-site and provide to the Contractor at the site.
3. Backfilling around structures shall not be commenced before the structure has developed sufficient strength to withstand the loads applied. No backfill material shall be allowed to fall directly on a structure until at least 12 inches of material have been placed and compacted, nor shall any material be pushed directly against a structure in backfilling.
4. Backfill shall be deposited in loose horizontal layers not exceeding 8 inches in thickness and at no greater thickness than can be compacted to obtain the specified minimum densities.
5. Any settlement occurring in the backfilled excavations shall be refilled and compacted.
6. Backfilling operations shall not be permitted next to recently installed concrete until the concrete has cured for a minimum of seven (7) days.

### **B. Compaction and Density Control**

1. The compaction shall be as specified for the type of earthwork (i.e., structural, trenching, or embankment).
  - a. Compact to achieve a 95% modified proctor density, in accordance with ASTM D1557.
  - b. The compaction specified shall be the percent of maximum dry density.
  - c. The compaction equipment shall be suitable for the material encountered.
2. Where required to assure adequate compaction, in-place density test shall be made by an approved testing laboratory, at no additional cost to the Owner.

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- a. The moisture-density relationship of the backfill material shall be determined by ASTM D 1557, Method C.
    - 1) Compaction curves for the full range of materials used shall be developed.
  - b. In-place density shall be determined by the methods of ASTM D1556 or ASTM D2922 and shall be expressed as a percentage of maximum dry density.
3. Where required, to obtain the optimum moisture content, add, at no additional cost to the Owner, sufficient water during compaction to assure the specified maximum density of the backfill. If, due to rain or other causes, the material exceeds the optimum moisture content, it shall be allowed to dry, assisted if necessary to meet the schedule, at no additional cost to the Owner, before resuming compaction or filling efforts.
  4. Compaction is not completed unless approved by the Construction Manager.

### C. Unsuitable Materials

1. Stones, pieces of rock, or pieces of pavement greater than 1 cubic foot in volume or greater than 1½ feet in any single dimension shall not be used in any portion of the backfill.
2. All stones, pieces of rock, or pavement shall be distributed through the backfill and alternated with earth backfill in such a manner that all interstices between them shall be filled with earth.
3. Frozen earth shall not be used for backfilling.

## 5.8 PROTECTION

- A. Take all necessary precautions for the safety and protection of employees and the public, with specific consideration of neighbors.
- B. Provide and daily maintain all safeguards, barriers, fences, bridges, planking, shoring, danger and warning signs, flares, lights, and detours.

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- C. Prior to any excavation, backfilling or construction operations, adequately protect by shoring, sheet piling or other means all structures, paving, utilities, and other existing objects from damage.
- D. Should a utility or service line be disrupted or otherwise damaged, arrange for the immediate restoration of the temporary service until substantial and proper corrective repairs and/or replacement can be made. Immediately inform the Owner, the Engineer, and the utility company. Provide a written statement of the occurrence within 24 hrs to the Owner and the Engineer.
- E. When, for any reason, the Work is to be left unfinished, all trenches and excavations shall be filled and all roadways, sidewalks and watercourses left unobstructed with their surfaces in a safe and satisfactory condition. The surface of all roadways and sidewalks shall be restored with gravel until the final asphalt or concrete surface is installed.
- F. Where an existing utility, service, equipment, or facility is damaged, the same shall be repaired to its original condition at no cost to the Owner.
- G. The Contractor shall be responsible for all damage or injury done to pipes, structures, property or persons due to improper placing or compacting of backfill.
- H. Care must be taken during excavation to prevent damage to existing features that shall remain. Any damage to existing features, such as the timber deck or concrete foundations, shall be repaired by the Contractor at no additional cost to the owner. The repairs shall restore the original capacity of the damaged element, and be acceptable to the Engineer and Owner
- I. It shall be the sole responsibility of the Contractor to control the dust created by any and all of his operations to such a degree that it will not endanger the safety and welfare of the general public.
- J. Dust control may require use of a water truck. When necessary, water trucks shall be supplied by the Contractor at no cost to the Owner.

### 5.9 UNAUTHORIZED EXCAVATION

- A. Description

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1. Whenever excavations are carried beyond or below the lines and grades shown on the Drawings, or as given or directed by the Construction Manager, all such excavated space shall be refilled with special granular materials, concrete, or other materials as the Construction Manager may direct. All refilling of unauthorized excavations shall be at no additional cost to the Owner.
  
2. All material which slides, falls, or caves into the established limits of excavations due to any cause whatsoever, shall be removed and disposed of at no additional cost to the Owner and no extra compensation will be paid to the Contractor for any materials removed and disposed, and any materials required for refilling the void areas left by the slide, fall, or cave-in.

- END OF SECTION -

## SECTION 31 62 16.19 - STEEL PIPE PILES

### **PART 1: GENERAL**

#### **1.1 SCOPE**

This specification covers steel pipe pile construction requirements for marine structure foundations located as shown on the construction documents. The number, size, and tip elevations of piles are shown on the contract drawings.

### **PART 2: PRODUCTS**

#### **2.1 MATERIAL**

- A. Pile material shall conform to ASTM A252, Grade 3, with a minimum yield stress of 50 ksi. The carbon equivalency (CE) of steel for pipe piles, as defined by AWS D1.1, Section XI-5.1, shall not exceed 0.45. As ASTM A252 is not a material specification, pile material certificates shall identify the applicable base metal for the determination of weldability. Base metals shall be prequalified, or qualified in accordance with AWS D1.1.
- B. Spiral Weld piles are acceptable, provided that all welds are qualified CJP welds; performed in accordance with AWS D1.1, capable of passing 100% UT testing to the criteria given in Table 6.3 of AWS D1.1.
- C. Pile tips shall be square and blunt, as received from the mill, unless beveled for field splicing.
- D. Pile Points, if required, shall be made of cast steel conforming to ASTM A27, Grade 65-35 or ASTM A148, Grade 90-60.
- E. Materials delivered to the site shall be new, undamaged, full length and shall be accompanied by certified test reports prior to, or at the time of, delivery.
- F. Inspect piles when delivered and when in the planned location immediately before driving. Piles shall be handled so as to protect piles from damage. Repair damage or defects in the pile prior to driving. Cut piles at cutoff grade by an approved method. Store piles at least six inches above ground, with timber blocking between the ground and the piles and between piles in a stack.

#### **2.2 COATINGS**

## SECTION 31 62 16.19 - STEEL PIPE PILES

If coating is required by the Contract Documents, piles shall be cleaned and coated with coal tar epoxy in the shop, in accordance with Section 099626, unless noted otherwise on Contract Drawings.

### **PART 3: SUBMITTALS**

- 3.1 The Contractor shall submit the following in accordance with Section 013300, Submittal Procedures:
- A. The Contractor shall submit pile driving hammer specifications, lead details, and drawings showing the driving sequence of installing piles to the Engineer for review, two (2) weeks prior to mobilization. Drawings shall include a plan showing the location of each individually numbered pile and fabrication details of false work, templates, bracing and other temporary support structures for installing piling.
  - B. The Contractor shall employ an Engineer registered in the State of Pennsylvania to design the falsework for pile installation. The calculations and drawings of falsework, sealed and signed by the registered Engineer shall be immediately submitted for review, if requested by the Owner's Engineer. The Engineer will review that the falsework has been designed and sealed by a registered PE, and that the falsework will not adversely impact any existing or proposed structures or elements. The Engineer's review will not encompass checking or approval of the falsework design concept, intent or calculations. The Contractor-appointed Professional Engineer will submit proof of professional liability insurance coverage equal to or greater than the Owner's requirements, and will assume all liability relating to the design of the falsework.
  - C. The Contractor shall perform and submit the results of the wave equation analysis (WEAP Analysis), to determine the characteristics of the hammer to be used for pile driving and pile driving criteria, if required by the Contract, at least two (2) weeks prior to mobilization. If it is determined after mobilization that a new hammer is required, a new submittal shall be made at least three (3) weeks prior to use of the hammer.
  - D. Mill material certificates, including mechanical properties, base metal identification, and chemical composition documentation shall be submitted to the Engineer for approval at least one (1) week prior to material procurement. At a minimum, the chemical analysis report shall include carbon, phosphorous, sulfur and manganese contents. Mill Certificates shall properly account for all project steel, and shall be accompanied by an inventory list that provides the quantities and lengths of the steel in each supplied heat.

## **SECTION 31 62 16.19 - STEEL PIPE PILES**

- E. A sample pile driving recording form shall be submitted to the Engineer for approval, at least two (2) weeks prior to initiating the pile driving operation.
- F. Submit complete and accurate job pile driving records on a daily basis.
- G. Only AWS (American Welding Society) qualified welders shall be employed for welding. Submit a Welding Personnel Qualification Record (WPQR), containing all variables listed in AWS Table 4.12, to the Engineer for review at least three (3) weeks prior to using the welder. If the qualification test listed on the WPQR is more than six (6) months old, a detailed employment history and letter must accompany the WPQR to certify that the welder has been engaged in the welding process in question since the date of original qualification.
- H. For each anticipated class of weld, submit Weld Procedure Specifications, containing joint geometries and all variables listed in AWS Table 3.8, to the Engineer for review at least three (3) weeks prior to welding. In general, only Welding Procedures that are prequalified, or have been qualified in accordance with AWS, shall be used.
- I. The Contractor shall submit As-Built drawings indicating the location of driven piles on a weekly basis.
- J. If it is not possible to drive a pile at the location shown on the contract drawings, the Engineer shall be notified and an alternate pile location requested. The contractor shall afford the Engineer three (3) calendar days to accommodate pile location and relocation. No payment shall be made to the Contractor for the delay due to the relocation of piles.
- K. The Contractor shall submit the results of each dynamic test, including CAPWAP analyses, within 3 days of the test, if dynamic testing is required by the Contract.

### **PART 4: QUALITY ASSURANCE**

#### **4.1 REFERENCE**

- A. Comply with the provisions specified in the latest revision of the following codes and standards, including all supplements and addenda:
  - 1. IBC (International Building Code).
  - 2. AISC (American Institute of Steel Construction) - Manual of Steel Construction.

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3. AWS D1.1 (American Welding Society) – Structural Welding Code.
4. AISC (American Institute of Steel Construction) - Manual of Steel Construction, Volume 2, Connections.

### 4.2 QUALIFICATIONS

- A. The contractor shall have a minimum of five (5) years of experience in marine pile driving and installation.

## PART 5: EXECUTION

### 5.1 PREPARATION

- A. Falsework shall **NOT** be attached to the existing structures. Falsework shall be removed and disposed off site at the end of construction work, unless noted otherwise.
- B. Obtain approval of all hammers. The Contractor shall perform and submit the results of the wave equation analysis (driveability analysis) to determine the characteristics of the hammer to be used for pile driving and pile driving criteria, if required by the Contract. This criterion may be modified by the Engineer, based upon the results of Pile Dynamic Tests, if required by the Contract. No additional compensation shall be made to the Contractor for any modifications to the criteria.
- C. Pile hammers shall be approved air, steam, diesel or hydraulic powered hammers, with a minimum rated energy of 13,000 ft-lobbs per blow, and shall be provided with an acceptable means of measuring hammer energy in the field. The hammer and pile shall be supported in fixed leads, unless specifically approved by the Engineer. Offshore leads shall not be used. Leads shall be designed with guys or braces, as necessary, to hold the pile firmly in position, remain concentric with the hammer, and provide support to the pile during driving.
- D. Use driving methods which will not cause damage to the pile being driven, including placing pile points or conical tips on the tip, providing UHMW pads at the falsework to protect the coating, and providing additional lateral bracing to reduce the effective length of the pile. The contractor shall protect existing piles, structures, mechanical equipment, pipelines and utilities from damage. Contractor shall include price for shoring and all other means necessary to protect the existing structure in his bid. Any

## SECTION 31 62 16.19 - STEEL PIPE PILES

damage to the existing structures, proposed structures, utilities, and piping shall be repaired by the Contractor at his own expense.

- E. Notify the adjacent land owners, leasees and building occupants, in writing, of the pile driving operation, at least 10 calendar days prior to mobilization. Copies of these correspondences shall be provided to the Owner.
- F. Notify the Engineer at least 24 hours prior to any pile driving. Where this is not feasible, the Contractor shall provide enough notice that the Engineer is able to witness pile driving.
- G. Measure and mark piles visibly with paint. Measurements shall be marked at each linear foot, with the following exceptions: Measurements along the bottom half of the pile may be marked at five foot intervals, and measurements in the top ten feet of the pile shall be marked at six inch intervals, or less, as required by the engineer. Measurements of six inches or less shall be marked with soapstone, or some other medium thin enough to negligible to the dimension being measured.

### 5.2 INSTALLATION & TESTING

- A. All excavation, removal of debris and obstructions, required within the area where piles are to be installed shall be completed prior to placing piles, unless noted otherwise in the Contract.
- B. Piles shall be carefully located as shown on the Contract Drawings, or directed by the Engineer. Pipe piles shall be driven open-end unless noted otherwise on the Contract Drawings. Piles shall be placed plumb and true to line or to the batter specified. Temporary wales, templates, or other falsework guide structures shall be provided to ensure that the piles are placed and driven to correct alignment after the removal of falsework, and that the hammer remains properly aligned during driving.
- C. Where plumb and batter piles shall be driven in a two-pile bent configuration, the Engineer recommends that the batter pile in each bent be driven before the corresponding plumb pile, as obstructions to the batter pile are generally more likely and could necessitate the relocation of the bent.
  - a. The tops of installed batter piles may be temporarily pulled out of design position to facilitate the installation of corresponding plumb piles. The pulling force must not be of sufficient magnitude to cause yielding, in the pile, and must be fully released before the pile bent connection is made.

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Such details shall be included in the pile driving plan submittals to be made prior to the initiation of pile driving.

- b. If the Contractor chooses to drive the plumb pile first, and an obstruction is subsequently encountered with the batter pile that requires relocation of the bent, the Contractor shall extract and re-drive the plumb pile in the new location at no additional cost to the Owner.
- D. Piles may be set using a vibratory hammer. At least the last 15 feet of the pile section shall be driven with an approved impact hammer.
- E. Operate the hammer at the manufacturer's rated speed and deliver hammer blows to the central axis of the pile.
- F. Except for making required splices, or for restrikes on test piles, impact-drive each pile continuously to the driving criteria specified on the Contract Drawings. Piles shall be cut off at the specified elevation once the Engineer confirms that they have met the driving criteria.
- G. The contractor shall record blow counts on a per foot basis for each pile and for each inch of penetration for at least the last 3 foot of driving.
- H. Records of the pile driving operations shall be submitted daily. These records shall provide a system of identification which shows the location of approved piles in the work, driving equipment performance data, pile dimensions and top and bottom elevations, and splicing of the installed piles.
- I. A minimum of 20 blows per inch obtained for 3 consecutive inches will constitute hammer refusal. If hammer refusal is reached, the contractor shall immediately notify the engineer so that the engineer may determine whether a larger hammer is necessary.
- J. Do not damage previously driven and existing piles during driving operations.
- K. Re-drive piles which have heaved due to driving adjacent piles or by soil uplift at no additional cost to the Owner.
- L. The proposed method of extracting existing or proposed piling shall be submitted and approved prior to extracting any piling.
- M. Jetting of piles is NOT permitted.
- N. Pre-drilling of piles is NOT permitted.

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- O. Perform dynamic testing of piles, as indicated on the Contract Drawings, in accordance with ASTM D4945. Do not perform pile re-strikes using a cold hammer. The results of the pile testing, including CAPWAP analysis, shall be submitted to the Engineer, within three (3) days of testing. A minimum of two CAPWAP analyses shall be performed on each dynamically tested pile. One CAPWAP shall be performed at the beginning of restrike, and the other shall be performed at a depth of the Engineer's choosing. No piles shall be driven until the Engineer has reviewed the test results, and the Engineer may revise the driving criteria based on the test results. It may be allowed to vibrate and splice other piles to a depth approved by the Engineer.

### 5.3 SPLICES & WELDING

- A. Unless noted otherwise on the Contract Drawings, not more than one splice shall be permitted in piles up to 100 feet in length, and not more than two splices shall be permitted in piles greater than 100 feet in length but shorter than 160 feet in length. The contractor shall obtain written approval of proposed splice locations from the engineer prior to purchasing pile material. Use of individual pile sections less than 8 feet in length shall not be permitted.
- B. Splicing of piles shall be performed as shown on the Contract Drawings using a CJP B-U4a prequalified butt weld capable of developing the full strength of the pile, in accordance with AWS D1.1. Only Engineer-approved splice backing rings shall be allowed (see below). The contractor shall submit a splicing detail and WPS for review at least two weeks prior to moving on the site.
- C. Splice backing rings shall have a minimum width of 1.5 times the pipe pile wall thickness or 2.5 inches, whichever is greater. Splice backing rings shall be made continuous for the full length of the weld, and any joints in the backing rings shall be CJP groove welded prior to splicing. Backing ring shall have a minimum thickness of 1/4 inch and shall be continuous. The attachment of the backing ring to the pile ends shall be done using the minimum size and spacing of tack welds. Tack welding shall be done in the root area of the weld splice. The gap between the backing ring and the pipe pile wall shall be no greater than 5/64 inch. One localized portion of the backing ring fit-up that is twenty (20) percent (%) of the outside circumference of the pipe pile, as determined by the Engineer, may be offset by a gap equal to or less than 1/4 inch provided this portion is first seal welded.

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- D. Except for tack welding, GMAW shall not be used for welding of pipe piles. When GMAW is used for tack welding, the electrode shall not be deposited by short circuit transfer.
- E. All welding shall be in accordance with AWS D1.1, using low-hydrogen E70XX electrodes, unless noted otherwise on Contract Drawings.
- F. In general, electrodes shall be new, or reconditioned, at the start of each work shift. The Contractor shall strictly adhere to the atmospheric exposure and baking requirements of Clause 5 of AWS D1.1, and shall provide suitable holding and conditioning ovens onsite, as necessary.
- G. Welds shall not be water quenched.
- H. Field welds shall be permitted only at air temperatures above zero (0) degrees F. When welding, surfaces of pipe within 3 inches, laterally and in advance of weld shall be preheated and maintained to the temperature recommended by AWS D1.1.
- I. The Contractor shall be responsible for the adequacy of welds during pile driving, and during the service life of the weld. The Contractor shall be responsible for visual inspection and necessary correction of all weld deficiencies in material and workmanship in conformance with AWS D1.1. The Contractor shall maintain records of these visual inspections and submit if requested by the Engineer.
- J. All connections shall be welded unless noted otherwise on the Contract Drawings. Field fabricated members shall be cut to within 1/4" of required dimensions, fitted and welded completely along the perimeter of intersecting members on both sides using a 3/8" fillet weld, unless shown otherwise on the Contract Drawings. No separate measurement or payment will be made for this work.
- K. The Owner, at his own discretion, may perform visual and ultrasonic testing of up to 10 percent of the welds on the project, using an independent agency. The contractor shall not be compensated for any delays due to the testing of welds. Contractor shall cooperate and provide access to the welds to the testing agency. The Contractor shall correct the deficient welds at no cost to the Owner.
- L. If groove welds have been rejected, they may be repaired no more than twice. If a third failure occurs, the member shall be trimmed or replaced at the discretion of the Engineer at no cost to the Owner.

### 5.4 TOLERANCES

## SECTION 31 62 16.19 - STEEL PIPE PILES

- A. Piles shall not be pulled, jacked, or otherwise manipulated into position. The Contractor shall employ all necessary measures during setting and driving of piles to ensure that the driven piles are installed in the locations and positions indicated on the drawings. The Contractor must coordinate with the Engineer and allow the Engineer to measure the pile position before welding or connecting driven piles, at the Engineer's discretion. The final horizontal tolerance allowed at the tops of the piles is 1" maximum. If a pile is outside of this tolerance after driving and/or falsework removal, the contractor shall immediately notify the Engineer and submit a modified connection detail to the Engineer for approval
- B. The slope of piles shall be within 4 percent of the plumb or the specified batter. Contractor shall record the in place batter of the battered piles on the pile records.
- C. The maximum vertical variation from Pile Cut-off Elevation shall be 1/4".

These tolerances are non-additive and the most severe condition shall apply.

### 5.5 PROJECT RECORD DOCUMENTS

- A. As a minimum, pile records for pile driving shall include the following:
  - 1. Pile number and location.
  - 2. Date and time pile driving started; stopped for splice or other event, and the time the pile was completed.
  - 3. Hammer manufacturer and complete description of weights, length of stroke, hammer cushion material, cap blocks, rate of operation and serial number.
  - 4. Pile material description, including ASTM description, length of original driven pile, location of splice, final length, tip to cut off length, and length of cut off.
  - 5. Elevation of existing grade, estimation of stage of tide elevation, tip elevation, splice elevation, tip elevation, and cut off elevation.
  - 6. A narrative of the driving experience shall accompany each pile, including but not limited to acknowledging splices, obstructions, equipment breakdowns and other information that may be associated with the driving of the pile.

**SECTION 31 62 16.19 - STEEL PIPE PILES**

5.6 UNACCEPTABLE PILES

- A. Unacceptable Piles: Piles that do not meet the specified tip elevation requirements, are placed out of position, or are damaged.
- B. Provide additional piles or extract and renew piles that do not conform to specified requirements at no additional cost to the Owner.

**- END OF SECTION -**

## SECTION 31 63 33 - MICROPILES

### PART 1: GENERAL

#### 1.1 SCOPE

- A. This specification covers requirements for the design, testing and construction of steel micropiles for marine structure foundations located as shown on the construction documents. The number, nominal size, and top elevations of micropiles are shown on the contract drawings. The micropile specialty Contractor is responsible for furnishing all design, materials, products, accessories, tools, equipment, services, transportation, labor and supervision, and manufacturing techniques required for the design, installation and testing of micropiles and pile top attachments for this project to meet the allowable pile capacities listed on the Contract Drawings.
- B. The selected micropile Contractor shall select the micropile type, size, pile top attachment, installation means and methods, estimate the ground-grout bond value and determine the required bond length and final micropile diameter. The micropile Contractor shall design and install micropiles that will develop the load capacities indicated on the Contract Drawings. The micropile load capacities shall be verified by verification and proof load testing as required and must meet the test acceptance criteria specified herein.
- C. Before bidding the Work, the Contractor shall review the available subsurface information provided in the Geotechnical Report and visit the site to assess the site geometry, equipment access conditions, and location of existing structures and above ground facilities.

#### 1.2 DEFINITIONS

- A. **Admixture:** Substance added to the grout to control bleed and/or shrinkage, improve flowability, reduce water content, or retard setting time.
- B. **Alignment Load (AL):** A minimum initial load (no greater than 5 percent of the Design Load) applied to micropile during testing to keep the testing equipment correctly positioned.
- C. **Bond Length:** The length of the micropile that is bonded to the ground and used to transfer the applied axial loads to the surrounding soil or rock.
- D. **Bond-breaker:** A sleeve placed over the steel reinforcement to prevent load transfer.
- E. **Casing:** Steel tube introduced during the drilling process in overburden soil to temporarily stabilize the drill hole. This is usually withdrawn as the pile is grouted, although in certain types of micropiles, some casing is permanently left in place to provide added pile reinforcement.

## SECTION 31 63 33 - MICROPILES

- F. **Centralizer:** A device to support and position the reinforcing steel in the drill hole and/or casing so that a minimum grout cover is provided.
- G. **Contractor:** The person/firm responsible for performing the micropile work.
- H. **Coupler:** The means by which load capacity can be transmitted from one partial length of reinforcement to another.
- I. **Creep Movement:** The movement that occurs during the creep test of a micropile under a constant load.
- J. **Design Load (DL):** The maximum load expected to be applied to the micropile during its service life. This load is unfactored.
- K. **Encapsulation:** A corrugated or deformed tube protecting the reinforcing steel against corrosion.
- L. **Engineer:** The Owner or Owner's authorized agent.
- M. **Free (unbonded) length:** The designed length of the micropile that is not bonded to the surrounding ground or grout.
- N. **Micropile:** A small-diameter, bored, cast-in-place composite pile, in which the applied load is resisted by steel reinforcement, cement grout and frictional grout/ground bond.
- O. **Maximum Test Load:** The maximum load to which the micropile is subjected during testing.
- P. **Ultimate Grout-to-Ground Bond Values:** The estimated ultimate geotechnical unit grout-to-ground bond strength selected for use in design.
- Q. **Overburden:** Material, natural or placed, that may require cased drilling methods to provide an open borehole to underlying strata.
- R. **Post-grouting:** The injection of additional grout into the load transfer length of a micropile after the primary grout has set. Also known as regrouting or secondary grouting.
- S. **Primary Grout:** Portland-cement-based grout injected into the micropile hole prior to or after the installation of the reinforcement to direct the load transfer to the surrounding ground along the micropile.
- T. **Proof Load Test:** Incremental loading of a production micropile, recording the total movement at each increment.
- U. **Reinforcement:** The steel component of the micropile that accepts and/or resists applied loadings.
- V. **Sheathing:** Smooth or corrugated piping or tubing that protects the reinforcing steel against corrosion.
- W. **Spacer:** A device to separate elements of a multiple-element reinforcement.
- X. **Verification Load Test:** Pile load test performed to verify the design of the pile system and the construction methods proposed, prior to installation of production piles.
- Y. **Working Drawings:** Detailed installation drawings containing all necessary information to install and assure the quality of the micropiles. Working Drawings are developed, signed and sealed by a Professional Engineer on behalf of the micropile Contractor.

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### **PART 2: PRODUCTS**

#### **2.1 MATERIALS**

Furnish materials new and without defects. Remove defective materials from the jobsite at no additional cost. Materials for micropiles shall consist of the following

##### **A. Admixtures for Grout**

1. Admixtures shall conform to the requirements of ASTM C494/AASHTO M194.
2. Admixtures that control bleed, improve flowability, reduce water content, and retard set may be used in the grout, subject to the review and acceptance of the Engineer.
3. Admixtures shall be compatible with the grout and mixed in accordance with the manufacturer's recommendations.
4. Expansive admixtures shall only be added to the grout used for filling sealed encapsulations and anchorage covers.
5. Accelerators are not permitted. Admixtures containing chlorides are not permitted.

##### **B. Cement**

1. All cement shall be Portland cement conforming to ASTM C 150/AASHTO M85, Types I, II I/II, III, or V.

##### **C. Centralizers and Spacers**

1. Centralizers and spacers shall be fabricated from schedule 40 PVC pipe or tube, steel, or material non-detrimental to the reinforcing steel. Wood shall not be used.

##### **D. Encapsulation**

1. Encapsulation (double corrosion protection) shall be shop fabricated using high-density, corrugated polyethylene tubing conforming to the requirements of ASTM D3350/AASHTO M252 with a nominal wall thickness of 1/32 inch.

## SECTION 31 63 33 - MICROPILES

2. The inside annulus between the reinforcing bars and the encapsulating tube shall be a minimum of ¼ inch and be fully grouted with non-shrink grout.
- E. Epoxy Coating
1. The minimum thickness of coating applied electrostatically to the reinforcing steel shall be 12 mils DFT.
  2. Epoxy coating shall be in accordance with ASTM A775 or ASTM A934. Bend test requirements are waived.
  3. Bearing plates and nuts encased in the pile concrete footing need not be epoxy coated unless the footing reinforcement is epoxy coated.
- F. Fine Aggregate
1. If sand - cement grout is used, sand shall conform to ASTM C144/AASHTO M45.
- G. Galvanization
1. If used, galvanization shall meet the requirements of ASTM A153.
- H. Grout
1. Neat cement or sand/cement mixture with a minimum 3-day compressive strength of 2 ksi and a 28-day compressive strength of 4 ksi per AASHTO T106/ASTM C109. The maximum w/c ratio shall not exceed 0.45.
- I. Permanent Casing Pipe
1. Permanent steel casing/pipe shall have the diameter and at least minimum wall thickness shown on the approved Working Drawings and design submittal, designed and sealed by the micropile Contractor.
  2. The permanent steel casing/pipe shall conform to the requirements of A252 Grade 3 with a minimum yield strength of 65 ksi, unless more stringent requirements are made in the micropile Contractor's design submittal.

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3. For permanent casing/pipe that will be welded for structural purposes, the following material conditions shall apply:
  - a. The carbon equivalency (CE), as defined in AWS D11, Section XI5.1, shall not exceed 0.45, as demonstrated by mill certifications.
  - b. The sulfur content shall not exceed 0.05%, as demonstrated by mill certifications.
4. For permanent casing/pipe that will be shop or field welded, the following fabrication or construction conditions shall apply:
  - a. The steel pipe shall not be joined by welded lap splicing.
  - b. All welded seams and splices shall be complete penetration welds.
  - c. The proposed welding procedure, whether prequalified or supported by qualification testing, shall be submitted for approval.
5. Threaded casing joints shall develop at least the required compressive, tensile, and/or bending strength used in the design of the micropile.

### **J. Plates and Shapes**

1. Structural steel plates and shapes for pile top attachments shall conform to ASTM A36/AASHTO M183, or ASTM A572/AASHTO M223, Grade 50.

### **K. Reinforcing Bars**

1. Reinforcing steel shall be deformed bars in accordance with ASTM A615/AASHTO M31, Grade 60, unless a higher strength is required by the Contractor's design submittal.
2. When a bearing plate and nut are required to be threaded onto the top end of reinforcing bars for the pile top-to-footing anchorage, the threading may be continuous spiral deformed ribbing provided by the bar deformations (e.g., Dywidag or Williams continuous threadbars) or may be cut into a reinforcing bar. If threads are cut into a reinforcing bar, the next larger bar number designation from that shown on the Plans shall be provided, at no additional cost.
3. Bar tendon couplers, if required, shall develop the ultimate tensile strength of the bars without evidence of any failure.

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### L. Sheathing

1. Smooth plastic sheathing, including joints, shall be watertight. Polyvinyl chloride (PVC) sheathing shall conform to ASTM D 1784, Class 13464-B.

### M. Water

1. Water used in the grout mix shall conform to AASHTO T 26 and shall be potable, clean, and free from substances that may be injurious to cement and steel.

## **PART 3: SUBMITTALS**

### 3.1 GENERAL DESIGN REQUIREMENTS

- A. The micropile Contractor shall select the drilling method, the grouting procedure, and the grouting pressure used for the installation of the micropiles. The micropile Contractor shall also determine the micropile casing size, final drill hole diameter and bond length, and central reinforcement steel sizing necessary to develop the specified load capacities and load testing requirements. The micropile Contractor is also responsible for estimating the grout take. There will be no extra payment for grout overruns.
- B. The micropiles shall be designed to meet the specified loading conditions, as shown on the Contract Drawings. Design the micropiles and pile top to footing connections using the procedures contained in the FHWA *Micropile Design and Construction*, Report No. FHWA NHI-05-039.
- C. All micropile design submittals shall be signed and sealed by the Contractor's Professional Engineer, who shall be registered in the Commonwealth of Pennsylvania. Regardless of whether the micropile Contractor uses a Consultant design engineer to prepare the micropile design, the micropile Contractor shall still bear overall contract responsibility for the adequacy of the design and construction of the micropiles.
- D. The required geotechnical factors of safety shall be in accord with the FHWA manual, unless specified otherwise. Estimated soil/rock design shear strength parameters, unit weights, applied foundation loadings, slope and external surcharge loads, corrosion protection requirements, known utility locations, easements, right-of-ways and other applicable

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design criteria will be as shown on the Contract Drawings or Geotechnical Report.

- E. Structural design of any individual micropile structure elements not covered in the FHWA Manual shall be by the service load design method in conformance with appropriate articles of the most current Edition of the ASCE 7, including current interim specifications.
- F. Where required by the Contract Drawings, or as specified herein, corrosion protection of the internal steel reinforcing bars, consisting of either encapsulation, epoxy coating, or grout, shall be provided in accordance with Part 2 of this Specification.
  - 1. Where permanent casing is used for a portion of the micropile, encapsulation shall extend at least 5 ft into the casing.
- G. Clearances shown on the Contract Drawings between the micropile tops and the tops of new concrete slabs must be maintained.
  - 1. Should the Contractor wish to alter these clearances, a written request for alteration may be submitted for the Engineer's approval. Any additional costs due to this proposed alteration shall be at the Contractor's expense.

### 3.2 DESIGN SUBMITTALS

- A. At least 21 calendar days before the planned start of micropile structure construction, submit complete design calculations and working drawings to the Engineer for review and approval. Calculations and drawings shall be sealed by a Professional Engineer and include all details, dimensions, quantities, ground profiles, and cross-sections necessary to construct the micropile structure. Verify the limits of the micropile structure and ground survey data before preparing the detailed working drawings.
- B. Design Calculations shall demonstrate the design basis for all quantities, sizes and lengths in the micropile systems. At a minimum, Design Calculations shall include:
  - 1. A written summary report which describes the overall micropile design.
  - 2. Applicable code requirements and design references.
  - 3. Micropile structure critical design cross-section(s) geometry including soil/rock strata location, magnitude and direction of design applied loadings, including slope or external surcharge loads.

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4. Design criteria including, soil/rock shear strengths (friction angle and cohesion), unit weights, and ground-grout bond values and micropile drill hole diameter assumptions for each soil/rock strata.
  5. Factors of safety and allowable stresses used in the design on the ground-grout bond values, surcharges, soil/rock and material unit weights, steel, grout, and concrete materials.
  6. Seismic design earthquake acceleration coefficient.
  7. Design calculation sheets (both static and seismic) with the project number, micropile structure location, designation, date of preparation, initials of designer and checker, and page number at the top of each page. Provide an index page with the design calculations.
  8. Design notes including an explanation of any symbols and computer programs used in the design.
  9. Pile to footing connection calculations.
- C. Working Drawings shall include all information necessary for the construction and quality control of the micropiles. Where some of the following details would constitute a reproduction of the Contract Drawings, the Contractor may seek approval from the Engineer to omit repeated information. At a minimum, Working Drawings shall include:
1. A plan view of the micropile structure(s) identifying:
    - a. A reference baseline and elevation datum.
    - b. The offset from the construction centerline or baseline to the face of the micropile structure at all changes in horizontal alignment.
    - c. Beginning and end of micropile structure stations.
    - d. Right-of-way and permanent or temporary construction easement limits, location of all known active and abandoned existing utilities, adjacent structures or other potential interferences. The centerline of any drainage structure or drainage pipe behind, passing through, or passing under the micropile structure.
    - e. Subsurface exploration locations shown on a plan view of the proposed micropile structure alignment with appropriate reference base lines to fix the locations of the explorations relative to the micropile structure.
  2. An elevation view of the micropile structure(s) identifying:
    - a. Micropile locations and elevations; vertical and horizontal spacing; batter and alignment and the location of drainage elements (if applicable).
    - b. Existing and finish grade profiles both behind and in front of the micropile structure.
  3. Design parameters and applicable codes.

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4. General notes for constructing the micropile structure including construction sequencing or other special construction requirements.
5. Horizontal and vertical curve data affecting the micropile structure and micropile structure control points (if applicable). Match lines or other details to relate micropile structure stationing to centerline stationing.
6. A listing of the summary of quantities on the elevation drawing of each micropile structure showing pay item estimated quantities.
7. Micropile typical sections including micropile spacing and inclination; minimum drill hole diameter; pipe casing and reinforcing bar sizes and details; splice types and locations; centralizers and spacers; grout bond zone and casing plunge lengths (if used); corrosion protection details; and connection details to the substructure footing, anchorage, plates, etc.
8. A typical detail of verification and production proof test micropiles defining the micropile length, minimum drill hole diameter, inclination, and load test bonded and unbonded test lengths. Details of the proposed reaction piles to be used in each load test.
9. Details, dimensions, and schedules for all micropiles, casing and reinforcing steel, including reinforcing bar bending details.
10. Details for constructing micropile structures around drainage facilities (if applicable).

D. The Engineer will approve or reject the Contractor's submittal within 15 calendar days after receipt of a complete submission.

1. If revisions are necessary, make the necessary corrections and resubmit.
2. When the drawings are approved, shall issue sets to all relevant field personnel.
3. The Contractor will not be allowed to begin micropile structure construction or incorporate materials into the work until the submittal requirements are satisfied and found acceptable to the Engineer.
4. Changes or deviations from the approved submittals must be re-submitted for approval.
5. No adjustments in contract time or delay or impact claims will be allowed due to incomplete submittals.

### 3.3 PRE-CONSTRUCTION SUBMITTALS

A. The Contractor shall prepare and submit to the Engineer, for review of completeness, the following for the micropile system or systems to be constructed:

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1. Detailed step-by-step description of the proposed micropile construction procedure, including personnel, testing and equipment to assure quality control. This step-by-step procedure shall be shown on the working drawings in sufficient detail to allow the Engineer to monitor the construction and quality of the micropiles.
2. Proposed start date and time schedule and micropile installation schedule providing the following:
  - a. Micropile number
  - b. Micropile design load
  - c. Type and size of reinforcing steel
  - d. Minimum bond length
  - e. Total micropile length
  - f. Micropile top footing attachment
3. Proposed micropile installation log.
4. If welding of casing is proposed, submit the proposed welding procedure specification (WPS). The WPS shall be prequalified, or be accompanied by procedure qualification records.
5. Information on headroom and space requirements for installation equipment that verify the proposed equipment can perform at the site.
6. Plan describing how surface water, drill flush, and excess waste grout will be controlled and disposed.
7. Certified mill test reports for the reinforcing steel or coupon test results for permanent casing without mill certification. The ultimate strength, yield strength, elongation, and material properties composition shall be included.
8. Proposed Grouting Plan. The grouting plan shall include complete descriptions, details, and supporting calculations for the following:
  - a. Grout mix design and type of materials to be used in the grout including certified test data and trial batch reports.
  - b. Previous test results for the proposed grout mix, completed within one year of the start of work, may be submitted for initial verification of the required compressive strengths for installation of pre-production verification test piles and initial production piles.
  - c. Methods and equipment for accurately monitoring and recording the grout depth, grout volume and grout pressure as the grout is being placed.
  - d. Grouting rate calculations, when requested by the Engineer. The calculations shall be based on the initial pump pressures or static head on the grout and losses throughout the placing system, including anticipated head of drilling fluid (if applicable) to be displaced.

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- e. Estimated curing time for grout to achieve specified strength. Previous test results for the proposed grout mix completed within one year of the start of grouting may be submitted for initial verification and acceptance and start of production work.
  - f. Procedure and equipment for Contractor monitoring of grout quality.
9. Detailed plans for the proposed micropile load testing method. This shall include all drawings, details, and structural design calculations necessary to clearly describe the proposed test method, reaction load system capacity and equipment setup, types and accuracy of apparatus to be used for applying and measuring the test loads and pile top movements in accordance with the pile load test procedures in Part 5 of this specification.
10. Calibration reports and data for each test jack, pressure gauge and master pressure gauge and electronic load cell to be used. The calibration tests shall have been performed by an independent testing laboratory, and tests shall have been performed within 90 calendar days of the date submitted. Testing shall not commence until the Engineer has reviewed and accepted the jack, pressure gauge, master pressure gauge and electronic load cell calibration data.
- B. Work, other than test pile installation, shall not begin until the construction submittals have been received, reviewed, and accepted in writing by the Engineer.
- 1. Provide submittal items 1 through 5 at least 21 calendar days prior to initiating micropile construction, item 7 as the work progresses for each delivery and submittal items 6, 8 and 9 at least 7 days prior to start of micropile load testing or incorporation of the respective materials into the work.
  - 2. The Contractor shall allow the Engineer 7 calendar days to review the construction submittals after a complete set has been received. Additional time required due to incomplete or unacceptable submittals shall not be cause for delay or impact claims. All costs associated with incomplete or unacceptable Contractor submittals shall be the responsibility of the Contractor.

### **3.4 PRE-CONSTRUCTION LOAD TEST SUBMITTALS**

- A. The Contractor shall conduct verification load testing, as described in greater detail in Part 5 of this Specification, to confirm that the micropiles will resist the required allowable loads with adequate factors of safety. The contractor shall submit the results of the verification testing. These

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results must be reviewed and accepted by the Engineer before the Contractor may begin installing production micropiles.

### 3.5 PRE-CONSTRUCTION ORGANIZATIONAL SUBMITTALS

A. At least 45 calendar days before the planned start of micropile construction, the Contractor shall submit the completed project reference list and a personnel list.

1. The project reference list shall include a brief project description with the owner's name and current phone number and load test reports.
2. The personnel list shall identify the micropile system design engineer (if applicable), supervising project Engineer, drill rig operators, and on-site foremen to be assigned to the project. The personnel list shall contain a summary of each individual's experience and be complete enough for the Engineer to determine whether each individual satisfies the required qualifications.
3. The Engineer will approve or reject the Contractor's qualifications within 15 calendar days after receipt of a complete submission. Additional time required due to incomplete or unacceptable submittals will not be cause for time extension or impact or delay claims. All costs associated with incomplete or unacceptable submittals shall be borne by the Contractor.
  - a. Work shall not be started, nor materials ordered, until the Engineer's written approval of the Contractor's experience qualifications is given.
  - b. The Engineer may suspend the Work if the Contractor uses non-approved personnel. If work is suspended, the Contractor shall be fully liable for all resulting costs and no adjustment in contract time will result from the suspension.

### 3.6 SUBMITTALS DURING CONSTRUCTION

A. Submit installation records for each installed micropile a maximum of three days after grouting. Records shall be recorded on a micropile installation log, and shall include:

1. Micropile design data (#, batter, case diameter, wall thickness, bond, plunge and other lengths, etc.).

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2. Micropile as-built data.
  3. Dates and start and stop times of drilling and grouting procedures.
  4. Drilling narrative, including drill equipment, soil/rock and flush description, comments and unusual conditions.
  5. Grouting narrative, including mix information, quantities, equipment operator, and the amounts and locations of grout placed under pressure.
- B. When field conditions, such as obstructions due to existing timber piles, require the relocation of a proposed micropile, submit an alternate location to the Engineer for approval within one work shift. The Engineer will accept or modify the proposed location within three business days.
- C. When plan dimensions are changed due to field conditions, or for any other reason, revise and submit the Working Drawings.
- D. When caving or unstable ground conditions exist, submit the proposed method to provide drill hole support and prevent ground movement for review.
- E. Submit grout test results, both for field density tests and cube sample breaks, within three days of testing.
- F. Submit the results of verification and proof load tests within 24 hours of the completion of testing.

### **3.7 SUBMITTALS AFTER CONSTRUCTION**

- A. Within 30 days after completion of the work, submit as-built drawings to the Engineer. Provide revised design calculations signed by the approved Registered Professional Engineer for all design changes made during the construction of the micropile structure.

## **PART 4: QUALITY ASSURANCE**

### **4.1 REFERENCE**

- A. Comply with the provisions specified in the latest revision of the following codes and standards, including all supplements and addenda:
1. IBC (International Building Code).

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2. AISC (American Institute of Steel Construction) - Manual of Steel Construction.
  3. AWS D1.1 (American Welding Society) – Structural Welding Code.
  4. AISC (American Institute of Steel Construction) - Manual of Steel Construction, Volume 2, Connections.
  5. ASTM (American Society for Testing and Materials) – All applicable standards. Of particular importance:
    - a. D1143 – Method of Testing Piles Under Static Axial Compressive Load
    - b. D3689 – Method of Testing Individual Piles Under Static Axial Tensile Load
    - c. D3966 – Standard Test Method for Piles Under Lateral Load
- B. Comply with the guidelines of the recommendations contained within the FHWA (Federal Highway Administration) *Micropile Design and Construction, Report No. FHWA NHI-05-039.*

### 4.2 QUALIFICATIONS

- A. The micropile Contractor shall be experienced in the construction and load testing of micropiles and have successfully constructed at least 5 projects in the last 5 years involving construction totaling at least 100 micropiles of similar capacity to those required in these plans and specifications.
- B. The Contractor shall have previous micropile drilling and grouting experience in soil/rock similar to project conditions. The Contractor shall submit construction details, structural details and load test results for at least three previous successful micropile load tests from different projects of similar scope to this project.
- C. The Contractor shall assign an Engineer to supervise the work with experience on at least 3 projects of similar scope to this project completed over the past 5 years. The Contractor shall not use consultants or manufacturers' representatives to satisfy the supervising Engineer requirements of this section.
- D. The on-site foremen and drill rig operators shall also have experience on at least 3 projects over the past 5 years installing micropiles of equal or greater capacity than required in these plans and specifications.

## **SECTION 31 63 33 - MICROPILES**

- E. The micropiles shall be designed by a Registered Professional Engineer with experience in the design of at least 3 successfully completed micropile projects over the past 5 years, with micropiles of similar capacity to those required in these plans and specifications. The micropile design engineer may be either an employee of the Contractor or a separate Consultant design engineer meeting the stated experience requirements.
- F. The contractor shall submit documentation of the above experience qualifications in accordance with Part 3 of this specification.

### **PART 5: EXECUTION**

#### **5.1 PREPARATION, EXCAVATION AND DRAINAGE**

- A. A pre-construction meeting will be scheduled by the Engineer and held prior to the start of micropile construction.
  - 1. The Engineer, prime Contractor, micropile specialty Contractor, micropile design engineer, excavation Contractor and geotechnical instrumentation specialist (if applicable) shall attend the meeting. Attendance is mandatory.
  - 2. The pre-construction meeting will be conducted to clarify the construction requirements for the work, to coordinate the construction schedule and activities, and to identify contractual relationships and delineation of responsibilities amongst the prime Contractor and the various Subcontractors - specifically those pertaining to excavation for micropile structures, anticipated subsurface conditions, micropile installation and testing, micropile structure survey control and site drainage control.
- B. Coordinate the work and the excavation so the micropile structures are safely constructed. Perform the micropile construction and related excavation in accordance with the Contract Drawings and approved submittals. No excavations steeper than those specified in the Contract Documents will be made above or below the micropile structure locations without the written approval of the Engineer.
- C. The Contractor shall control and properly dispose of drill flush and construction related waste, including excess grout, in accord with the standard specifications and all applicable local codes and regulations.

## SECTION 31 63 33 - MICROPILES

- D. Provide positive control and discharge of all surface water that will affect construction of the micropile installation. Maintain all pipes or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost.
- E. Upon substantial completion of the Work, remove surface water control pipes or conduits from the site. Alternatively, with the approval of the Engineer, pipes or conduits that are left in place, may be fully grouted and abandoned or left in a way that protects the structure and all adjacent facilities from migration of fines through the pipe or conduit and potential ground loss.
- F. Immediately contact the Engineer if unanticipated existing subsurface drainage structures are discovered during excavation or drilling. Suspend work in these areas until remedial measures meeting the Engineer's approval are implemented. Cost of remedial measures or repair work resulting from encountering unanticipated subsurface drainage structures, will be paid for as Extra Work.
- G. Falsework and the stability of micropiles during installation shall be the Contractor's sole responsibility.

### 5.2 DRILLING

- A. The drilling equipment and methods shall be suitable for drilling through the conditions to be encountered, without causing damage to any overlying or adjacent structures or services. The drill hole must be open along its full length to at least the design minimum drill hole diameter prior to placing grout and reinforcement.
- B. Hard drilling conditions through rubble, concrete inclusions and/or timber sections may exist in the fill inside the timber mud fence and should be anticipated.
- C. Temporary casing, or other approved method of pile drill hole support, will be required in caving or unstable ground to permit the pile shaft to be formed to the minimum design drill hole diameter. The Contractor's proposed method(s) to provide drill hole support and to prevent detrimental ground movements shall be reviewed by the Engineer.
  - 1. Detrimental ground movement is defined as movement which requires remedial repair measures. Use of drilling fluid containing bentonite is not allowed.

### 5.3 GROUND HEAVE AND SUBSIDENCE

## SECTION 31 63 33 - MICROPILES

- A. During construction, the Contractor shall observe the conditions in the vicinity of the micropile construction site on a daily basis for signs of ground heave or subsidence.
- B. Immediately notify the Engineer if signs of movements are observed. The Contractor shall immediately suspend or modify drilling or grouting operations if ground heave or subsidence is observed, if the micropile structure is adversely affected, or if adjacent structures are damaged from the drilling or grouting. If the Engineer determines that the movements require corrective action, the Contractor shall take corrective actions necessary to stop the movement or perform repairs.
- C. When due to the Contractor's methods or operations or failure to follow the specified/approved construction sequence, as determined by the Engineer, the costs of providing corrective actions will be borne by the Contractor. When due to differing site conditions, as determined by the Engineer, the costs of providing corrective actions will be paid as Extra Work.

### 5.4 PIPE CASING AND REINFORCEMENT INSTALLATION

- A. Reinforcement shall be placed prior to grouting.
- B. Reinforcement surface shall be free of deleterious substances such as soil, mud, grease or oil that might contaminate the grout or coat the reinforcement and impair bond.
- C. Pile cages and reinforcement groups, if used, shall be sufficiently robust to withstand the installation and grouting process and the withdrawal of the drill casings without damage or disturbance.
- D. The Contractor shall check pile top elevations and adjust all installed micropiles to the planned elevations.
- E. Centralizers and spacers (if used) shall be provided at 10 ft maximum spacing. The upper and lower most centralizer shall be located a maximum of 4 ft from the top and bottom of the micropile. Centralizers and spacers shall permit the free flow of grout without misalignment of the reinforcing bar(s) and permanent casing.
- F. The central reinforcement bars with centralizers shall be lowered into the stabilized drill hole and set. The reinforcing steel shall be inserted into the drill hole to the desired depth without difficulty.

## SECTION 31 63 33 - MICROPILES

- G. Partially inserted reinforcing bars shall not be driven or forced into the hole. The Contractor shall redrill and reinsert reinforcing steel when necessary to facilitate insertion.
- H. Lengths of casing and reinforcing bars to be spliced shall be secured in proper alignment and in a manner to avoid eccentricity or angle between the axes of the two lengths to be spliced.
- I. Splices and threaded joints shall meet the requirements of Part 2 of this specification.
- J. Threaded pipe casing joints shall be located at least two casing diameters (OD) from a splice in any reinforcing bar. When multiple bars are used, bar splices shall be staggered at least 1 ft.

### 5.5 GROUTING

- A. Micropiles shall be primary grouted on the same day that the load transfer bond length is drilled.
- B. The Contractor shall use a stable neat cement grout or a sand cement grout with a minimum unconfined compressive strength of 4000 psi at 28 days.
- C. Admixtures, if used; shall be mixed in accordance with the manufacturer's recommendations.
- D. The grouting equipment used shall produce a grout free of lumps and undispersed cement.
- E. The Contractor shall have means and methods of measuring the grout quantity and pumping pressure during the grouting operations, and reporting these values for documentation.
- F. The grout pump shall be equipped with a pressure gauge to monitor grout pressures. A second pressure gauge shall be placed at the point of injection into the pile top. The pressure gauges shall be capable of measuring pressures of at least 150 psi or twice the actual grout pressures used, whichever is greater.
- G. The grout shall be kept in agitation prior to pumping, and shall be placed within one hour of mixing.

## SECTION 31 63 33 - MICROPILES

- H. The grouting equipment shall be sized to enable each pile to be grouted in one continuous operation.
- I. The grout shall be injected from the lowest point of the drill hole and injection shall continue until uncontaminated grout flows from the top of the pile.
- J. The grout may be pumped through grout tubes, casing, hollow-stem augers, or drill rods.
  - 1. Temporary casing, if used, shall be extracted in stages ensuring that, after each length of casing is removed the grout level is brought back up to the ground level before the next length is removed.
- K. The tremie pipe or casing shall always extend below the level of the existing grout in the drill hole.
- L. The grout pressures and grout takes shall be controlled to prevent excessive heave or fracturing of rock or soil formations.
- M. Upon completion of grouting, the grout tube may remain in the hole, but must be filled with grout.
- N. Grout within the micropiles shall be allowed to attain the required design strength prior to being loaded.
- O. Should problems occur during grouting such that the micropile's capacity to adequately resist the design load is in doubt, the Contractor may pursue one of the following options, both of which shall be at the Contractor's expense:
  - 1. Perform an additional proof test on the micropile in question to demonstrate its capacity.
  - 2. Abandon the micropile in question and install a replacement nearby, at a location approved by the Engineer. Note that any additional costs associated with footing redesign as a result of such a relocation shall be borne by the Contractor.

### 5.6 GROUT TESTING

- A. Grout within the micropile verification and proof test piles shall attain the minimum required compressive strength, verified by break tests of grout cube samples, prior to load testing. Grout cubes and density tests shall be

## SECTION 31 63 33 - MICROPILES

taken during verification tests to inform the confirmation of proof and production micropile testing.

- B. During production grouting, micropile grout shall be tested by the Contractor for compressive strength in accordance with AASHTO T106/ASTM C109 at a frequency of no less than one sampling from each grout plant on each day of operation, or per every 10 piles, whichever occurs more frequently.
  - 1. A sampling shall consist of a minimum of four sets of three 3-inch grout cubes, which will allow breaks to be made at 3, 7 and 28 days, with a reserve set.
  - 2. The compressive strength shall be the average of the 3 cubes tested.
- C. Grout consistency, as measured by grout density testing, shall be determined by the Contractor per ASTM C 188/AASHTO T 133 or API RP-13B-1 at a frequency of at least one test per pile, conducted just prior to start of pile grouting.
  - 1. The Baroid Mud Balance used in accordance with API RP-13B-1 is an approved device for determining the grout density of neat cement grout.
  - 2. The measured grout density shall be 119 lbs/ft<sup>3</sup>, with a tolerance of 5%.
- D. Provide grout cube compressive strength and grout density test results to the Engineer within 24 hours of testing.

### 5.7 VERIFICATION LOAD TESTS

- A. Perform verification testing of micropiles at the locations and quantities specified on the Contract Drawings. Perform compression load testing in accord with ASTM D1143, tension load testing in accord with ASTM D3689, and lateral load testing in accord with ASTM D3966, except as modified herein.
- B. Perform pre-production verification micropile load testing to verify the design of the micropile system and the construction methods proposed prior to installing any production piles.
- C. Verification load tests shall be performed to verify that the micropiles designed and installed by the Contractor will meet the required load

## SECTION 31 63 33 - MICROPILES

capacities and load test acceptance criteria, and to verify that the length of the micropile bond zone is adequate. The load test results must be reviewed and accepted by the Engineer prior to beginning installation of production micropiles.

- D. Verification test piles shall be sacrificial and constructed in conformance with the approved Working Drawings.
- E. The drilling-and-grouting method, casing length and outside diameter, reinforcing bar lengths, and depth of embedment for the verification test pile(s) shall be identical to those specified for the production piles at the given locations.
- F. The verification test micropile structural steel sections shall be sized to safely resist the maximum test load.
- G. The maximum verification and proof test loads applied to the micropile shall not exceed 80 percent of the structural capacity of the micropile structural elements, to include steel yield in tension, steel yield or buckling in compression, or grout crushing in compression. Any required increase in strength of the verification test pile elements above the strength required for the production piles shall be provided for in the contractor's bid price.
- H. When both compression and tension load testing is to be performed on the same pile, the pile shall be tested under compression loads prior to testing under tension loads.
- I. Testing Equipment and Data Recording:
  - 1. Testing equipment shall include dial gauges, dial gauge support, jack and pressure gauge, electronic load cell, and a reaction frame. The load cell is required only for the creep test portion of the verification test.
  - 2. The testing reaction frame shall be designed to be sufficiently rigid and of adequate dimensions such that excessive deformation of the testing equipment does not occur.
  - 3. Align the jack, bearing plates, and stressing anchorage such that unloading and repositioning of the equipment will not be required during the test.
  - 4. Apply and measure the test load with a hydraulic jack and pressure gauge.
    - a. The pressure gauge shall be graduated in 50 psi increments or less.

## SECTION 31 63 33 - MICROPILES

- b. The jack and pressure gauge shall have a pressure range not exceeding twice the anticipated maximum test pressure.
- 5. Monitor the creep test load hold during verification tests with both the pressure gauge and the electronic load cell. Use the load cell to accurately maintain a constant load hold during the creep test load hold increment of the verification test.
- 6. Measure the pile top movement with a dial gauge capable of measuring to one thousandth of an inch.
  - a. The dial gauge shall have a travel sufficient to allow the test to be done without having to reset the gauge.
  - b. Visually align the gauge to be parallel with the axis of the micropile and support the gauge independently from the jack, pile or reaction frame.
  - c. Use a minimum of two dial gauges when the test setup requires reaction against the ground or single reaction piles on each side of the test pile.
- 7. Representatives from the micropile design engineer and the owner's Engineer shall witness all testing.
- J. Test verification piles designated for compression or tension load testing to a maximum test load of 2.0 times the micropile Design Load shown on the Contract Drawings.
- K. The verification pile load tests shall be made by incrementally loading the micropile in accordance with the following cyclic load schedule for both compression and tension loading:

**SECTION 31 63 33 - MICROPILES**

Step	Loading	Applied Load	Hold Time (minute)
1	Apply AL	AL	2.5
2	Cycle 1	0.15 DL	2.5
		0.30 DL	2.5
		0.45 DL	2.5
		AL	1
3	Cycle 2	0.15 DL	1
		0.30 DL	1
		0.45 DL	2.5
		0.60 DL	2.5
		0.75 DL	2.5
		0.90 DL	2.5
		1.00 DL	2.5
		AL	1
4	Cycle 3	0.15 DL	1
		1.00 DL	1
		1.15 DL	2.5
		1.30 DL	10 to 60
		1.45 DL	2.5
		AL	1
5	Cycle 4	0.15 DL	1
		1.45 DL	1
		1.60 DL	1
		1.75 DL	2.5
		1.90 DL	2.5
		2.00 DL	10
		1.50 DL	5

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	1.00 DL	5
	0.50 DL	5
	AL	5

- L. Pile top movement shall be measured at each load increment. The load-hold period shall begin as soon as each test load increment is applied.
- M. The verification test pile shall be monitored for creep at the 1.30 Design Load (DL).
1. Pile movement during the creep test shall be measured and recorded at 1, 2, 3, 4, 5, 6, 10, 20, 30, 50, and 60 minutes.
  2. The alignment load (AL) shall not exceed 5 percent of the DL load. Dial gauges shall be reset to zero after the initial AL is applied.
- N. Acceptance criteria for micropile verification load tests:
1. The pile shall sustain the first compression or tension 1.0 DL test load with no more than  $\frac{3}{4}$  inch total vertical movement at the top of the pile, relative to the position of the top of the pile prior to testing.
  2. At the end of the 1.30 DL creep test load increment, test piles shall have a creep rate not exceeding 0.04 inches/log cycle time (1 to 10 minutes) or 0.08 inches/log cycle time (6 to 60 minutes or the last log cycle if held longer).
  3. The creep rate shall be linear or decreasing throughout the creep load hold period.
  4. Failure does not occur at the 2.0 DL maximum test load.
    - a. Failure is defined as the load where the slope of the load versus head settlement curve first exceeds  $\frac{1}{4}$  inch/kip.
- O. The Engineer will provide the Contractor written confirmation of the micropile design and construction within 3 working days of the completion of the verification load tests. This written confirmation will either confirm the capacities and bond lengths specified in the Working Drawings for micropiles or reject the piles based upon the verification test results.
- P. Verification test pile rejection:
1. It is the sole responsibility of the Contractor to attain the required acceptance criteria.
  2. If a verification-tested micropile fails to meet the acceptance criteria, the Contractor shall modify the design, the construction procedure, or both. These modifications may include modifying the

**SECTION 31 63 33 - MICROPILES**

installation methods, increasing the bond length, or changing the micropile type.

3. Any modification that necessitates changes to the structure shall require the Engineer's prior review and acceptance. Any modifications of design or construction procedures or cost of additional verification test piles and load testing shall be at the Contractor's expense.

- Q. At the completion of verification testing, test piles shall be removed down to the elevation specified by the Engineer.

**5.8 PROOF LOAD TESTS**

- A. Perform proof testing on the first set of production piles installed at each designated substructure unit prior to the installation of the remaining production piles in that unit. The first set of production piles is the number required to provide the required reaction capacity for the proof tested pile. The initial proof test piles shall be installed at the locations specified on the Contract Drawings. Perform compression load testing in accord with ASTM D1143, tension load testing in accord with ASTM D3689, and lateral load testing in accord with ASTM D3966, except as modified herein.
- B. The proof pile load tests shall be made by incrementally loading the micropile in accordance with the following cyclic load schedule for both compression and tension loading:

Step	Loading	Applied Load	Hold Time (minute)
1	Apply AL	AL	2.5
2	Load Cycle	0.15 DL	2.5
		0.30 DL	2.5
		0.45 DL	2.5
		0.60 DL	2.5
		0.75 DL	2.5
		0.90 DL	2.5
		1.00 DL	2.5
		1.15 DL	2.5
		1.30 DL	10 to 60 minutes
		1.45 DL	2.5
1.60 DL	2.5		
3	Unload	1.30 DL	4

## SECTION 31 63 33 - MICROPILES

	Cycle	1.0 DL	4
		0.75 DL	4
		0.50 DL	4
		0.25 DL	4
		AL	4

- C. Depending on performance, either a 10 minute or 60 minute creep test shall be performed at the 1.30DL Test Load.
1. Where the pile top movement between 1 and 10 minutes exceeds 0.04 inches, the Maximum Test Load shall be maintained an additional 50 minutes.
  2. Movements shall be recorded at 1, 2, 3, 5, 6, 10, 20, 30, 50 and 60 minutes.
  3. The alignment load shall not exceed 5 percent of DL. Dial gauges shall be reset to zero after the initial AL is applied.
- D. Acceptance criteria for micropile proof load testing:
1. The pile shall sustain the compression or tension 1.0 DL test load with no more than  $\frac{3}{4}$  inch total vertical movement at the top of the pile, relative to the position of the top of the pile prior to testing.
  2. At the end of the 1.30 DL creep test load increment, test piles shall have a creep rate not exceeding 0.04 inches/log cycle time (1 to 10 minutes) or 0.08 inches/log cycle time (6 to 60 minutes).
  3. The creep rate shall be linear or decreasing throughout the creep load hold period.
  4. Failure does not occur at the 1.6 DL maximum test load.
    - a. Failure is defined as the load where the slope of the load versus head settlement curve first exceeds  $\frac{1}{4}$  inch/kip.
- E. Proof test pile rejection:
1. It is the sole responsibility of the Contractor to attain the required acceptance criteria.
  2. If a proof-tested micropile fails to meet the acceptance criteria, the Contractor shall immediately proof test another micropile within that footing.
  3. For failed piles and further construction of other piles, the Contractor shall modify the design, the construction procedure, or both. These modifications may include installing replacement micropiles, incorporating piles at not more than 50% of the maximum load attained, postgrouting, modifying installation

## **SECTION 31 63 33 - MICROPILES**

methods, increasing the bond length, or changing the micropile type.

4. Any modification that necessitates changes to the structure design shall require the Engineer's prior review and acceptance. Any modifications of design or construction procedures, or cost of additional verification test piles and verification and/or proof load testing, or replacement production micropiles, shall be at the Contractor's expense.

### 5.9 TOLERANCES

- A. Micropile centerlines shall be within 3" of the indicated plan locations. Where this is not possible due to the presence of existing piles, the Contractor shall immediately notify the Engineer and submit an alternate location for approval.
- B. Micropiles shall be plumb, or battered, within 2 percent of the proposed alignment.
- C. Micropile top elevations shall be not less than 2" below, nor 1" above, the indicated vertical elevation.
- D. The centerline of reinforcing steel shall not be more than 3/4" from the indicated location.

**- END OF SECTION -**

## **SECTION 32 10 00 – BITUMINOUS PAVEMENTS**

### **PART 1 : GENERAL**

#### 1.1 SCOPE

- A. Construction of bituminous concrete pavement on a prepared base laid to the required grade, thickness, and cross-section as shown on the Drawings or as specified in this Section.
- B. The quality of materials and performance of the Work shall be in accordance with the Standard Specifications of the Pennsylvania Department of Transportation (PennDOT), unless otherwise specified in this Section.

### **PART 2 : PRODUCTS**

#### 2.1 MATERIALS

- A. Bituminous Concrete Products
  - 1. Base course shall be PennDOT Section 320 – Aggregate-Bituminous Base Course.
  - 2. Binder course shall be PennDOT Section 431 - Bituminous Binder Course FB-2.
  - 3. Top course shall be PennDOT Section 430 - Bituminous Wearing Course FB-2.
  - 4. Tack coats of asphalt emulsions, PennDOT Section 460.
  - 5. The subbase shall consist of PennDOT 2A aggregate as specified in Section 703 of Publication 408.

### **PART 3 : SUBMITTALS**

#### 3.1 SUBMITTALS FOR REVIEW

- A. Bituminous concrete mix designs shall be submitted and approved by the Construction Manager prior to the start of paving operations.
- B. Compaction testing plan shall be submitted at least two (2) weeks before the start of paving activities.
- C. Submit compaction test results within 24 hours of each day of

## SECTION 32 10 00 – BITUMINOUS PAVEMENTS

paving.

### **PART 4 : QUALITY ASSURANCE**

#### **4.1 REFERENCES**

- A. American Society for Testing and Materials (ASTM)
  - 1. D 1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.

### **PART 5 : EXECUTION**

#### **5.1 PAVEMENT INSTALLATION**

- A. Subgrade
  - 1. The subgrade shall be shaped to line and grade and compacted with self-propelled rollers. Compaction of the subgrade shall be as required by Table 1 of Section 310000 – Earthwork.
  - 2. All depressions which develop under rolling shall be filled with acceptable material and the area re-rolled with approval of the Construction Manager.
  - 3. Soft areas shall be removed and filled with acceptable materials and the area re-rolled with approval of the Construction Manager.
  - 4. Should the subgrade become rutted or displaced prior to the placing of the subbase, it shall be reworked to bring to line and grade.
- B. Subbase
  - 1. The subbase shall in lifts not to exceed 6 inches, compacted thickness.
  - 2. Provide subbase over excavated areas only and/or as directed by the Construction Manager.
  - 3. Rolling shall begin at the sides and continue toward the center and shall continue until there is no movement ahead

## **SECTION 32 10 00 – BITUMINOUS PAVEMENTS**

of the roller. Compaction shall be to 98 percent compaction throughout the subbase as determined by ASTM D1557.

4. After completion of the subbase rolling, there shall be no hauling over the subbase other than the delivery of material for the overlying course.

### **C. Bituminous Material**

1. Placement of bituminous mixtures shall be in accordance with PennDOT Publication 408, Section 409.3.
2. The thickness of the bituminous courses shall be as shown on the Drawings.
3. Prior to placing any bituminous wearing course, a tack coat of asphalt emulsions shall be furnished and applied to the bituminous binder course surface.

- END OF SECTION -

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**Appendix A**

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**GEOTECHNICAL INVESTIGATION  
PIER 84 SOUTH  
S. COLUMBUS BLVD. & POTTER ST.  
PHILADELPHIA, PENNSYLVANIA**

Prepared for:

**URBAN ENGINEERS, INC.**  
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Philadelphia, Pennsylvania 19106-3685



Prepared by:

**GEOSYSTEMS CONSULTANTS, INC.**

514 Pennsylvania Avenue  
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Project No. 2006G419

May, 2006



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May 30, 2006  
2006G419

Urban Engineers, Inc.  
530 Walnut Street, 14<sup>th</sup> Floor  
Philadelphia, Pennsylvania 19106-3685  
Attention: Mr. Michael J. Gabor, P.E.

**GEOTECHNICAL INVESTIGATION  
PIER 84 SOUTH  
S. COLUMBUS BLVD. & POTTER ST  
PHILADELPHIA, PENNSYLVANIA**

Dear Mr. Gabor,

GeoSystems Consultants, Inc. is pleased to submit herewith our report of a Geotechnical Investigation in connection with the design of proposed modifications at Pier 84 South located on S. Columbus Boulevard at the foot of Potter Street, Philadelphia, Pennsylvania. This work was performed in accordance with our Proposal No. 2006P419 dated January 30, 2006 and your subsequent authorization.

Soil samples obtained during the course of this investigation will be retained at our facility for a period of three months following the date of this report. After that time the samples will be discarded unless other arrangements are made.

We sincerely appreciate the opportunity to work with you on this project. If you have any questions concerning the contents of this report, or if we can be of assistance during the construction phase of the project, please do not hesitate to contact us.

**GEOSYSTEMS CONSULTANTS, INC.**

*Ram D. Singh*  
Ram D. Singh, Ph.D., P.E.  
Principal Engineer

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**GEOTECHNICAL INVESTIGATION  
MUNICIPAL PIER 84 SOUTH  
PHILADELPHIA, PENNSYLVANIA**

**INTRODUCTION**

The Philadelphia Regional Port Authority is planning to rehabilitate and renovate Municipal Pier 84 South. The Pier is located on the western bank of the Delaware River in South Philadelphia on South Columbus Boulevard at the foot of Potter Street as shown on Figure 1. The Engineer for the project is Urban Engineers, Inc. of Philadelphia, Pennsylvania. GeoSystems Consultants, Inc. was retained by Urban Engineers to perform a Geotechnical Investigation for the project. The scope of the investigation included subsurface exploration by test borings, laboratory testing of representative soil samples, engineering evaluation of the accumulated information, formulation of recommendations for design and construction of foundations, and preparation of this report.

**PROJECT AND SITE DESCRIPTIONS**

Municipal Pier 84 South was constructed circa early 1900's and is an earth mound fill placed over the river silt and restrained by a timber sheetpile wall, typical of the piers of that era. The precise depth of the timber sheetpile is unknown to us. The Pier deck is a concrete arch structure supported by vertical and batter timber piles. The ground is sloping towards the river and the depth of water is about 30 feet. The channel depth is maintained by periodic dredging.

The pier has a warehouse of about 200,000-square-foot area and with a high ceiling having clearance of about 22 feet. The warehouse is presently used as a storage and handling facility for dry food-stuff, mainly cocoa-beans. The eastern wall of the warehouse is supported over the arch structure of the deck. The warehouse column footings are supported on timber piles. The eastern portion of the warehouse and deck structure is in distress with extensive cracking. The distress may be due to the settlement

of supporting piles due to negative friction and creep of the soil slope with time. The distress also could be due to deterioration of supporting piles and differential settlement.

As a part of pier rehabilitation, it is proposed to install a new sheetpile wall around the eastern portion of the pier for improved stability. The exact location of the sheetpile wall will be determined by Urban Engineers, Inc. A new pier deck will be constructed, supported on vertical and batter piles subjected to compressive and tensile loads. The warehouse building also will be modified in footprint and renovated.

### **SUBSURFACE CONDITIONS**

The subsurface conditions at the site were explored by a total of five borings: three borings inside the warehouse and two boring offshore of the eastern deck, located as shown on Figure 2. A safety hammer was used for the Standard Penetration Test for the offshore Borings B-1 and B-2, whereas, an automatic hammer was used in the other borings. The locations of the borings were selected by Urban Engineers, taking into consideration the accessibility and presence of column footings.

Logs of the test borings are presented in Appendix A, together with a description of the drilling and sampling methods. The results of geotechnical laboratory testing on representative soil samples retrieved from the borings are presented in Appendix B. An inferred Subsurface Profile is shown on Figure 3, and the subsurface materials encountered are described below in descending order.

#### **Stratum 1: Fill**

Random fill, about 40 feet thick, was encountered in Borings B-3 and B-4 underlying the asphalt floor. Thickness of the asphalt floor varied from about 8 inches in B-3 to 12 inches in B-4. These borings are inside the warehouse and inshore of the timber sheetpile retaining wall. The fill was found to consist of gray-black to gray-brown silty medium to fine sand and coarse to fine sand and gravel, with occasional pieces of concrete, brick and

wood. The thickness of the fill in this area varied from 38 to 39 feet and the bottom elevation varied from -26 to -27. The Standard Penetration Test N-values were in the range of 3 to 23 blows per foot. The fill, in general, is loose to medium dense. No fill was encountered in Boring B-5, which was drilled over the slope outside the timber sheet pile wall.

### **Stratum 2: River Silt**

Dark gray and gray-brown fine sandy organic clayey silt with occasional coarse gravel inclusions (organic river silt) was encountered in all borings. The offshore thickness varied from 15 feet in Boring B-1 to 5 feet in Boring B-5. N-values varied from weight of rod to weight of hammer, indicating a very soft consistency. The bottom elevation varies from -32 to 44.9.

For the onshore warehouse borings the thickness of stratum 2 varied from 10 feet in B-3 and B-4 to 31 feet in B-5 and the bottom elevation varied from -34.5 to -37.0. Pocket penetrometer strengths of 0.5 and 0.75 tsf was obtained for two samples in Boring B-4. Several attempts had to be made obtain undisturbed Shelby tube samples of this material due to the presence of thin sand partings. N-values in the onshore borings varied from weight of rod to 10 blows per foot with most of the values between 2 and 6, signifying a soft to medium stiff consistency.

Organic content varied from 11 to 21 percent in three tests, with an average of 16 percent.

### **Stratum 3: Silty Sand**

Beneath the organic silt, a layer of brown silty fine gravelly coarse to fine sand was encountered in all borings. The thickness of this stratum varied from 32 feet in Boring B-1 to 47 feet in B -2. N-values varied, in general, from 19 to over 100 blows per foot, with typical values over 40, indicating a very dense condition. Boring B-5 was terminated in

this stratum. The bottom elevation of this stratum in the other borings varied from -77 to -82.

**Stratum 4: Clay (Potomac Formation)**

Very stiff to hard reddish brown and gray clay of the Potomac Formation was encountered in Borings B-1 through B-4. Pocket Penetrometer strength varied between 2 to 4.5 tsf. The thickness of this layer ranges from 47 to 51 feet and the bottom elevation varied from -123 to -132. N-value varied from 20 to 68, signifying that the layer is very stiff to hard in consistency.

**Stratum 5: Sand and Gravel with Silt**

Under Stratum 4, very dense gray and light gray silty medium to fine sand with coarse to fine gravel and silt, and trace mica, was encountered in Borings B-1 through B-4, extending beyond the depth of exploration. All borings (except B-5) were terminated in this stratum. N-values from 88 to over 100 were obtained, signifying a very dense condition.

**Groundwater**

The borings were advanced using the rotary method with "drilling mud," which precludes the observation of groundwater. From field observations, a depth of about 10 feet was estimated in the warehouse borings. However, the ground water at the site is controlled by the water level in the Delaware River and is influenced by tides.

**GEOTECHNICAL PROPERTIES**

An estimation of the geotechnical properties of the various soil strata has been made, based on the Standard Penetration Resistance (N-values, blows per foot), laboratory test results, and visual classification. The methodology used is described below.

### **Cohesive Soils**

The undrained in-situ strength of cohesive soils was estimated based on the results of laboratory strength tests, field Pocket Penetrometer tests, and N-values. Unconsolidated-undrained (UU) triaxial compression strength tests were conducted for the organic clayey silt (Stratum 2). The correlation in the literature relating undrained strength to N-values by Terzaghi and Peck was used for the Potomac Formation( Stratum 4). It should be noted that the design of the sheetpile wall should be based on the undrained strength, as the failure of this structure would mobilize the undrained strength of the organic silts and clays.

Two sensitivity determinations also were conducted on samples from the organic clayey silt (Stratum 2), by performing UU strength tests on both undisturbed and remolded specimens. A sensitivity ratio of about 4 was obtained, indicating that the organic silt has a low sensitivity and will not degrade significantly in strength due to pile driving. The estimated shear strength parameters are presented in Table 1 along with unit weights.

### **Cohesionless Soils**

The strength parameters of the sand strata were estimated based on laboratory gradation tests, visual classifications, and N-values. N-values and the corresponding effective vertical pressure were used to estimate relative density of the sands using the U.S. Bureau of Reclamation correlation. The angles of internal friction were estimated for the average relative density for each layer using the correlation presented in US NAVFAC Design Manual DM-7. Relative density data was also used to estimate total unit weight of the layers. The estimated strength properties and total unit weights are presented in Table 1.

## **GEOTECHNICAL ANALYSIS**

An idealized inferred subsurface profile is shown in Figure 3. Data from all of the test borings is shown. An examination of the profile shows continuity in stratigraphy for the

offshore and warehouse areas of the site, below the fill. The following proposed structural elements require Geotechnical Design Parameters:

- Sheetpile retaining wall.
- Piles for new pier deck
- New building column foundations

It is proposed to install a new sheetpile wall around the eastern face of the pier to improve stability. The sheetpile wall may be designed using the soil properties in Table 1.

Piles for the pier deck structure support will be subjected to both compressive and tensile loads. Concrete-filled, 12- and 16-inch diameter pipe piles are suitable to resist the imposed loads. However, steel piles in water will be subjected to corrosion, and prestressed concrete piles may be a suitable alternate to expensive corrosion protection measures. Capacities of both types of piles were analyzed and are provided in the design parameters section which follows.

The new warehouse maximum column loads are estimated to be about 175 kips. For a spread footing, with an allowable design bearing pressure of 4 ksf, settlement is expected to be about 1.5 inches, which is more than allowable for this type of structure. The random fill, though old, was not compacted when placed and its density is variable. Therefore, the settlements of shallow foundations cannot be reliably estimated. Also the new addition is to be connected to the existing warehouse area. Any settlements will be differential and it will be prudent to support these new columns on pile foundations. Design capacity for the warehouse piles is discussed in the next section.

## **DESIGN RECOMMENDATIONS**

Recommendations pertaining to the design of the proposed new facilities are presented below.

### **Sheetpile: Lateral Earth Pressure Coefficients**

The recommended coefficients of lateral earth pressure under active and passive conditions for each subsurface stratum are listed in Table 1. The active pressure coefficients are based on the Rankine theory, whereas, the passive earth pressure coefficients are based on the Caquot and Kerisel assumption of a log spiral failure surface. Above the groundwater level the coefficients should be applied to total vertical pressure, whereas, below water level to the effective vertical pressure. Estimated densities of the various strata are also provided in Table 1.

### **Pipe and Concrete Piles**

The warehouse columns and the deck structure facility may be supported on concrete-filled pipe piles or pre-stressed concrete piles. Pipe piles should be fitted with a properly sized, conical steel driving point in order to maintain the integrity of the pile while driving through dense sands and to facilitate placement of concrete. Minimum spacing between piles should be 3 times the diameter or width of the pile. The piles should be driven using a hammer consistent with required compression capacity.

Since the design compression capacity of piles exceeds 40 tons, a pile load test is recommended. The estimated design soil capacities for concrete-filled pipe piles and pre-stressed concrete piles for different aspects of the project, using a factor of safety of 3.0 with regard to ultimate capacity, are given below.

For the estimated capacities, the pipe piles have been assumed to have been driven with closed ends and filled with 4,000 psi concrete. The tensile capacities include effective self weight of the piles. The *Modified Engineering News Formula* should be used to confirm compressive load capacity of the piles during installation.

**Deck Piles:** A depth of water of 35 feet was assumed at the site and piles are assumed to be founded in the lower dense sand and gravel (Stratum 5). A pile length of 115 feet

below the mud line (or a total length of 160 feet) was analyzed. The assumed tip elevation is -146 ft. Allowable design capacities using a Factor of Safety of 3.0 are given below:

Type of Pile	Compressive Capacity (Tons)	Tensile Capacity <sup>1</sup> (Tons)
12" Pipe	85	35
14" Pipe	120	45
16" Pipe	160	50
16"x16" Concrete Pile	260	105

The engineer should estimate any reduction in the structural capacity of the piles due to unsupported length. Loss due to corrosion should also be considered. Load capacities of the pipe piles should be reduced accordingly for loss of section if no corrosion protection is provided. The design pile capacity also should not exceed the unsupported and supported structural capacity, as determined by the Engineer.

**Warehouse Piles:** Compressive capacities using a Factor of Safety of 3.0 with regards to the ultimate estimated capacity are listed below:

Pile Type	Pile Length	
	60 Ft.	80 Ft.
12" Pipe (Tons)	60	70
14" Pipe (Tons)	80	95
16" Pipe (Tons)	110	130
16"x16" Concrete Pile (Tons)	160	200

<sup>1</sup> The tensile capacity includes the effective weight of the pile.

### **Timber Piles**

It may be economical to support the new warehouse columns on timber piles. Timber piles should consist of either Douglas Fir or Southern Pine species and should be creosote-treated in accordance with AWWA Standard C3 or treated with another acceptable preservative. The pile should have a minimum tip diameter of 25 inches and conform in all respect to ASTM D25. A tight fitting or a flat steel tip should be firmly attached to the bottom of each pile to prevent damage to the tip during driving.

The timber pile described above may be designed for 50 kips and should be driven with a diesel, steam, or pneumatic pile driver. Which delivers about 10,000 foot-pounds of energy per blow. The piles should be driven to a maximum terminal resistance of 50 kips as determined from the Modified Engineering News Formula. It is estimated that the pile will penetrate about 55 to 60 feet below the existing grade of the warehouse. A pile load test is not required.

### **SEISMIC DESIGN**

According to the IBC 2003 Code, the site classification for the warehouse is "E" and for the deck is "D". For 2 percent probability of exceedence in 50 years (return period about 2,500 years) the seismic design parameters are as follows:

Peak ground acceleration	= 0.17 g
0.2 sec SA	= 0.32 g
1.0 sec SA	= 0.080 g

### **CONSTRUCTION OBSERVATION**

It is recommended that full-time observation and testing services be provided during pile driving and retention system construction by a firm specializing in Geotechnical Engineering, in order to verify conformance to the project plans and specifications.

These services should include observation, documentation and evaluation of pile load tests and documentation of the installation of piles for the pier and the warehouse.

### **LIMITATIONS**

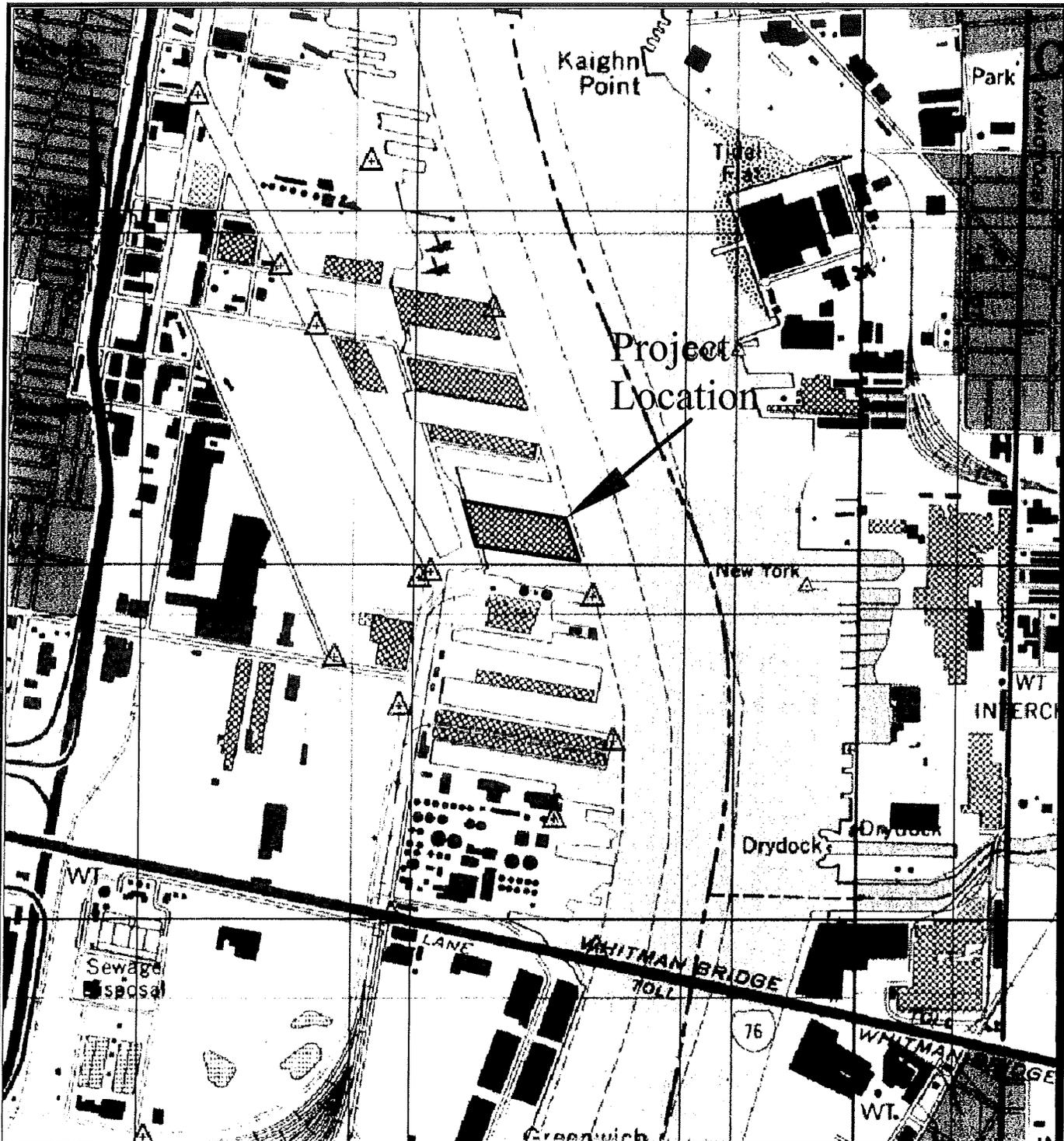
The conclusions and recommendations presented in this report are based on the assumptions that the subsurface conditions at the site do not deviate appreciably from those disclosed by the test borings, and that the proposed construction is substantially in conformance with the project description contained herein. GeoSystems Consultants should be notified immediately should differing conditions be encountered during construction so that appropriate revisions can be made to the recommendations. The recommendations are also based on competent field observation and testing during construction.

This report is intended for the sole use of the Design Professionals and/or Owner's Representatives involved with the subject project. The use or reliance by third parties, such as construction contractors, shall be at their own risk. The recommendations should not be used for any other project or purpose without the expressed written consent of GeoSystems Consultants, Inc.

**TABLE1**  
**PIER 84 SOUTH**  
**DESIGN PARAMETERS**  
**PHILADELPHIA, PENNSYLVANIA**

Stratum	Total Unit Weight	Bouyant Unit Weight	Total Stress Basis		Effective Stress Basis		Eff.-Stress Basis	
	(pcf)	(pcf)	Strength Parameters		Strength Parameters		Basis	
			c (psf)	$\phi$ (deg)	c (psf)	$\phi$ (deg)	$K_a$	$K_p$
FILL	120.0	57.5	0	30.0	0	30.0	0.33	4.8
RIVER SILT	102.0	40.0	500	0.0	0	27.0	0.38	4.0
SILTY SAND	130.0	67.5	0	38.0	0	38.0	0.24	9.0
CLAY	128.0	65.0	2500	0.0	0	30.0	0.33	4.8
SAND & GRAVEL with SILT	132.0	70.0	0	39.0	0	39.0	0.23	9.7

NOTE :  $K_a$  and  $K_p$  for river silt and lean clay are 1.00 for total stress basis analysis  
For sands and fill the effective and total stress parameters are same  
Design on total stress basis( near term ) and check for effective (long term) basis



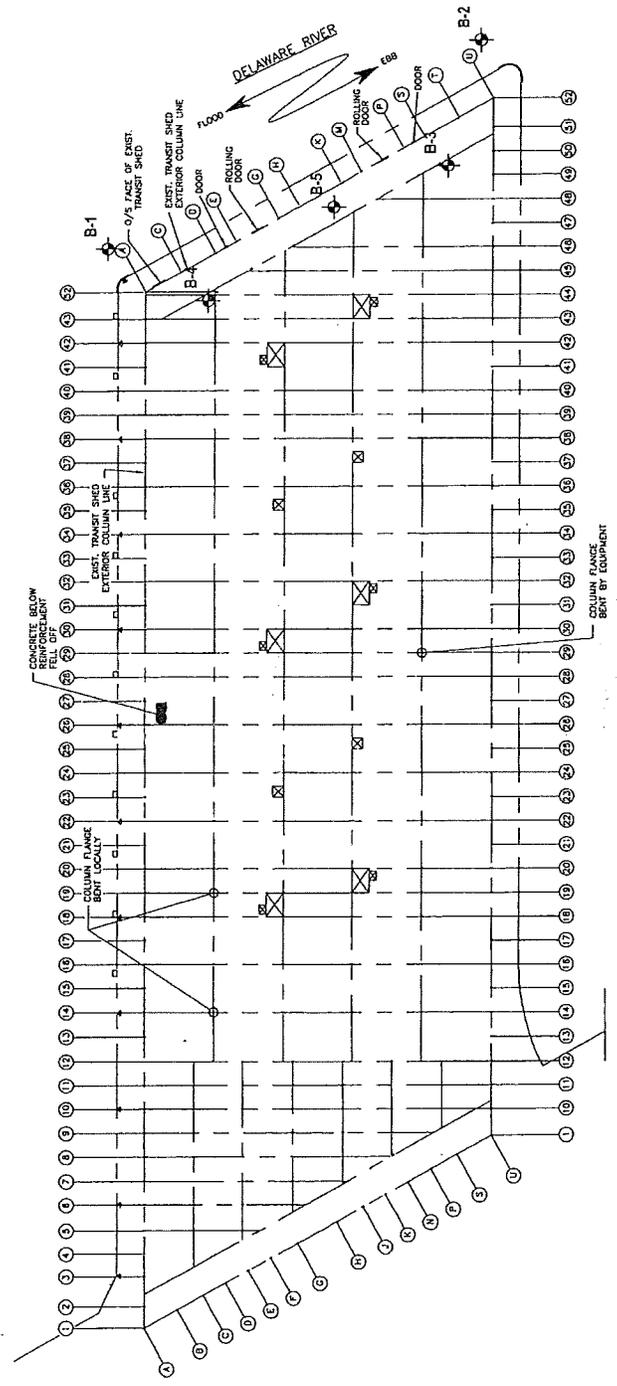
REGIONAL LOCATION PLAN  
 PIER 84 SOUTH  
 SOUTH COLUMBUS BLVD. & POTTER STREET  
 PHILADELPHIA, PA

**GeoSystems Consultants, Inc.**

PROJECT NO.: 2006G419

FIGURE 1

MAY 2006



BORING LOCATION PLAN  
 PIER 84 SOUTH  
 PHILADELPHIA, PENNSYLVANIA

**GeoSystems Consultants, Inc.**

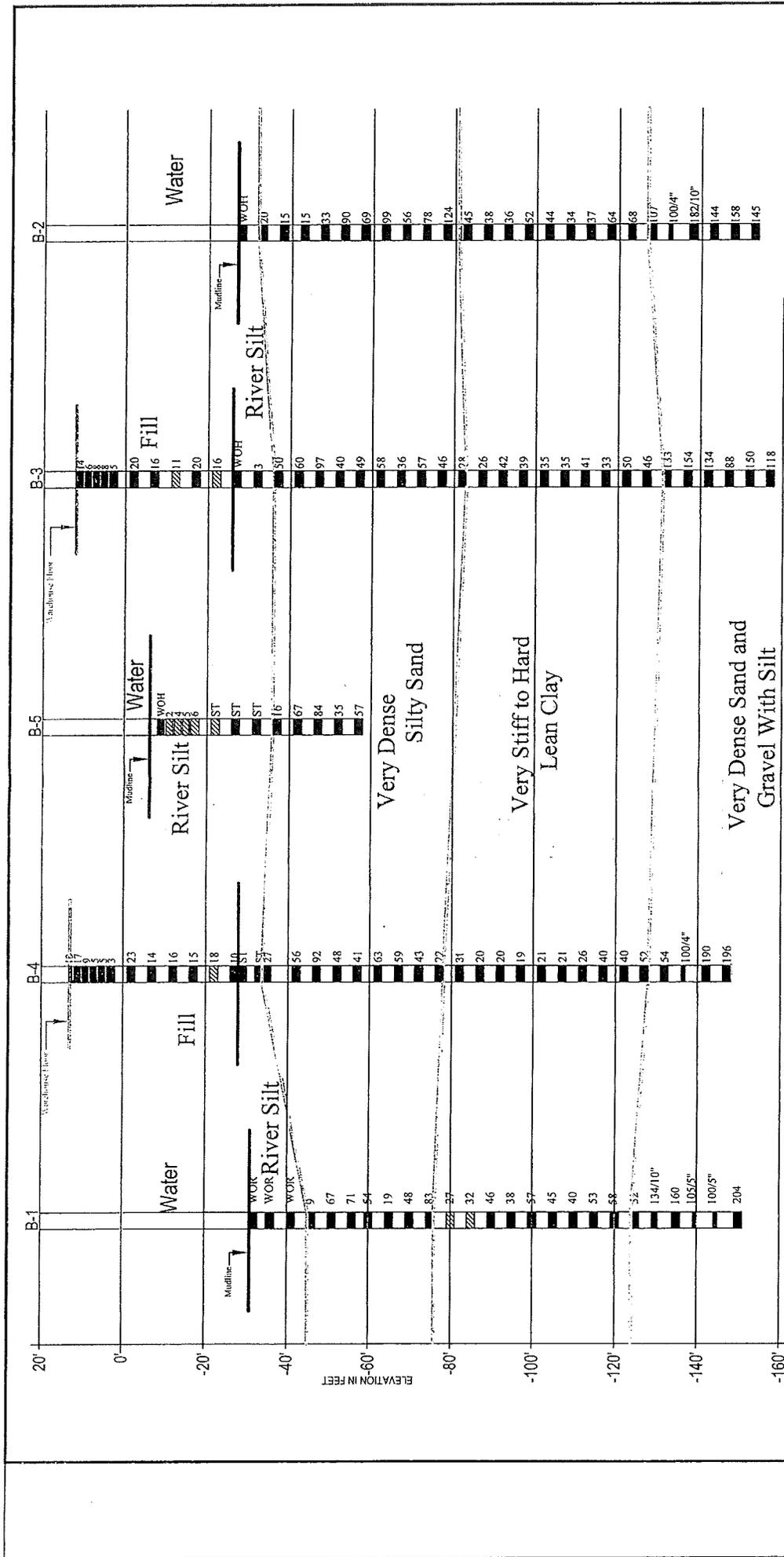
PROJECT NO.: 06G419  
 JUNE 2001

FIGURE 2

REFERENCE:

DRAWING NO. GA-1, ENTITLED "COLUMN LOCATIONS, PIER 84 SOUTH REHABILITATION", PREPARED BY URBAN ENGINEERS, INC., DATED FEBRUARY 2006





**APPENDIX A**  
**SUBSURFACE EXPLORATION**

The subsurface conditions at the site of Pier 84 South, South Columbus Boulevard and Potter Street in Philadelphia, Pennsylvania were explored by five test borings, located as shown on Figure 2, Boring Location Plan. The boring locations were selected and laid out in the field by Urban Engineers, Inc. The offshore Borings B-1 and B-2 were drilled by Warren George Inc. of Jersey City, New Jersey. The onshore borings was drilled by Craig Test Boring Company, Inc. of Mays Landing, New Jersey. All borings were drilled with full-time oversight by GeoSystems Consultants. After completion, the borings were grouted. The test boring logs are presented on the following pages.

The onshore test borings were drilled using a CME-55 track rig and were advanced between samples using the rotary method with "drilling mud." The offshore borings were drilled using a Mobile B-51 rig on a jack-up barge. Soil samples were obtained from the boreholes for identification and classification purposes by means of a 2-inch O.D. split-barrel sampler driven up to 24 inches with a 140-pound "Safety Hammer" for offshore and an Automatic Trip-Hammer for on-shore borings, freely falling 30 inches (the Standard Penetration Test ASTM D 1586). The number of hammer blows required for driving the sampler during the interval from 6 to 18 inches, or fraction thereof, is known as the "N-value,"<sup>2</sup> and is noted on the boring logs.

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<sup>2</sup> The automatic trip hammer results in N-values that are approximately 30 percent lower than those which would be obtained with the formerly standard "Safety Hammer".

# LOG of BORING NO. B-1

Sheet 1 of 4

DATE: 2-Feb-06

BARGE DECK SURFACE ELEVATION: +15.1

LOCATION:

See Figure 2

DEPTH, ft.	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0				Airspace to 12.7 ft below barge deck level						
			▼		+2.4					
15				Water to 46 ft below barge deck level						
45					-30.9					
	wor		SS	Very soft brown clayey silt			106.1	72	44	
50				- with fine sand			94.5	67	53	
55				- with trace gravel			83.6	72	47	
60				[Organic Silt]	-44.9					
	3-4-5-7		SS	Medium dense brown clayey fine gravelly coarse to fine sand						
					-48.4					
65		26-29-38-26	SS	Very dense brown clayey coarse to fine sandy coarse to fine gravel			9.9			X
					-52.4					
70										
	see below		SS	Continued on sheet 2						

Completion Depth: <u>165.5 feet</u>	Water Depth: _____ ft After _____ hrs
Project No.: <u>2006G419</u>	_____ ft After _____ hrs
Project Name: <u>Pier 84 South</u>	_____ ft After _____ hrs
Drilling Method: <u>Mud Rotary, Manual SPT Hammer</u>	_____ ft After _____ hrs

# LOG of BORING NO. B-1

Sheet 2 of 4

DATE: 2-Feb-06

BARGE DECK SURFACE ELEVATION: +15.1

LOCATION:

See Figure 2

DEPTH, ft	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
70		30-36-35-22	SS	Very dense brown silty medium to fine sand						
75		10-24-30-30	SS	Very dense gray silty fine sand with 1" layer of brown silty coarse to fine sand			17.2			X
80		7-7-12-56	SS	Medium dense brown and gray silty fine gravely coarse to fine sand	-64.4					
85		6-8-40-37	SS	Very dense brown silty medium to fine sand, trace fine gravel			18.4			X
90		29-33-50-52	SS	Very dense gray clayey silty fine sand, trace fine gravel	-74.4					
90				Very dense brown silty coarse to fine sand, trace fine gravel [Alluvium]	-76.9					
95		7-11-16-20	SS	- no recovery						
100		8-13-19-21	SS	- no recovery						
105		see below	SS	Continued on sheet 3		2.5 - 2.7				

Completion Depth:	165.5 feet	Water Depth:	_____ ft After _____ hrs
Project No.:	2006G419		_____ ft After _____ hrs
Project Name:	Pier 84 South		_____ ft After _____ hrs
Drilling Method:	Mud Rotary, Manual SPT Hammer		_____ ft After _____ hrs

# LOG of BORING NO. B-1

Sheet 3 of 4

DATE: 8-Feb-06

BARGE DECK SURFACE ELEVATION: +15.1

LOCATION:

See Figure 2

DEPTH, ft	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
105		15-19-27-32	SS	Stiff to very stiff reddish-brown, gray, and green-brown clay		2.5 - 2.7	27.1	48	24	
110		11-16-22-23	SS			1.8 - 2.5				
115		17-23-34-40	SS			1.7 - 2.25	26.2	42	24	
120		18-18-27-24	SS	- with trace coarse sand and fine gravel		1.75 - 2.75				
125		17-17-23-24	SS			1.3 - 2.5				
130		15-22-31-36	SS			2.9 - 3.5				
135		18-27-31-39	SS			2.5	25.9	43	24	
				[Potomac Formation]	-122.9					
140		13-15-17-27	SS	Stiff to hard gray micaceous fine sandy clay/clayey sand		1.0 - 1.6				

Completion Depth: 165.5 feet	Water Depth: _____ ft After _____ hrs
Project No.: 2006G419	_____ ft After _____ hrs
Project Name: Pier 84 South	_____ ft After _____ hrs
Drilling Method: Mud Rotary, Manual SPT Hammer	_____ ft After _____ hrs

# LOG of BORING NO. B-1

Sheet 4 of 4

DATE: 8-Feb-06

BARGE DECK SURFACE ELEVATION: +15.1

LOCATION:

See Figure 2

DEPTH, ft.	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
140		13-15-17-27	SS	Stiff to hard gray micaceous fine sandy clay/clayey sand	-127.9	1.0 - 1.6				
145		22-34-100/5"	SS	Very dense gray micaceous clayey fine sand	-132.4					
150		56-76-84-83	SS	Very dense gray micaceous silty medium to fine sand			15.2			X
155		73-100/5"	SS		-141.9					
160		76-100/5"	SS	Very dense gray silty coarse to fine sand, trace fine gravel						
165		60-74-130	SS	- with trace coarse to fine gravel	-150.4		7.7			X
				End of test boring						
170										
175										

Completion Depth:	165.5 feet	Water Depth:	_____ ft After _____ hrs
Project No.:	2006G419		_____ ft After _____ hrs
Project Name:	Pier 84 South		_____ ft After _____ hrs
Drilling Method:	Mud Rotary, Manual SPT Hammer		_____ ft After _____ hrs

# LOG of BORING NO. B-2

Sheet 1 of 4

DATE: 2-Feb-06

BARGE DECK SURFACE ELEVATION: +17.5 LOCATION:

See Figure 2

DEPTH, ft	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0				Airspace to 15.9 ft below barge deck level						
15			▼		+1.6					
45		wor	SS	Water to 45 ft below barge deck level	-27.5		134.3	70	41	
50				Very soft brown fine sandy clayey silt [Organic Silt]	-32.0					
55	8-11-9-10		SS	Medium dense brownish gray silty coarse to fine sandy coarse to fine gravel						
60	8-8-12-10		SS	- becoming gray silty coarse to fine sand and gravel			15.9			X
65	8-6-9-17		SS							
70	16-14-19-25		SS		-51.0					
70	see below		SS	Very dense gray silty coarse to fine sandy coarse to fine gravel Continued on sheet 2			7.7			X

Completion Depth: <u>172.0 feet</u>	Water Depth: _____ ft After _____ hrs
Project No.: <u>2006G419</u>	_____ ft After _____ hrs
Project Name: <u>Pier 84 South</u>	_____ ft After _____ hrs
Drilling Method: <u>Mud Rotary, Manual SPT Hammer</u>	_____ ft After _____ hrs

# LOG of BORING NO. B-2

Sheet 2 of 4

DATE: 10-Feb-06

BARGE DECK SURFACE ELEVATION: +17.5

LOCATION:

See Figure 2

DEPTH, ft	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
70		12-34-56-70	SS	Very dense gray silty coarse to fine sandy coarse to fine gravel	-56.0					
75		28-41-28-41	SS	Very dense brown silty coarse to fine sand						
80		39-41-58-62	SS	-becoming gray with trace coarse to fine gravel						
85		29-21-35-58	SS	-becoming gray and brown			9.8			X
90		30-40-38-52	SS							
95		46-50-74-47	SS	- becoming light gray, trace medium to fine gravel, trace to little silt			8.6			X
				[Alluvium]	-81.5					
100		10-19-26-30	SS	Stiff reddish brown with light gray mottling silty clay and medium to fine gravel, trace coarse sand						
					-85.5					
105		see below	SS	Stiff to very stiff light gray and reddish brown mottled silty clay						
				Continued on sheet 3		1.5	33.2	43	27	

Completion Depth: 172.0 feet Water Depth: \_\_\_\_\_ ft After \_\_\_\_\_ hrs  
 Project No.: 2006G419 \_\_\_\_\_ ft After \_\_\_\_\_ hrs  
 Project Name: Pier 84 South \_\_\_\_\_ ft After \_\_\_\_\_ hrs  
 Drilling Method: Mud Rotary, Manual SPT Hammer \_\_\_\_\_ ft After \_\_\_\_\_ hrs

# LOG of BORING NO. B-2

Sheet 4 of 4

DATE: 16-Feb-06

BARGE DECK SURFACE ELEVATION: +17.5 LOCATION:

See Figure 2

DEPTH, ft.	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
140		17-31-37-47	SS	Hard light gray and reddish brown mottled silty clay - becoming purplish red and light gray mottled at 141.5 ft.		>4.5	24.6	45	25	
				[Potomac Formation]	-127.7					
145		31-41-66-100/2"	SS	Very dense light gray clayey silty fine sand						
150		75-100/4"	SS							
					-134.0					
155		74-82-100/4"	SS	Very dense light gray medium to fine sand, trace silt			16.7			X
					-142.5					
160		70-78-66-52	SS	Very dense gray coarse to fine sand, some coarse to fine gravel, trace to little silt						
165		60-68-90-89	SS	- with trace fine gravel and silt			15.1			X
170		71-73-72-82	SS	- with some coarse to fine gravel, trace silt			9.7			X
					-154.5					
				End of test boring						
175										

Completion Depth: <u>172.0 feet</u>	Water Depth: _____ ft After _____ hrs
Project No.: <u>2006G419</u>	_____ ft After _____ hrs
Project Name: <u>Pier 84 South</u>	_____ ft After _____ hrs
Drilling Method: <u>Mud Rotary, Manual SPT Hammer</u>	_____ ft After _____ hrs

# LOG of BORING NO. B-3

Sheet 1 of 5

DATE: 12-Apr-06

WAREHOUSE FLOOR ELEVATION: 13(±)

LOCATION:

See Figure 2

DEPTH, ft.	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0				7.5" Asphalt	+12.4					
		43-83-32	SS	Loose to medium dense dark gray, brown, and light gray silty coarse to fine sandy coarse to fine gravel, with occasional brick and concrete rubble fragments			10.8			X
		8-7-7-4	SS							
5		3-3-3-3	SS							
		2-4-4-4	SS							
		2-3-5-5	SS							
10		2-3-2-5	SS	Loose to medium dense grayish brown silty coarse to fine sand and coarse to fine gravel	+3.0		9.8			X
15		10-10-10-9	SS	-coarse gravel limited sample recovery						
20		6-8-8-7	SS	-coarse gravel limited sample recovery			8.1			X
25		7-8-3-5	SS	- no recovery						
30		8-12-8-6	SS	- becoming gray silty coarse to fine sand and fine gravel			10.8			X
35		7-8-8-9	SS	- no recovery	[Fill]					

Completion Depth:	172 ft.	Water Depth:	See Note	hrs
Project No.:	2006G419		ft After	hrs
Project Name:	Pier 84 South		ft After	hrs
Drilling Method:	Mud Rotary, Automatic SPT Hammer		ft After	hrs

# LOG of BORING NO. B-3

Sheet 2 of 5

DATE: 12-Apr-06

WAREHOUSE FLOOR ELEVATION: 13(±)

LOCATION:

See Figure 2

DEPTH, ft.	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
35		7-8-8-9		- no recovery						
				[Fill]	-27.0					
40		2-1-woh		Soft brownish gray micaceous clayey silt, trace wood inclusions		0.3 - 0.5	68.4	68	33	X
45		woh	SS	- becoming medium stiff		0.6 - 0.7	58.8	57	30	X
				[Organic Silt]	-37.0					
50		17-23-27-25	SS	Very dense grayish brown silty coarse to fine sand and coarse to fine gravel						
55		12-22-38-40	SS				7.5			X
60		33-50-47-39	SS							
65		10-18-22-21	SS	Dense light gray silty medium to fine sand	-52.0					
				[Alluvium]						
70		12-22-	SS	Continued on sheet 3			14.3			X

Completion Depth:	172.0 feet	Water Depth:	See Note	hrs
Project No.:	2006G419		ft After	hrs
Project Name:	Pier 84 South		ft After	hrs
Drilling Method:	Mud Rotary, Automatic SPT Hammer		ft After	hrs

# LOG of BORING NO. B-3

Sheet 3 of 5

DATE: 12-Apr-06

WAREHOUSE FLOOR ELEVATION: 13(±)

LOCATION:

See Figure 2

DEPTH, ft	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
70		12-22-27-32	SS	Medium dense to dense gray to light brown silty medium to fine sand			14.3			X
75		21-33-25-28	SS							
80		11-16-20-14	SS							
85		13-21-26-20	SS	Stiff to very stiff gray and brown clayey silt and coarse to fine sand	-72.0 -73.3	1.3 - 2.2				
90		19-24-22-25	SS	Medium dense gray silty coarse to fine sand and coarse to fine gravel			8.3			X
95		7-12-16-22	SS	[Alluvium] Very stiff light gray and reddish brown silty clay, trace fine sand lenses	-82.0	2.9 - 3.3				
100		6-11-15-19	SS			2.9 - 3.3				
105		14-20-	SS	Continued on sheet 4		2.2 - 3.5	27.4	47	28	

Completion Depth: 172.0 feet	Water Depth: See Note	hrs
Project No.: 2006G419	ft After	hrs
Project Name: Pier 84 South	ft After	hrs
Drilling Method: Mud Rotary, Automatic SPT Hammer	ft After	hrs

# LOG of BORING NO. B-3

Sheet 4 of 5

DATE: 17-Apr-06

WAREHOUSE FLOOR ELEVATION: 13(±)

LOCATION:

See Figure 2

DEPTH, ft.	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
105		14-20-22-22	SS	Very stiff light gray and reddish brown clayey silt		2.2 - 3.5	27.4	47	28	
110		8-17-22-26	SS	- with trace fine sand below 110 ft.						
115		9-16-19-24	SS			2.8 - 3.3				
120		8-14-21-24	SS	- becoming very stiff to hard with some greenish brown mottling silty clay		2.6 - 4.5+	29.2	53	27	
125		8-15-18-21	SS	- with trace coarse to fine sand		2.9 - 3.3				
130		14-20-21-29	SS			2.4 - 3.7	28.3	48	25	
135		12-23-27-38	SS	- becoming hard		4.5+				
140		15-22-	SS	Continued on sheet 5		3.1 - 4.5+	21.3	38	19	

Completion Depth: <u>172.0 feet</u>	Water Depth: <u>See Note</u> hrs
Project No.: <u>2006G419</u>	ft After _____ hrs
Project Name: <u>Pier 84 South</u>	ft After _____ hrs
Drilling Method: <u>Mud Rotary, Automatic SPT Hammer</u>	ft After _____ hrs

# LOG of BORING NO. B-3

Sheet 5 of 5

DATE: 17-Apr-06

WAREHOUSE FLOOR ELEVATION: 13(±)

LOCATION:

See Figure 2

DEPTH, ft.	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
140		15-22- 24-31	SS	Very stiff to hard reddish brown, brown, light gray, and greenish brown silty clay, trace fine sand		3.1 - 4.5+				
				[Potomac Formation]	-132.0					
145		20-33 100/6"	SS	Very dense light gray micaceous silty fine sand						
150		44-64- 90-75	SS	- becoming silty medium to fine sand			17.4			X
155		50-61- 73-77	SS		-143.3					
				Very dense light gray silty coarse to fine sand with fine gravel						
160		33-42- 46-42	SS	- with trace clay			6.4			X
165		31-68- 82-59	SS				7.3			X
170		30-45- 73-86	SS		-159.0					
				End of test boring						
175				<u>Note:</u> Use of mud for drilling precluded direct observation of groundwater						

Completion Depth: 172.0 feet	Water Depth: See Note		hrs
Project No.: 2006G419		ft After	hrs
Project Name: Pier 84 South		ft After	hrs
Drilling Method: Mud Rotary, Automatic SPT Hammer		ft After	hrs

# LOG of BORING NO. B-4

DATE: 18-Apr-06

WAREHOUSE FLOOR ELEVATION: 13(±)

LOCATION:

See Figure 2

DEPTH, ft.	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0				12" Asphalt	+12.0					
	1-13		SS	Loose to medium dense black, light gray, and white silty coarse to fine sand and gravel, with coarse to fine sand-sized cinders to 1.8 ft.  - becoming medium to fine sand and gravel with trace medium to fine gravel-sized mica schist fragments  - becoming loose black silty coarse to fine sand and gravel						
	8-10-7-7		SS							
5	6-5-4-4		SS							
	2-3-2-4		SS							
	4-3-2-2		SS							
10	1-2-1-2		SS							
				-----	-1.0					
15	10-12-11-14		SS	Medium dense to dense gray silty coarse to fine sand and gravel						
20	10-9-5-8		SS							
25	9-7-9-11		SS							
30	7-6-9-8		SS							
35	11-8-10-		SS	- no recovery	[Fill]					

Completion Depth:	162 ft.	Water Depth:	See Note	hrs
Project No.:	2006G419		10 ft After	Encountered
Project Name:	Pier 84 South		ft After	hrs
Drilling Method:	Mud Rotary, Automatic SPT Hammer		ft After	hrs

# LOG of BORING NO. B-4

Sheet 2 of 5

DATE: 12-Apr-06

WAREHOUSE FLOOR ELEVATION: 13(±)

LOCATION:

See Figure 2

DEPTH, ft.	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
35		11-8-10-16		Medium dense to dense gray silty coarse to fine sand and gravel						
				[Fill]	-26.0					
40		4-5-5-3		Soft to medium stiff dark gray sandy silt, with occasional coarse gravel inclusions;		0.75				
		PUSH	ST				43.2			
45		PUSH	ST							
				[Organic Silt]	-34.5		41.8	46	34	X
50		1-11-16-12	SS							
				Medium dense to very dense gray silty coarse to fine sand and coarse to fine gravel						
55		16-25-31-30	SS							
60		29-44-48-45	SS							
65		22-23-25-25	SS							
				[Alluvium]						
70		12-17-	SS	Continued on sheet 3						

Completion Depth: 162 ft. Water Depth: See Note \_\_\_\_\_ hrs  
 Project No.: 2006G419 \_\_\_\_\_ ft After \_\_\_\_\_ hrs  
 Project Name: Pier 84 South \_\_\_\_\_ ft After \_\_\_\_\_ hrs  
 Drilling Method: Mud Rotary, Automatic SPT Hammer \_\_\_\_\_ ft After \_\_\_\_\_ hrs

# LOG of BORING NO. B-4

Sheet 3 of 5

DATE: 12-Apr-06

WAREHOUSE FLOOR ELEVATION: 13(±)

LOCATION:

See Figure 2

DEPTH, ft	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
70		12-17-24-30	SS	Medium dense to dense light grayish brown to light brown silty medium to fine sand, trace fine gravel						
75		21-33-30-28	SS							
80		20-29-30-24	SS							
85		20-21-22-22	SS	- becoming brown silty fine gravelly coarse to fine sand						
90		6-10-12-17	SS	[Alluvium]	-77.0					
95		5-11-20-13	SS	Stiff to very stiff light gray and reddish brown fine sandy silty clay		1.75 - 3.3				
100		4-8-12-12	SS	- with trace peat at 105.5 ft.		3.0 - 3.7				
105		5-8-12-15	SS	Continued on sheet 4		1.5 - 2.2				
						2.0 - 4.1				

Completion Depth: 162 ft.	Water Depth: See Note		hrs
Project No.: 2006G419		ft After	hrs
Project Name: Pier 84 South		ft After	hrs
Drilling Method: Mud Rotary, Automatic SPT Hammer		ft After	hrs

# LOG of BORING NO. B-4

Sheet 4 of 5

DATE: 17-Apr-06

WAREHOUSE FLOOR ELEVATION: 13(±)

LOCATION:

See Figure 2

DEPTH, ft.	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
105		6-8-11-13	SS	Very stiff to hard light gray and reddish brown silty clay		2.0 - 4.1				
110		6-8-11-13	SS			1.5 - 2.2				
115		4-9-12-15	SS			2.2 - 4.2				
120		6-10-11-14	SS	- with trace coarse sand and peat		2.1 - 2.25				
125		7-11-15-17	SS	- with little greenish-gray mottling		2.4 - 4.0				
130		10-18-22-27	SS			2.7 - 4.0.7				
135		11-17-23-24	SS			3.0 - 4.5+				
140		21-31-	SS	[Potomac Formation]	-127.0					
				Continued on sheet 5		1.75 - 3.3				

Completion Depth: 162 ft.	Water Depth: See Note	hrs
Project No.: 2006G419		ft After
Project Name: Pier 84 South		hrs
Drilling Method: Mud Rotary, Automatic SPT Hammer		ft After
		hrs

# LOG of BORING NO. B-4

Sheet 5 of 5

DATE: 20-Apr-06

WAREHOUSE FLOOR ELEVATION: 13(±)

LOCATION:

See Figure 2

DEPTH, ft.	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
140		21-31- 21-30	SS	Very stiff to hard light gray micaceous clayey silty fine sand		1.75- 3.3				
145		12-22- 32-43	SS			2.7- 4.2				
150		77-100/4"	SS	Very dense light gray micaceous silty fine sand	-137.0					
155		68-100- 90-100/3"	SS	- becoming fine gravelly coarse to fine sand at 155.5 ft.						
160		44-87- 109-141	SS	-becoming silty sand with gravel	-149.0					
165				End of test boring						
170										
175										

Note: Use of mud for drilling precluded direct observation of groundwater

Completion Depth: 162 ft.	Water Depth: See Note	hrs
Project No.: 2006G419		ft After
Project Name: Pier 84 South		hrs
Drilling Method: Mud Rotary, Automatic SPT Hammer		ft After
		hrs

# LOG of BORING NO. B-5

Sheet 1 of 3

DATE: 21-Apr-06

WAREHOUSE FLOOR ELEVATION: 13(±)

LOCATION:

See Figure 2

DEPTH, ft	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS	
0				4" Asphalt, 5" concrete slab	+12.25						
		9-9-3/3"	SS	Loose to medium dense dark gray, brown, and light gray silty coarse to fine sandy coarse to fine gravel, with occasional brick fragments, cinders, and ashes and inclusions of brown coarse to fine sandy silt [Fill] Concrete Slab at 5.0 to 5.75 ft.							
		4-3-3-3	SS								
5		4-14-100/0"	SS			+8.0					
					Open void-space	+7.25					
					+3.75						
10				Water							
15											
20											
		woh	SS	Very soft to medium stiff dark gray organic clayey silt, trace wood and fine gravel inclusions							
		0-1-1-2	SS		- no recovery						
25		2-1-1-1	SS		- no recovery						
		2-2-2-1	SS		- no recovery						
		2-3-2-4	SS		- no recovery						
30		5-2-4-1	SS		- no recovery						
35		PUSH	ST	- no recovery						[Organic Silt]	

Completion Depth:	72.0 feet	Water Depth:	See Note	hrs
Project No.:	2006G419		ft After	hrs
Project Name:	Pier 84 South		ft After	hrs
Drilling Method:	Mud Rotary, Automatic SPT Hammer		ft After	hrs

# LOG of BORING NO. B-5

Sheet 2 of 3

DATE: 12-Apr-06

WAREHOUSE FLOOR ELEVATION: 13(±)

LOCATION:

See Figure 2

DEPTH, ft.	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
35		PUSH	ST	- no recovery						
				Very soft to medium stiff dark gray organic clayey silt						
40		PUSH	ST				12.5	65	28	X
45		PUSH	ST				86.9	58	26	X
50				[Organic Silt]	-37.5					
	1-5-11-17		SS	Medium dense to very dense grayish brown coarse to fine sandy coarse to fine gravel becoming silty coarse to fine sand and coarse to fine gravel						
55		12-31-36-37	SS							
60		30-46-38-29	SS							
65		13-13-22-28	SS	- becoming layered with brown silty medium to fine sand, trace coarse sand						
70				[ ALLUVIUM ]						
	25-32-		SS	Continued on sheet 3						

Completion Depth: 72.0 feet	Water Depth: See Note	hrs
Project No.: 2006G419		ft After
Project Name: Pier 84 South		hrs
Drilling Method: Mud Rotary, Automatic SPT Hammer		ft After
		hrs

# LOG of BORING NO. B-5

Sheet 3 of 3

DATE: 12-Apr-06

WAREHOUSE FLOOR ELEVATION: 13(±)

LOCATION:

See Figure 2

DEPTH, ft.	SAMPLES	N VALUE OR CORE RECOVERY	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
70		25-32- 25-25	SS	Dense grayish brown silty coarse to fine sand, trace fine gravel layered with brown silty medium to fine sand, trace coarse sand	-59.0					
75				End of test boring						
80										
85										
90										
95										
100										
105										

Note: Use of mud for drilling precluded direct observation of groundwater

Completion Depth: 72.0 feet	Water Depth: See Note	hrs
Project No.: 2006G419		ft After
Project Name: Pier 84 South		hrs
Drilling Method: Mud Rotary, Automatic SPT Hammer		ft After
		hrs

**APPENDIX B**  
**LABORATORY TESTING**

Physical property tests were conducted on selected representative soil samples to aid in classification and to provide an indication of soil behavior. These tests included natural water content (ASTM D 2216), gradation (ASTM D 422), and liquid & plastic limits (ASTM D 4318). In addition unconsolidated undrained triaxial compression tests (ASTM D 2850), organic content (ASTM D 2974), and one-dimensional consolidation tests (ASTM D 2435) were performed. The test results are presented on the following pages. Numerical results are also presented on the boring log.

### Organic Content (ASTM D 2974)

Boring No.	Station #	Depth	% Organic Matter
TB-4	ST-02	46.0-47.5	20.91
TB-5	ST-01	40.0-42.0	16.51
TB-5	ST-02	45.0-47.0	11.29

Project No. 2006G419

Client: Urban Engineers,  
Inc

Remarks:

Project: Pier 84 South

Date: 27-Apr-06

Organic Content

**GeoSystems Consultants, Inc.**

# GeoSystems Consultants, Inc.

Fort Washington, Pa 19034

Laboratory Testing Assignment & Billing Summary Sheet

Project Name: 2006G419      PIER 84 SOUTH      Client: URBAN ENGINEERS  
 Date: February 21, 2006      Reviewed By: RDS      Project No. RDS  
 File No. 2006G419 LSI      Page No. 1 of 3

Boring No.	Station No.	Depth (ft)	Water Content (%) ASTM D 2216	Atterberg Limits liquid/plastic ASTM D 4318	Specific Gravity ASTM D 854	Sieve / Hydrometer ASTM D 422	Classification on ASTM D 2487	Carbonate ASTM D 3042	Permeability Test ASTM D 5084	Permeability Test ASTM D 2434	Consolidation Test ASTM D 2435	UU Shear Test ASTM D 2850	Unconfined Shear Test ASTM D 2938	CU w/ PP Shear Test ASTM D 4767	Compaction Test ASTM D 698	Unit Weight
B-1	S-1	46' - 48'	106.1	72/44	1.15	1.06	1.10	1.16	3.01	3.04	5.03	4.04a	4.02b	4.04c	2.01	1.17
	S-2	50' - 52'	94.5	67/53												
	S-3	55' - 57'	83.6	72/47												
	S-4	60' - 62'														
	S-5	65' - 67'	9.9				X									
	S-6	70' - 72'														
	S-7	74' - 76'	17.2				X									
	S-8A	79' - 79.5'														
	S-8B	79.5' - 80.2'														
	S-9	84' - 86'	18.4				X									
	S-10A	89' - 89.5'														
	S-10B	89.5' - 90.2'														
	S-13	104' - 106'	27.1	48/24												
	S-14	109' - 111'														
	S-15	114' - 116'	26.2	42/24												
	S-16	119' - 121'														
	S-17	124' - 126'														
	S-18	129' - 131'														
	S-19	134' - 136'	25.9	43/24												
	S-20	139' - 141'														
	S-21	144' - 146'														
	S-22	149' - 151'	15.2				X									
B-1	S-23	154' - 156'														

# GeoSystems Consultants, Inc.

Fort Washington, Pa 19034

Laboratory Testing Assignment & Billing Summary Sheet

Proj No: 2006G419      Project Name: PIER 84 SOUTH      Client: URBAN ENGINEERS  
 Date: February 21, 2006      Reviewed By: RDS      Proj Eng: RDS  
 File No: 2006G419 LS1      Page No: 2 of 3

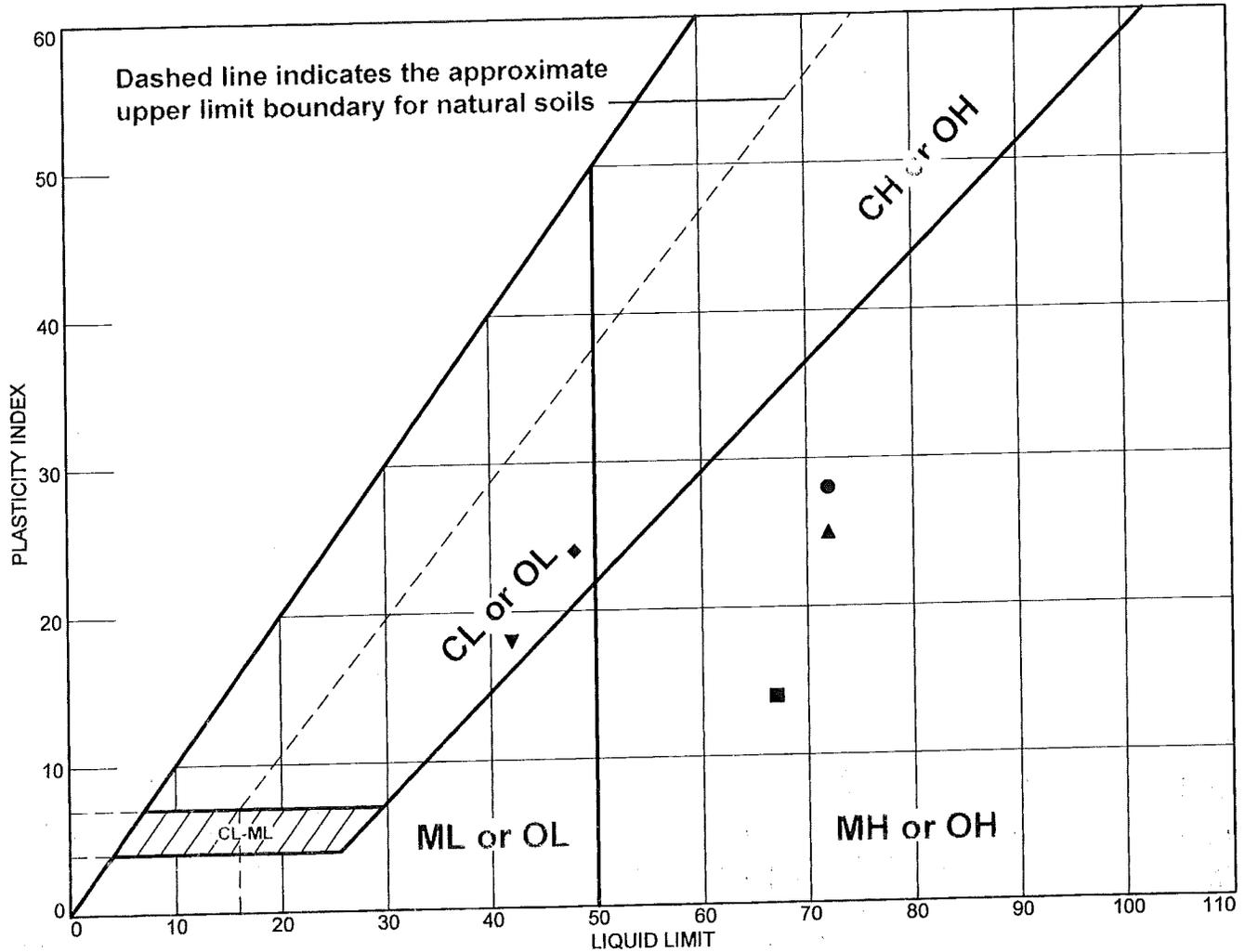
Boring No.	Station No.	Depth (ft)	Water Content (%) ASTM D 2216	Atterberg Limits liquid/plastic ASTM D 4318	Specific Gravity ASTM D 854	Sieve / Hydrometer ASTM D 422	Classification on ASTM D 2487	Carbonate ASTM D 3042	Permeability Test ASTM D 5084	Permeability Test ASTM D 2434	Consolidation Test ASTM D 2435	UU Shear Test ASTM D 2850	Unconfined Shear Test ASTM D 2938	CU w/ PP Shear Test ASTM D 4767	Compaction Test ASTM D 698	Unit Weight
			1.02	1.03	1.15	1.06	1.10	1.16	3.01	3.04	5.03	4.04a	4.02b	4.04c	2.01	1.17
B-1	S-24A	159' - 159.7'														pcf
	S-24B	159.7' - 159.9'														
	S-25	164' - 166'	7.7			X	SM									
B-2	S-1	46' - 47'	134.3	70/41			MH									
	S-2	50' - 52'														
	S-3	55' - 57'	15.9			X	SP									
	S-4	60' - 62'														
	S-5	65' - 67'														
	S-6	70' - 72'	7.7			X	SP									
	S-7	75' - 77'														
	S-8A	80' - 80.3'														
	S-8B	80.3' - 81.1'														
	S-9	85' - 87'	9.8			X	SP-SM									
	S-10	90' - 92'														
	S-11	95' - 97'	8.6			X	SW-SM									
	S-12	100' - 102'														
	S-13	105' - 107'	33.2	43/27			ML									
	S-14	110' - 112'														
	S-16A	120' - 120.7'	21.7	42/23			CL									
	S-16B	120.7' - 122'														
	S-17	125' - 127'														
B-2	S-18	130' - 132'	32.4	52/28			CH									







# LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Grayish brown elastic silt	72	44	28			MH
■	Grayish brown elastic silt	67	53	14			MH
▲	Grayish brown elastic silt	72	47	25			MH
◆	Reddish-brown lean clay	48	24	24			CL
▼	Reddish-brown lean clay	42	24	18			CL

**Project No.** 06G419      **Client:** Urban Engineers, Inc.  
**Project:** Pier 84 South

● **Source of Sample:** B-1      **Depth:** 46.0-48.0      **Sample Number:** S-1  
 ■ **Source of Sample:** B-1      **Depth:** 50.0-52.0      **Sample Number:** S-2  
 ▲ **Source of Sample:** B-1      **Depth:** 55.0-57.0      **Sample Number:** S-3  
 ◆ **Source of Sample:** B-1      **Depth:** 104.0-106.0      **Sample Number:** S-13  
 ▼ **Source of Sample:** B-1      **Depth:** 114.0-116.0      **Sample Number:** S-15

**GeoSystems Consultants, Inc.**  
**Fort Washington, Pennsylvania**

**Remarks:**

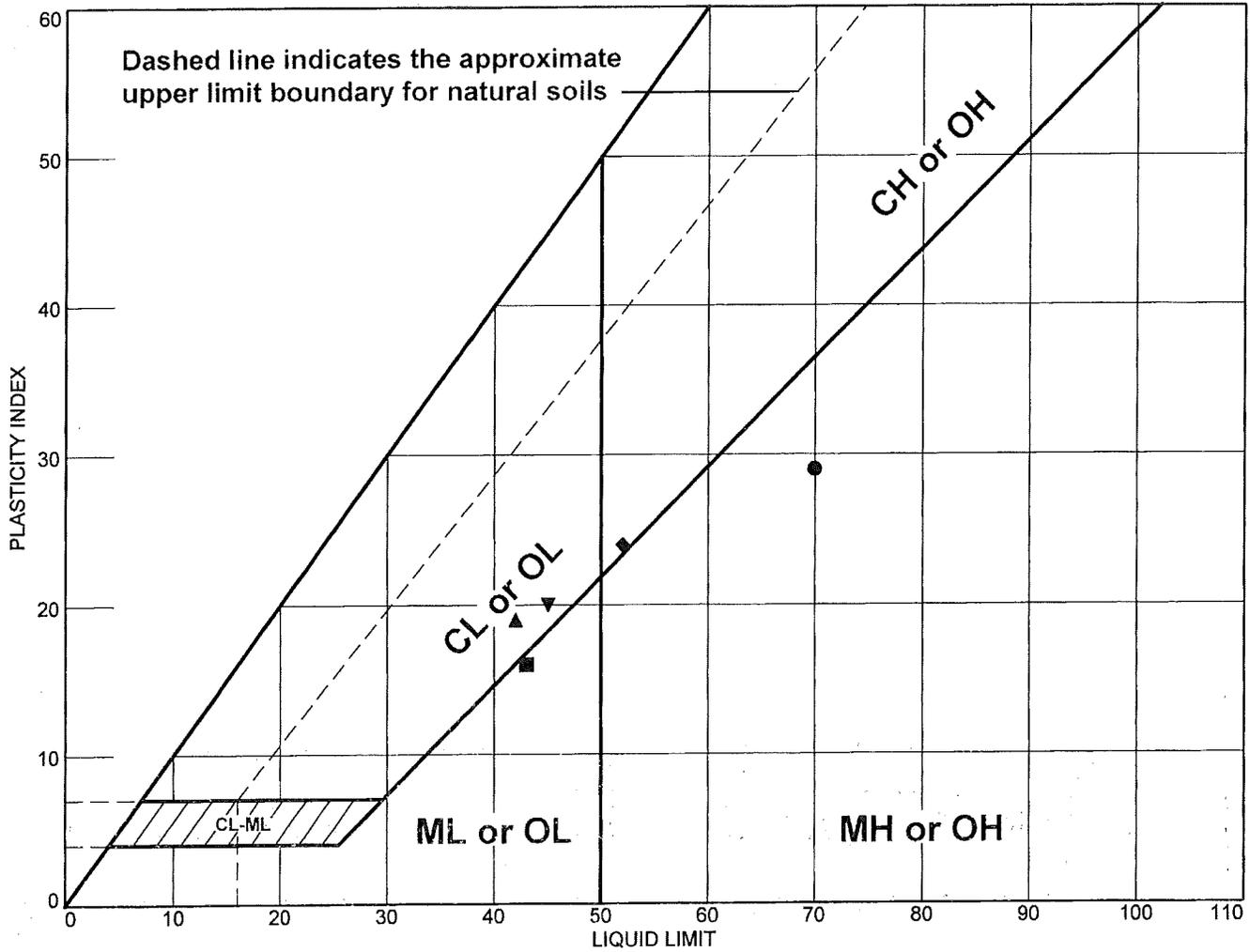
- Moisture Content - 106.1%
- Moisture Content - 94.5%
- ▲ Moisture Content - 83.6%
- ◆ Moisture Content - 27.1%
- ▼ Moisture Content - 26.2%

**Plate**

**Tested By:** D. Allen      **Checked By:** K. Nordeng



# LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown elastic silt	70	41	29			MH
■	Reddish-brown silt	43	27	16			ML
▲	Reddish-brown lean clay	42	23	19			CL
◆	Reddish-brown fat clay	52	28	24			CH
▼	Reddish-brown lean clay	45	25	20			CL

**Project No.** 06G419      **Client:** Urban Engineers, Inc.  
**Project:** Pier 84 South

● <b>Source of Sample:</b> B-2	<b>Depth:</b> 46.0-47.0	<b>Sample Number:</b> S-1
■ <b>Source of Sample:</b> B-2	<b>Depth:</b> 105.0-107.0	<b>Sample Number:</b> S-13
▲ <b>Source of Sample:</b> B-2	<b>Depth:</b> 120.0-120.7	<b>Sample Number:</b> S-16A
◆ <b>Source of Sample:</b> B-2	<b>Depth:</b> 130.0-132.0	<b>Sample Number:</b> S-18
▼ <b>Source of Sample:</b> B-2	<b>Depth:</b> 140.0-142.0	<b>Sample Number:</b> S-20

**GeoSystems Consultants, Inc.**

**Fort Washington, Pennsylvania**

**Remarks:**

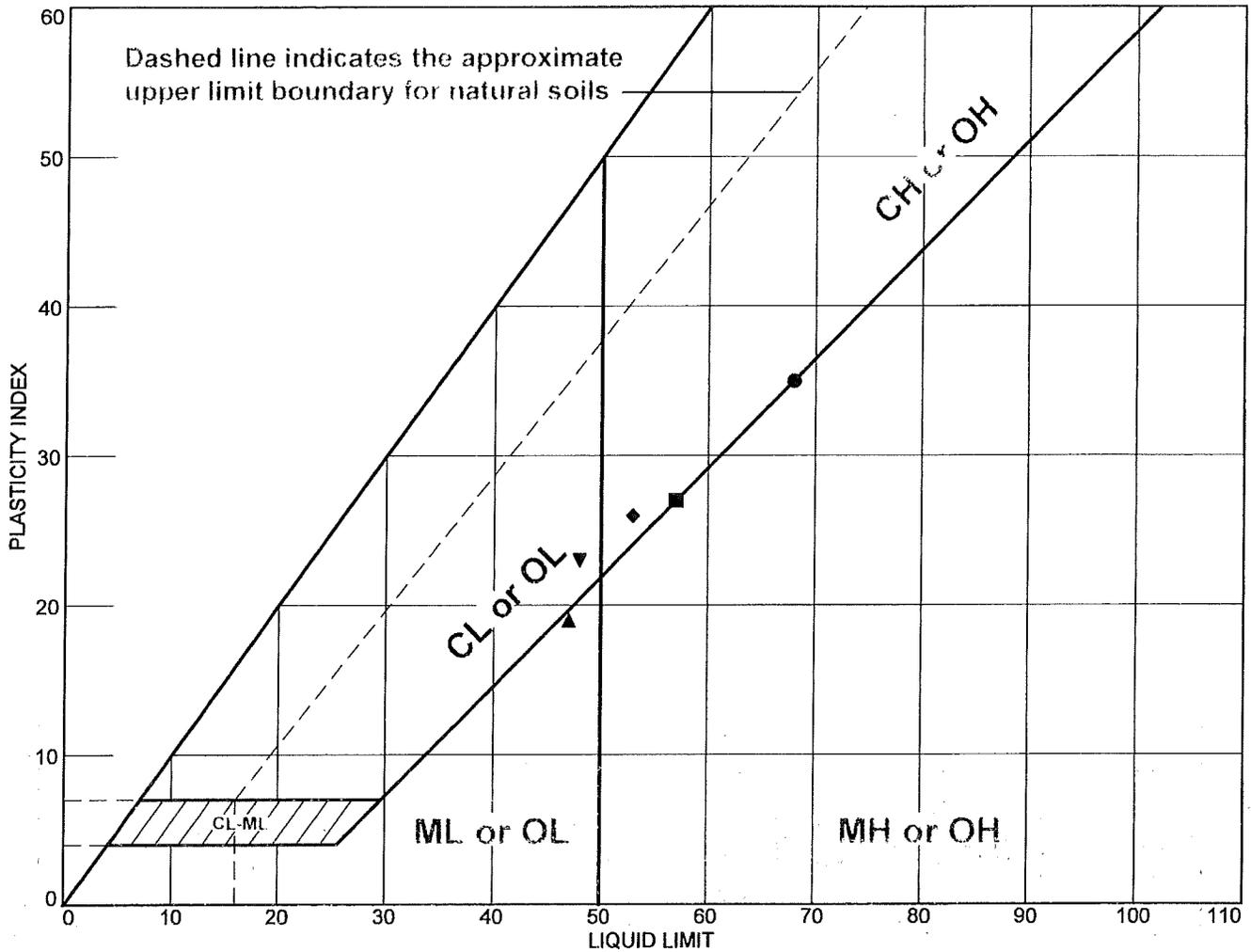
- Moisture Content - 134.3%
- Moisture Content - 33.2%
- ▲ Moisture Content - 21.7%
- ◆ Moisture Content - 32.4%
- ▼ Moisture Content - 24.6%

**Plate**

**Tested By:** D. Allen

**Checked By:** K. Nordeng

# LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark brown fat clay with sand	68	33	35	87.7	81.0	CH
■	Dark brown fat clay with sand	57	30	27	96.3	83.2	CH
▲	Reddish-brown silt	47	28	19			ML
◆	Reddish-brown lean clay	53	27	26			CL
▼	Reddish-brown lean clay	48	25	23			CL

**Project No.** 06G419      **Client:** Urban Engineers, Inc.

**Project:** Pier 84 South

- |                                |                           |                            |
|--------------------------------|---------------------------|----------------------------|
| ● <b>Source of Sample:</b> B-3 | <b>Depth:</b> 40.0-42.0   | <b>Sample Number:</b> S-12 |
| ■ <b>Source of Sample:</b> B-3 | <b>Depth:</b> 45.0-47.0   | <b>Sample Number:</b> S-13 |
| ▲ <b>Source of Sample:</b> B-3 | <b>Depth:</b> 105.0-107.0 | <b>Sample Number:</b> S-25 |
| ◆ <b>Source of Sample:</b> B-3 | <b>Depth:</b> 120.0-122.0 | <b>Sample Number:</b> S-28 |
| ▼ <b>Source of Sample:</b> B-3 | <b>Depth:</b> 130.0-132.0 | <b>Sample Number:</b> S-30 |

**GeoSystems Consultants, Inc.**

**Fort Washington, Pennsylvania**

**Remarks:**

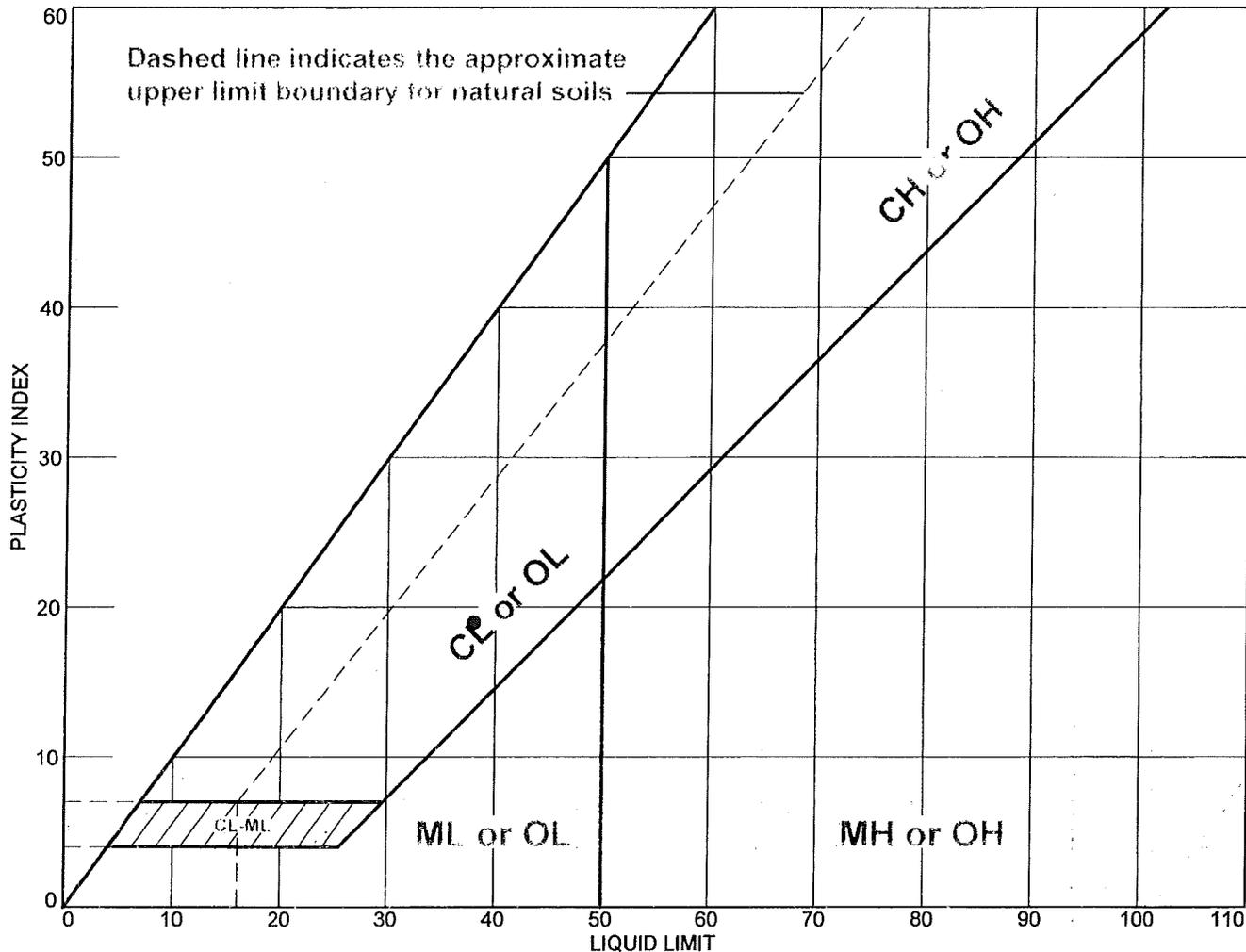
- ▲ Moisture Content - 27.4%
- ◆ Moisture Content - 29.2%
- ▼ Moisture Content - 28.3%

Plate

Tested By: D. Allen

Checked By: K. Nordeng

# LIQUID AND PLASTIC LIMITS TEST REPORT



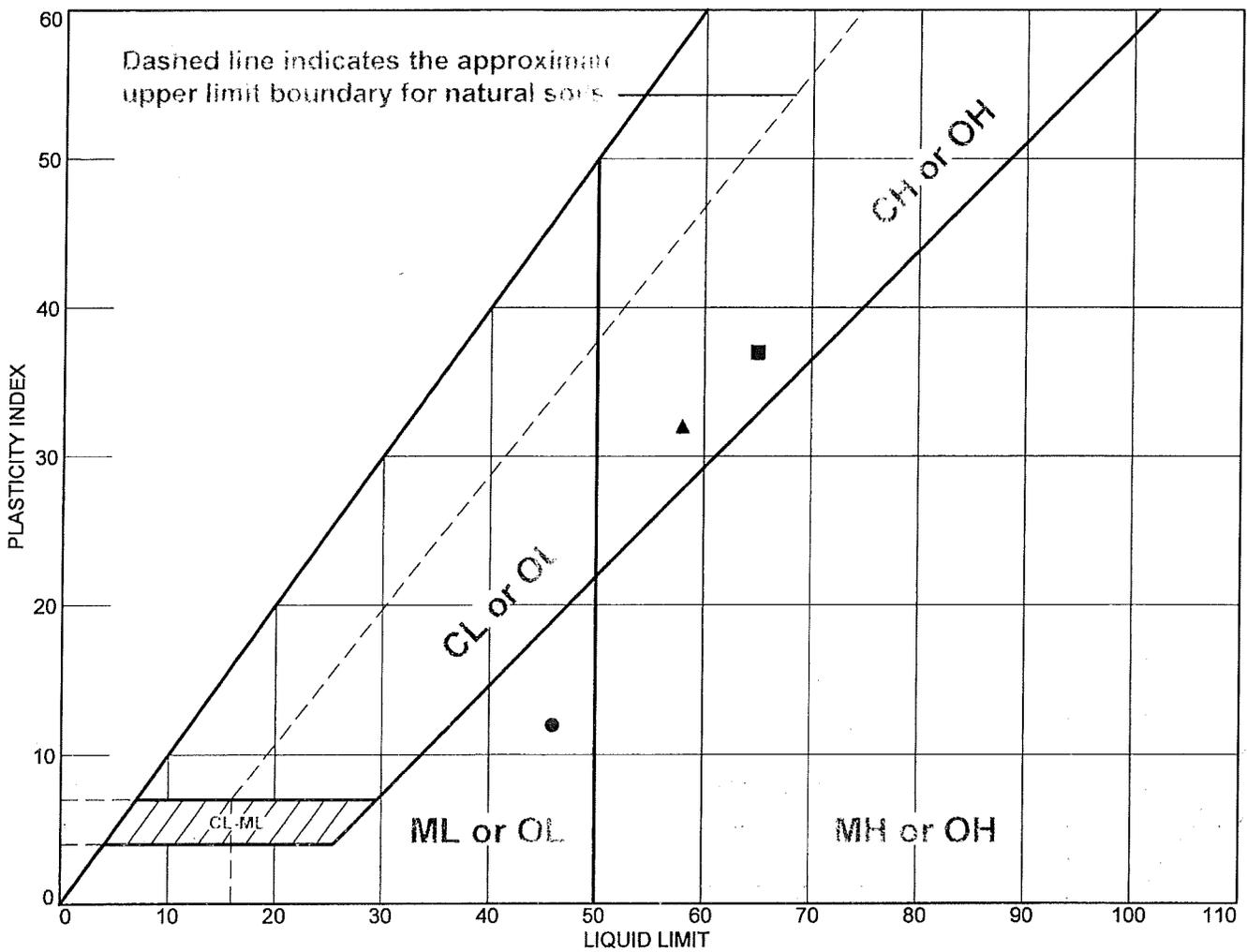
MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
● Reddish-brown lean clay	38	19	19			CL

**Project No.** 06G419      **Client:** Urban Engineers, Inc.  
**Project:** Pier 84 South  
**● Source of Sample:** B-3      **Depth:** 140.0-142.0      **Sample Number:** S-32  
  
**GeoSystems Consultants, Inc.**  
**Fort Washington, Pennsylvania**

**Remarks:**  
 ● Moisture Content - 21.3%  
  
  
  
**Plate**

**Tested By:** D. Allen      **Checked By:** K. Nordeng

# LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Grayish brown silt	46	34	12	99.5	84.8	ML
■	Greenish brown fat clay	65	28	37	99.2	95.5	CH
▲	Brown fat clay	58	26	32	99.1	89.4	CH

**Project No.** 06G419      **Client:** Urban Engineers, Inc.  
**Project:** Pier 84 South

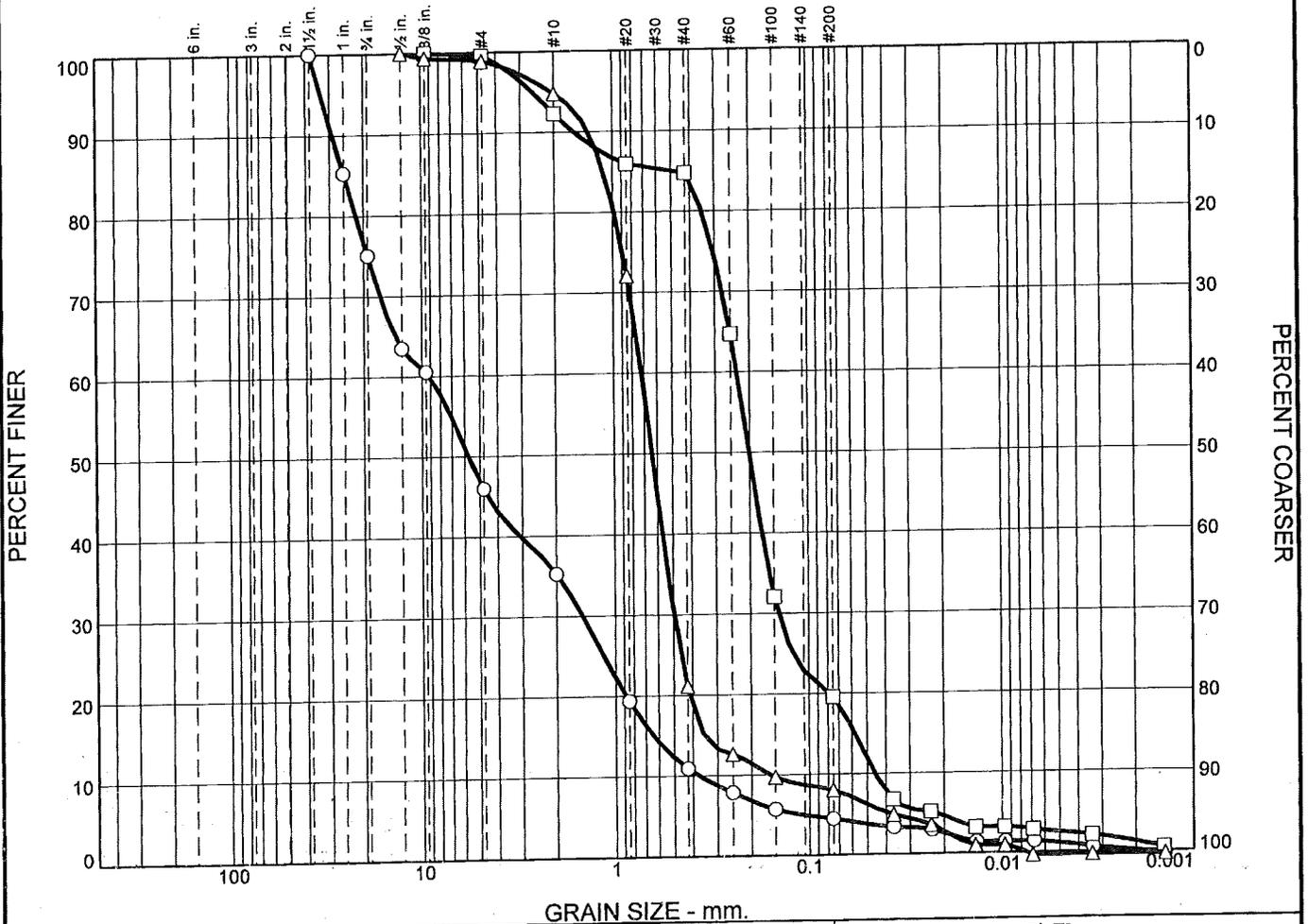
**● Source of Sample:** B-4      **Depth:** 46.0-47.5      **Sample Number:** ST-02  
**■ Source of Sample:** B-5      **Depth:** 40.0-42.0      **Sample Number:** ST-01  
**▲ Source of Sample:** B-5      **Depth:** 45.0-47.0      **Sample Number:** ST-02

**GeoSystems Consultants, Inc.**  
**Fort Washington, Pennsylvania**

**Remarks:**

**Plate**

# Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	24.9	29.1	10.8	24.3	6.4	3.4	1.1
□	0.0	0.0	0.4	7.3	7.5	65.2	17.1	2.5
△	0.0	0.0	1.1	4.1	73.7	13.1	8.0	

	LL	PL	D85	D60	D50	D30	D15	D10	Cc	Cu
○			25.1963	9.1243	5.7106	1.4689	0.6352	0.3733	0.63	24.44
□			0.4863	0.2322	0.2008	0.1429	0.0578	0.0453	1.94	5.12
△			1.1076	0.7204	0.6379	0.4945	0.3485	0.1586	2.14	4.54

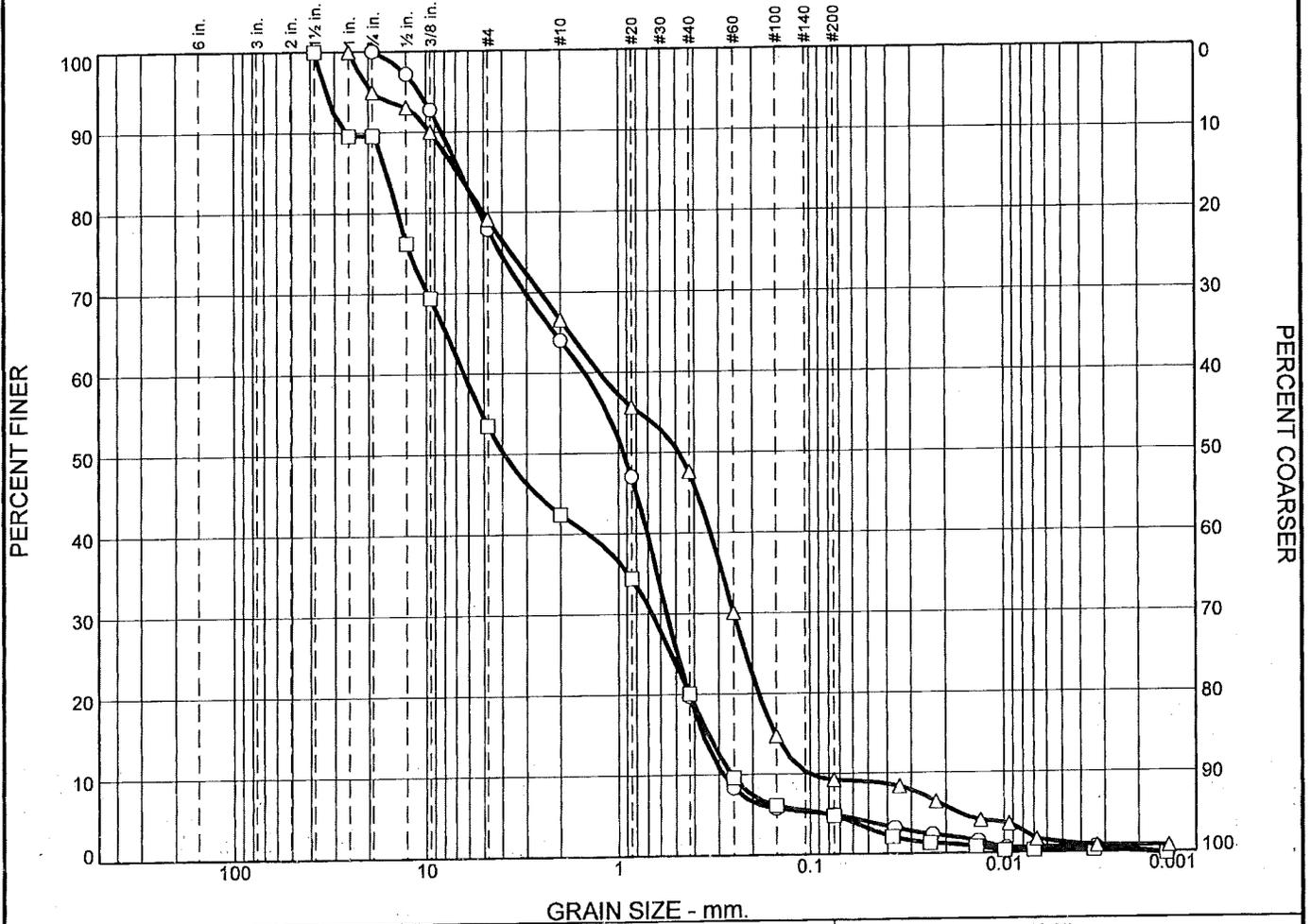
Material Description	USCS	AASHTO
○ Brown poorly graded gravel with sand	GP	A-1-a
□ Light brown silty sand	SM	A-2-4(0)
△ Brown poorly graded sand with silt	SP-SM	A-1-b

<b>Project No.</b> 06G419 <b>Project:</b> Pier 84 South	<b>Client:</b> Urban Engineers, Inc.	<b>Remarks:</b> ○ Moisture Content - 9.9% □ Moisture Content - 17.2% △ Moisture Content - 18.4%
○ <b>Source of Sample:</b> B-1 <b>Depth:</b> 65.0-67.0 <b>Sample Number:</b> S-5 □ <b>Source of Sample:</b> B-1 <b>Depth:</b> 74.0-76.0 <b>Sample Number:</b> S-7 △ <b>Source of Sample:</b> B-1 <b>Depth:</b> 84.0-86.0 <b>Sample Number:</b> S-9		
<b>GeoSystems Consultants, Inc.</b> <b>Fort Washington, Pennsylvania</b>		<b>Plate</b>

**Tested By:** ○ D.Allen   □ D. Allen   △ D. Allen   **Checked By:** K. Nordeng



# Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	22.1	13.9	44.2	14.9	4.3	0.6
□	0.0	10.4	36.1	11.1	22.3	15.3	4.5	0.3
△	0.0	5.0	15.8	12.6	19.0	38.4	8.0	1.2

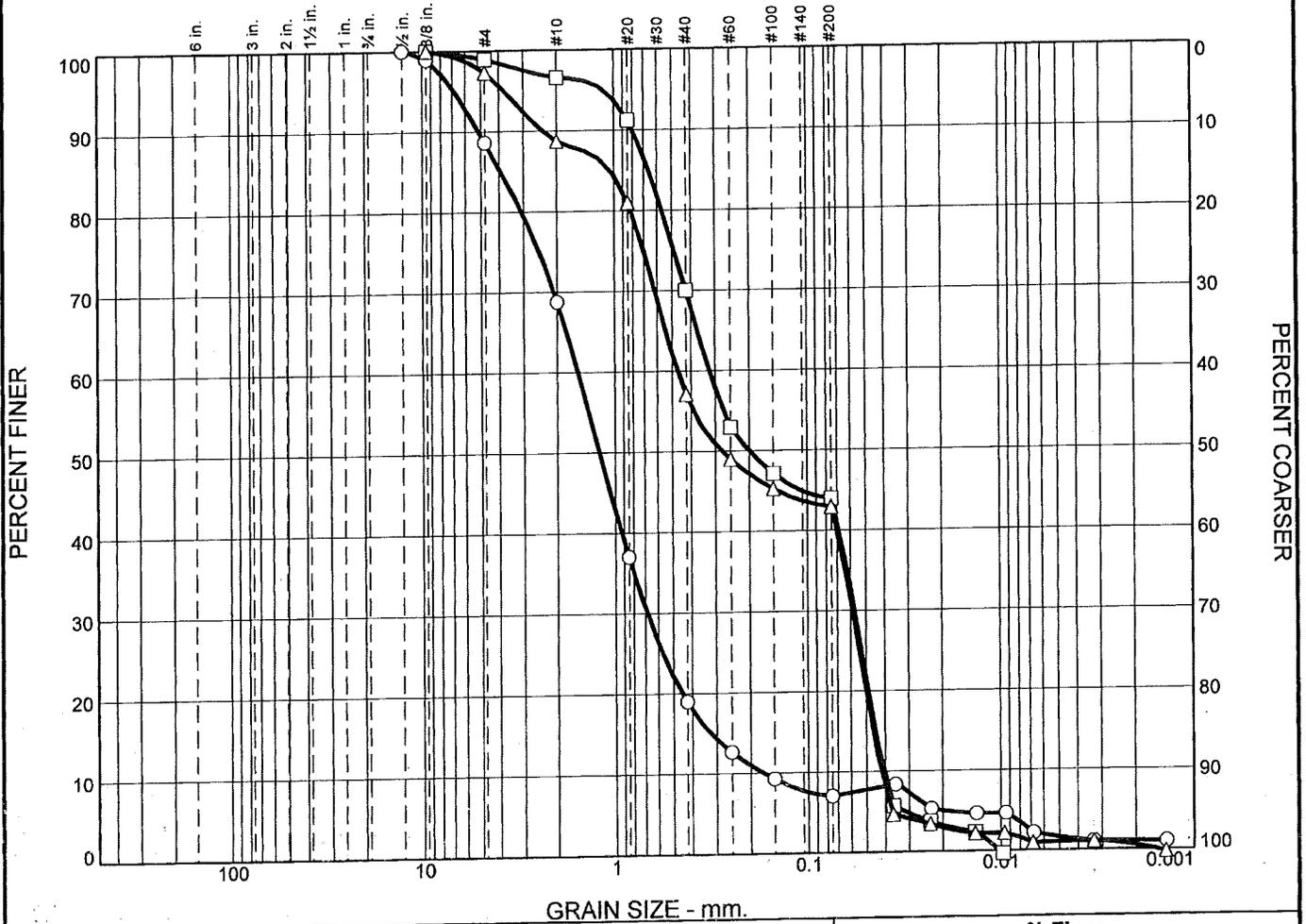
  

	LL	PL	D <sub>85</sub>	D <sub>60</sub>	D <sub>50</sub>	D <sub>30</sub>	D <sub>15</sub>	D <sub>10</sub>	C <sub>c</sub>	C <sub>u</sub>
○			6.5942	1.4974	0.9335	0.5545	0.3617	0.2835	0.72	5.28
□			15.9989	6.3442	3.9102	0.6638	0.3386	0.2571	0.27	24.67
△			6.8337	1.2536	0.4784	0.2495	0.1519	0.1007	0.49	12.45

Material Description	USCS	AASHTO
○ Brown poorly graded sand with gravel	SP	A-1-b
□ Brown poorly graded sand with gravel	SP	A-1-a
△ Brown poorly graded sand with silt and gravel	SP-SM	A-1-b

<b>Project No.</b> 06G419 <b>Client:</b> Urban Engineers, Inc. <b>Project:</b> Pier 84 South	<b>Remarks:</b> ○ Moisture Content - 15.9% □ Moisture Content - 7.7% △ Moisture Content - 9.8%
○ <b>Source of Sample:</b> B-2 <b>Depth:</b> 55.0-57.0 <b>Sample Number:</b> S-3 □ <b>Source of Sample:</b> B-2 <b>Depth:</b> 70.0-72.0 <b>Sample Number:</b> S-6 △ <b>Source of Sample:</b> B-2 <b>Depth:</b> 85.0-87.0 <b>Sample Number:</b> S-9	
<b>GeoSystems Consultants, Inc.</b> <b>Fort Washington, Pennsylvania</b>	

# Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines			
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay		
○	0.0	0.0	11.4	19.8	49.8	12.0	5.4	1.6		
□	0.0	0.0	1.1	2.3	26.6	26.0	44.0			
△	0.0	0.0	2.7	8.6	31.6	14.2	41.9	1.0		
⊗	LL	PL	D <sub>85</sub>	D <sub>60</sub>	D <sub>50</sub>	D <sub>30</sub>	D <sub>15</sub>	D <sub>10</sub>	C <sub>c</sub>	C <sub>u</sub>
○			3.9220	1.5561	1.2016	0.6826	0.3202	0.1705	1.76	9.12
□			0.6601	0.3194	0.1990	0.0572	0.0448	0.0406	0.25	7.86
△			1.0437	0.4682	0.2753	0.0583	0.0459	0.0418	0.17	11.20

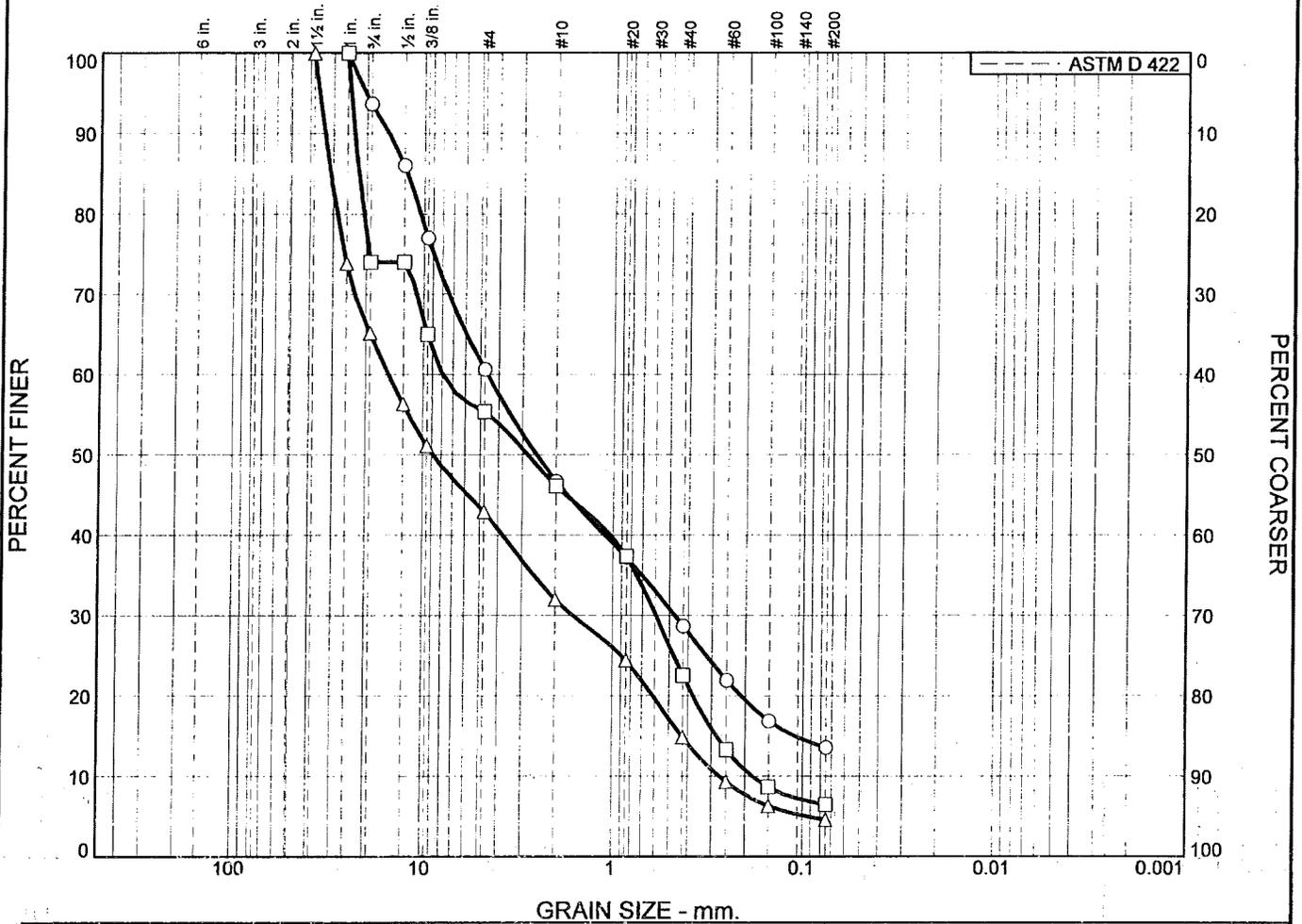
Material Description	USCS	AASHTO
○ Light brown well-graded sand with silt	SW-SM	A-1-b
□ Red silty sand	SM	A-4(0)
△ Red silty sand	SM	A-4(0)

<b>Project No.</b> 06G419 <b>Project:</b> Pier 84 South	<b>Client:</b> Urban Engineers, Inc.	<b>Remarks:</b> ○ Moisture Content - 8.6% □ Moisture Content - 16.7% △ Moisture Content - 15.1%
○ <b>Source of Sample:</b> B-2 <b>Depth:</b> 95.0-97.0 <b>Sample Number:</b> S-11 □ <b>Source of Sample:</b> B-2 <b>Depth:</b> 155.0-156.3 <b>Sample Number:</b> S-23 △ <b>Source of Sample:</b> B-2 <b>Depth:</b> 165.0-167.0 <b>Sample Number:</b> S-25		
<b>GeoSystems Consultants, Inc.</b> <b>Fort Washington, Pennsylvania</b>		
		<b>Plate</b>

**Tested By:** D. Allen      **Checked By:** K. Nordeng



# Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines			
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay		
○	0.0	6.3	33.1	13.9	18.0	15.1	13.6			
□	0.0	26.0	18.6	9.3	23.5	16.1	6.5			
△	0.0	34.8	22.3	10.9	17.1	10.3	4.6			
×	LL	PL	D <sub>85</sub>	D <sub>60</sub>	D <sub>50</sub>	D <sub>30</sub>	D <sub>15</sub>	D <sub>10</sub>	C <sub>c</sub>	C <sub>u</sub>
○			12.2255	4.5893	2.5325	0.4694	0.1094			
□			22.1001	7.9187	2.8133	0.5903	0.2821	0.1827	0.24	43.35
△			30.9091	15.1158	8.8278	1.6050	0.4292	0.2710	0.63	55.78

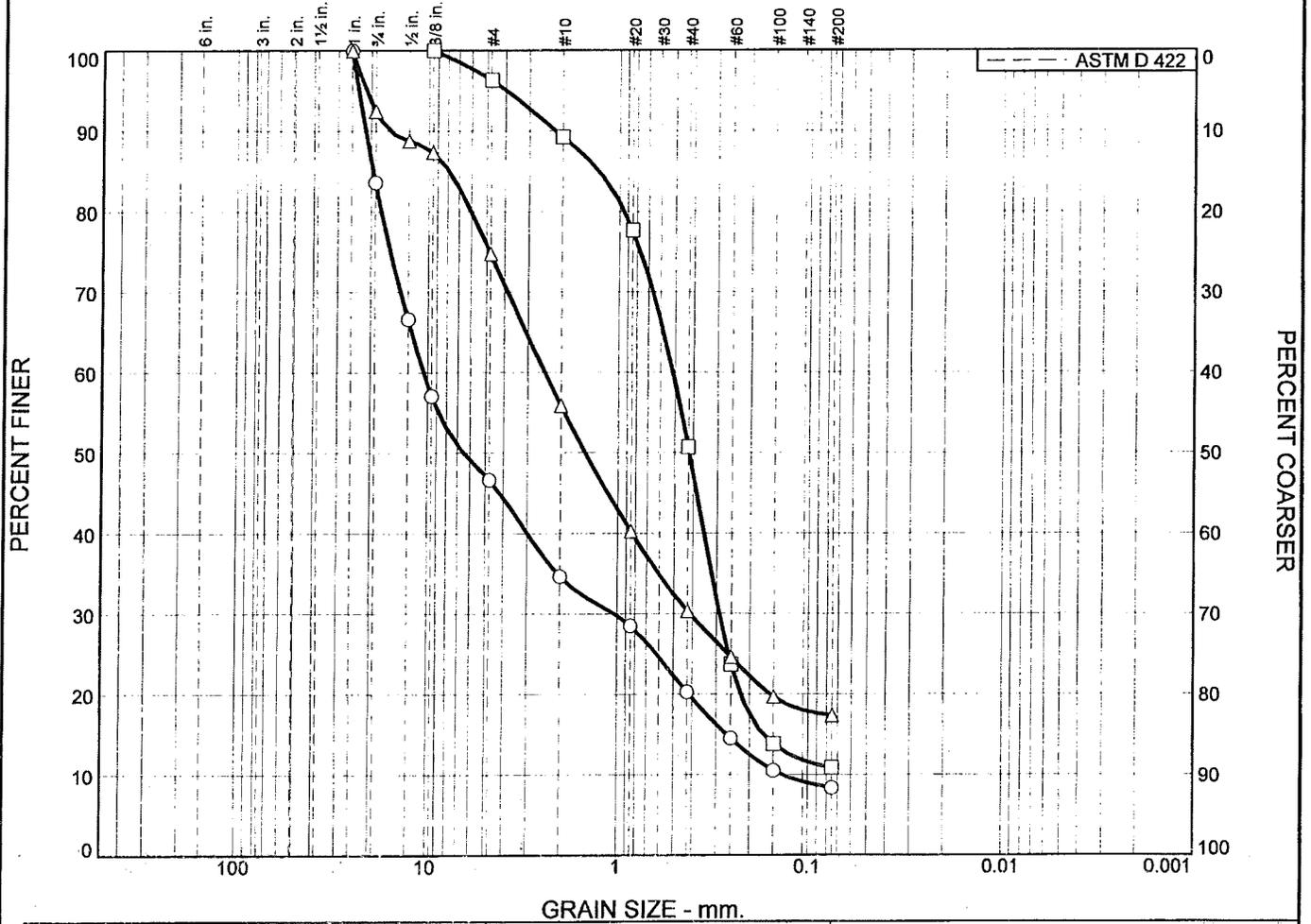
Material Description	USCS	AASHTO
○ Orange brown silty sand with gravel	SM	A-1-a
□ Brown poorly graded sand with silt and gravel	SP-SM	A-1-a
△ Brown poorly graded gravel with sand	GP	A-1-a

<b>Project No.</b> 06G419 <b>Client:</b> Urban Engineers, Inc. <b>Project:</b> Pier 84 South	<b>Remarks:</b> ○ Moisture Content - 10.8% □ Moisture Content - 9.8% △ Moisture Content - 8.1%
○ <b>Source of Sample:</b> B-3 <b>Depth:</b> 6.0-8.0 <b>Sample Number:</b> S-4 □ <b>Source of Sample:</b> B-3 <b>Depth:</b> 10.0-12.0 <b>Sample Number:</b> S-6 △ <b>Source of Sample:</b> B-3 <b>Depth:</b> 20.0-22.0 <b>Sample Number:</b> S-8	
<b>GeoSystems Consultants, Inc.</b> <b>Fort Washington, Pennsylvania</b>	

Plate



# Particle Size Distribution Report

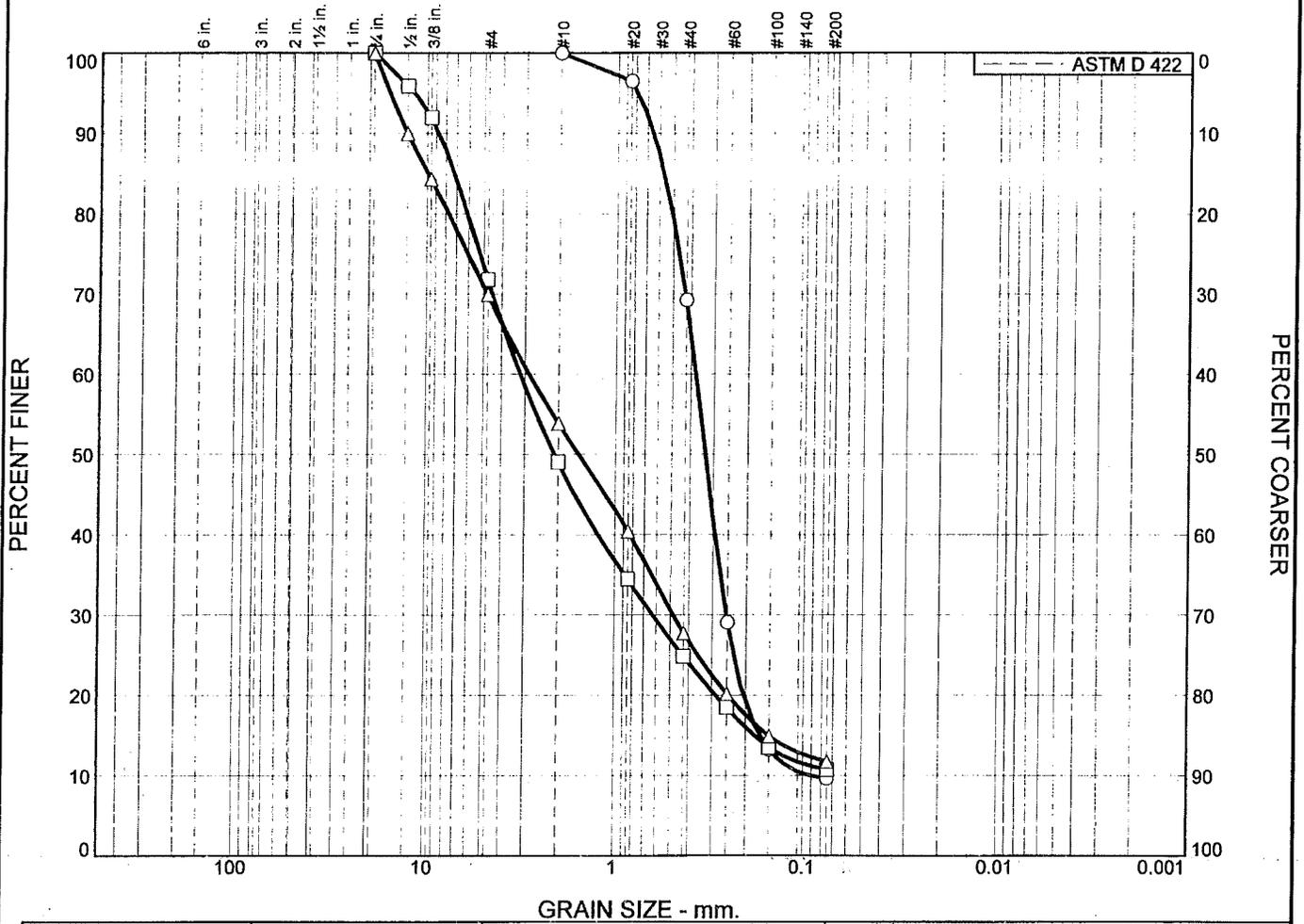


	% +3"	% Gravel		% Sand			% Fines			
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay		
○	0.0	16.3	37.0	12.0	14.4	11.9	8.4			
□	0.0	0.0	3.7	7.0	38.6	39.9	10.8			
△	0.0	7.5	17.7	18.9	25.6	12.9	17.4			
×	LL	PL	D <sub>85</sub>	D <sub>60</sub>	D <sub>50</sub>	D <sub>30</sub>	D <sub>15</sub>	D <sub>10</sub>	C <sub>c</sub>	C <sub>u</sub>
○			19.5485	10.5026	6.4183	1.0314	0.2623	0.1348	0.75	77.92
□			1.2752	0.5142	0.4195	0.2891	0.1695			
△			7.8268	2.4344	1.4776	0.4128				

Material Description	USCS	AASHTO
○ Brown poorly graded gravel with silt and sand	GP-GM	A-1-a
□ Light brown poorly graded sand with silt	SP-SM	A-2-4(0)
△ Light brown silty sand with gravel	SM	A-1-b

<b>Project No.</b> 06G419 <b>Client:</b> Urban Engineers, Inc. <b>Project:</b> Pier 84 South	<b>Remarks:</b> ○ Moisture Content - 7.5% □ Moisture Content - 14.3% △ Moisture Content - 8.3%
○ <b>Source of Sample:</b> B-3 <b>Depth:</b> 55.0-57.0 <b>Sample Number:</b> S-15 □ <b>Source of Sample:</b> B-3 <b>Depth:</b> 70.0-72.0 <b>Sample Number:</b> S-18 △ <b>Source of Sample:</b> B-3 <b>Depth:</b> 90.0-92.0 <b>Sample Number:</b> S-22	
<b>GeoSystems Consultants, Inc.</b> <b>Fort Washington, Pennsylvania</b>	

# Particle Size Distribution Report



GRAIN SIZE - mm.

	% +3"	% Gravel		% Sand			% Fines			
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay		
○	0.0	0.0	0.0	0.0	30.7	59.6	9.7			
□	0.0	0.0	28.2	22.8	24.1	14.2	10.7			
△	0.0	0.0	30.1	16.0	26.1	16.1	11.7			
×	LL	PL	D <sub>85</sub>	D <sub>60</sub>	D <sub>50</sub>	D <sub>30</sub>	D <sub>15</sub>	D <sub>10</sub>	C <sub>c</sub>	C <sub>u</sub>
○			0.5647	0.3756	0.3321	0.2538	0.1684	0.0912	1.88	4.12
□			7.1814	3.1740	2.0938	0.6234	0.1794			
△			9.8618	2.8532	1.5574	0.4836	0.1517			

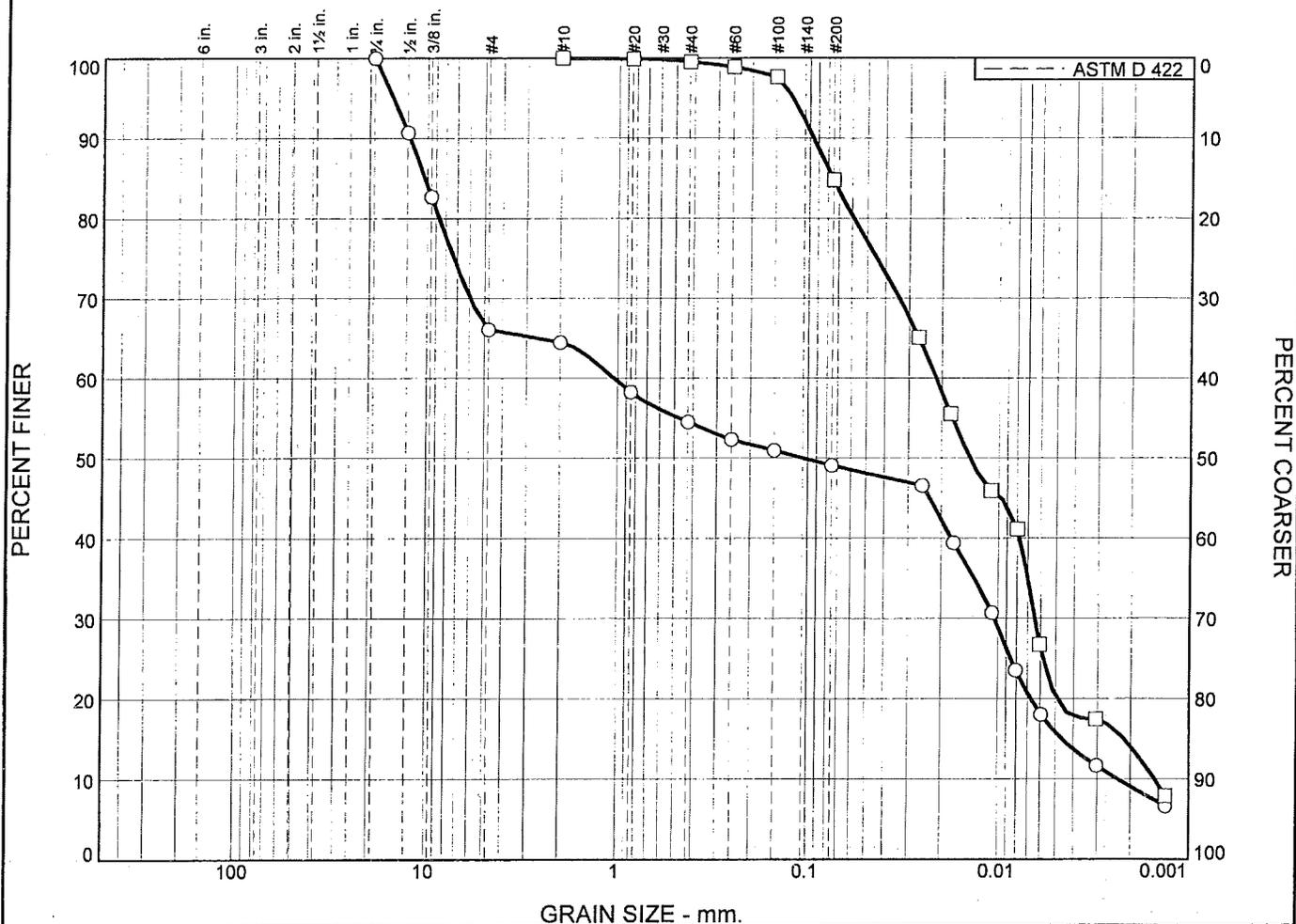
Material Description	USCS	AASHTO
○ Brownish gray poorly graded sand with silt	SP-SM	A-3
□ Brownish gray poorly graded sand with silt and gravel	SP-SM	A-1-a
△ Brownish gray poorly graded sand with silt and gravel	SP-SM	A-1-b

<b>Project No.</b> 06G419 <b>Client:</b> Urban Engineers, Inc. <b>Project:</b> Pier 84 South	<b>Remarks:</b> ○ Moisture Content - 17.4% □ Moisture Content - 6.4% △ Moisture Content - 7.3%
○ <b>Source of Sample:</b> B-3 <b>Depth:</b> 150.0-152.0 <b>Sample Number:</b> S-34 □ <b>Source of Sample:</b> B-3 <b>Depth:</b> 160.0-162.0 <b>Sample Number:</b> S-36 △ <b>Source of Sample:</b> B-3 <b>Depth:</b> 165.0-167.0 <b>Sample Number:</b> S-37	
<b>GeoSystems Consultants, Inc.</b> <b>Fort Washington, Pennsylvania</b>	
<b>Plate</b>	

Tested By: D. Allen

Checked By: K. Nordeng

# Particle Size Distribution Report



GRAIN SIZE - mm.

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	33.9	1.6	9.9	5.5	33.2	15.9
□	0.0	0.0	0.0	0.0	0.5	14.7	64.5	20.3

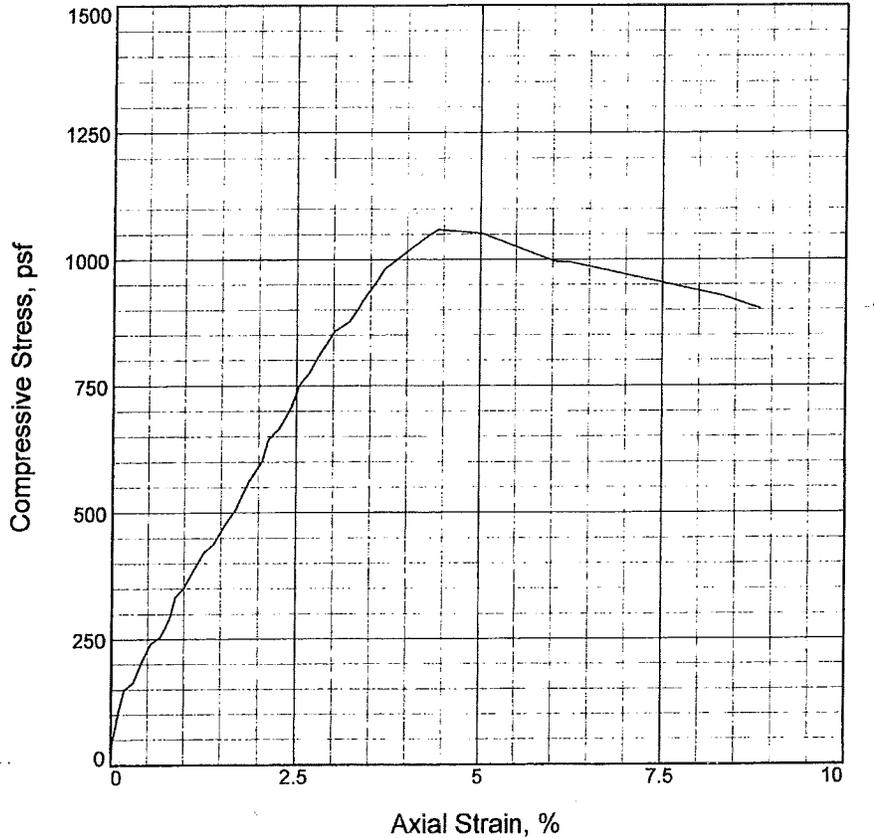
	LL	PL	D <sub>85</sub>	D <sub>60</sub>	D <sub>50</sub>	D <sub>30</sub>	D <sub>15</sub>	D <sub>10</sub>	C <sub>c</sub>	C <sub>u</sub>
○			10.3052	1.0392	0.1048	0.0104	0.0046	0.0023	0.04	444.20
□	46	34	0.0757	0.0215	0.0143	0.0064	0.0022	0.0015	1.28	14.25

Material Description							USCS	AASHTO
○ Brown silty gravel with sand							GM	A-4(0)
□ Grayish brown silt							ML	A-7-5(13)

<b>Project No.</b> 06G419 <b>Client:</b> Urban Engineers, Inc. <b>Project:</b> Pier 84 South  ○ <b>Source of Sample:</b> B-4 <b>Depth:</b> 40.0-42.0 <b>Sample Number:</b> ST-01 □ <b>Source of Sample:</b> B-4 <b>Depth:</b> 46.0-47.5 <b>Sample Number:</b> ST-02	<b>Remarks:</b> ○ Moisture Content - 43.2% □ Moisture Content - 41.8%
<b>GeoSystems Consultants, Inc.</b>  <b>Fort Washington, Pennsylvania</b>	
<b>Plate</b>	



# UNCONSOLIDATED UNDRAINED TEST



Sample No.	1			
Fail. Stress, psf	1059			
Ult. Stress, psf				
Cell pressure, psi	2160			
Strain rate, in./min.	0.030			
Water content, %	41.8			
Wet density, pcf	108.7			
Dry density, pcf	76.6			
Saturation, %	96.2			
Void ratio	1.1428			
Specimen diameter, in.	2.843			
Specimen height, in.	5.595			
Height/diameter ratio	1.97			

**Description:** Grayish brown silt

LL = 46    PL = 34    PI = 12    GS = 2.63    Type: Undisturbed

**Project No.:** 06G419  
**Date Sampled:** 4/28/06  
**Remarks:**

**Client:** Urban Engineers, Inc.

**Project:** Pier 84 South

**Source of Sample:** B-4      **Depth:** 46.0-47.5

**Sample Number:** ST-02

UNCONSOLIDATED UNDRAINED TEST

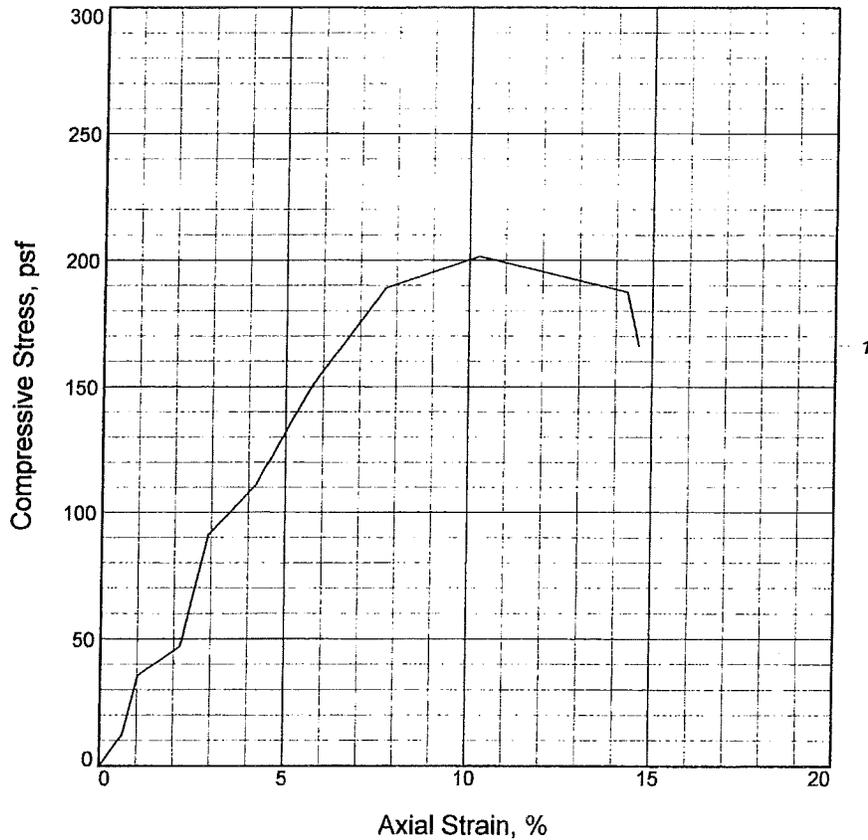
## GeoSystems Consultants, Inc.

Plate \_\_\_\_\_

Tested By: E. Drew

Checked By: K. Nordeng

# UNCONSOLIDATED UNDRAINED TEST



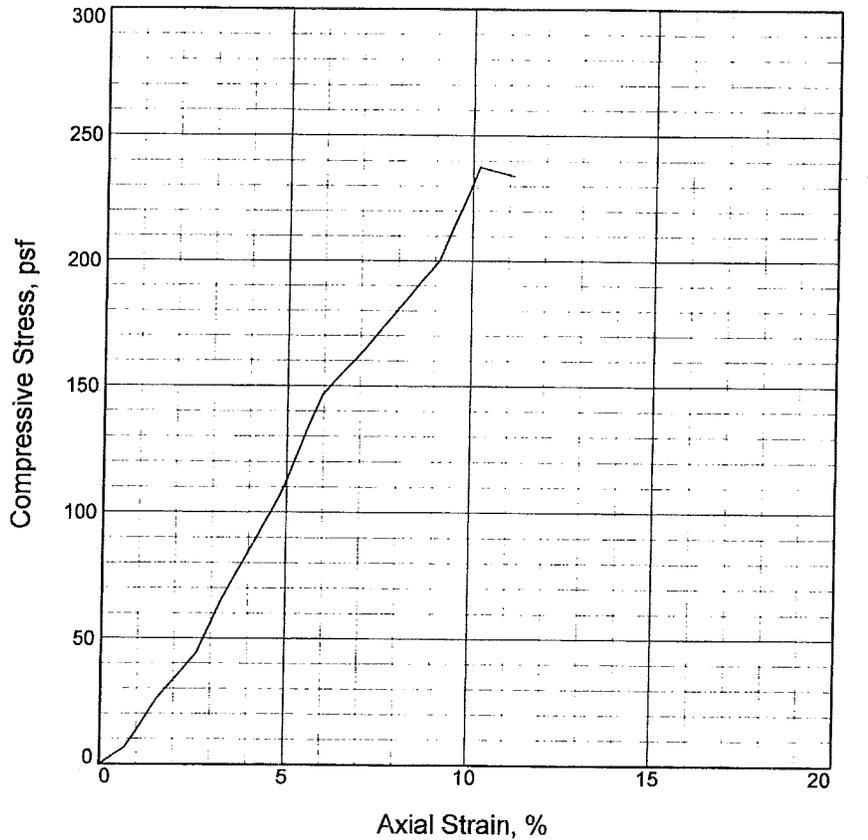
Sample No.	1			
Fail. Stress, psf	202			
Ult. Stress, psf				
Cell pressure, psi	2160			
Strain rate, in./min.	0.030			
Water content, %	86.9			
Wet density, pcf	88.0			
Dry density, pcf	47.1			
Saturation, %	91.2			
Void ratio	2.5537			
Specimen diameter, in.	2.800			
Specimen height, in.	5.450			
Height/diameter ratio	1.95			

**Description:** Brown fat clay

LL = 58	PL = 26	PI = 32	GS = 2.68	Type: Undisturbed
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<p><b>Project No.:</b> 06G419</p> <p><b>Date Sampled:</b> 5/1/2006</p> <p><b>Remarks:</b></p> <p>Plate _____</p>	<p><b>Client:</b> Urban Engineers, Inc.</p> <p><b>Project:</b> Pier 84 South</p> <p><b>Source of Sample:</b> B-5      <b>Depth:</b> 45.0-47.0</p> <p><b>Sample Number:</b> ST-02</p> <p style="text-align: center;">UNCONSOLIDATED UNDRAINED TEST</p> <p style="text-align: center; font-size: 1.2em;"><b>GeoSystems Consultants, Inc.</b></p>
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# UNCONSOLIDATED UNDRAINED TEST

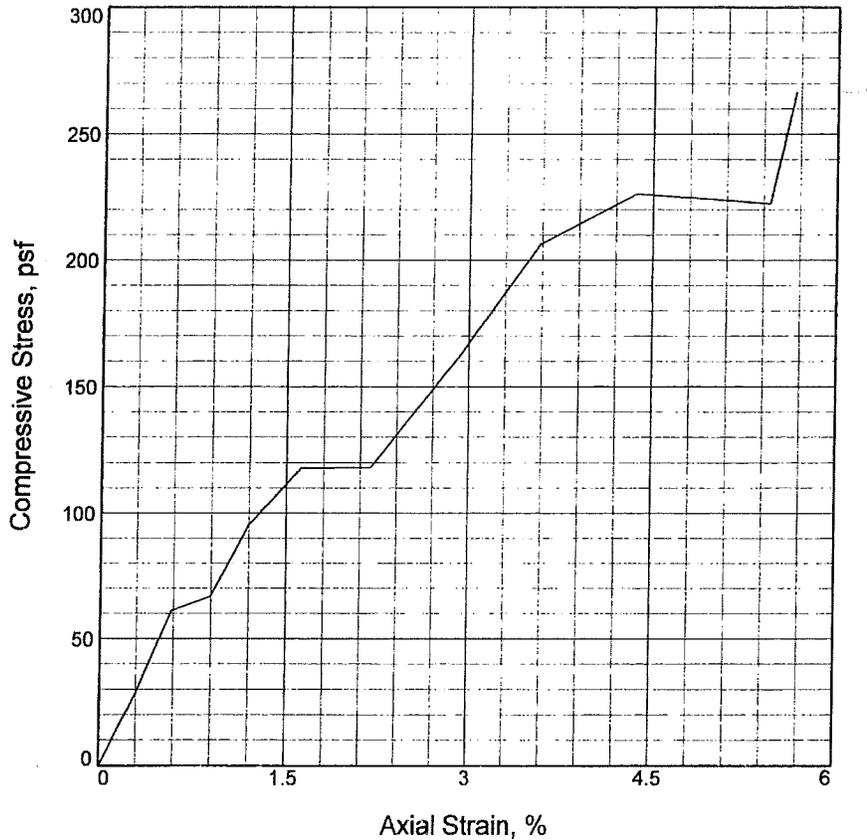


Sample No.	1			
Fail. Stress, psf	238			
Ult. Stress, psf				
Cell pressure, psi	2160			
Strain rate, in./min.	0.030			
Water content, %	41.8			
Wet density, pcf	109.2			
Dry density, pcf	77.0			
Saturation, %	97.1			
Void ratio	1.1332			
Specimen diameter, in.	2.830			
Specimen height, in.	5.600			
Height/diameter ratio	1.98			

**Description:**  
 LL =  PL =  PI =  GS= 2.63 Type: Remolded

Project No.: 06G419 Date Sampled: 5/1/2006 Remarks:  Plate _____	Client: Urban Engineers, Inc. Project: Pier 84 South Source of Sample: B-4      Depth: 46.0-47.5 Sample Number: ST-02 Remolded UNCONSOLIDATED UNDRAINED TEST <h2 style="text-align: center; margin: 0;">GeoSystems Consultants, Inc.</h2>
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# UNCONSOLIDATED UNDRAINED TEST



Sample No.	1			
Fail. Stress, psf	267			
Ult. Stress, psf	/			
Cell pressure, psi	2160			
Strain rate, in./min.	0.030			
Water content, %	80.3			
Wet density, pcf	91.0			
Dry density, pcf	50.5			
Saturation, %	93.1			
Void ratio	2.3036			
Specimen diameter, in.	2.780			
Specimen height, in.	5.500			
Height/diameter ratio	1.98			

**Description:** Greenish brown fat clay

**LL = 65      PL = 28      PI = 37      GS = 2.67      Type: Undisturbed**

**Project No.:** 06G419

**Date Sampled:**

**Remarks:**

Incomplete test - data acquisition system malfunctioned

**Client:** Urban Engineers, Inc.

**Project:** Pier 84 South

**Source of Sample:** B-5

**Depth:** 40.0-42.0

**Sample Number:** ST-01

UNCONSOLIDATED UNDRAINED TEST

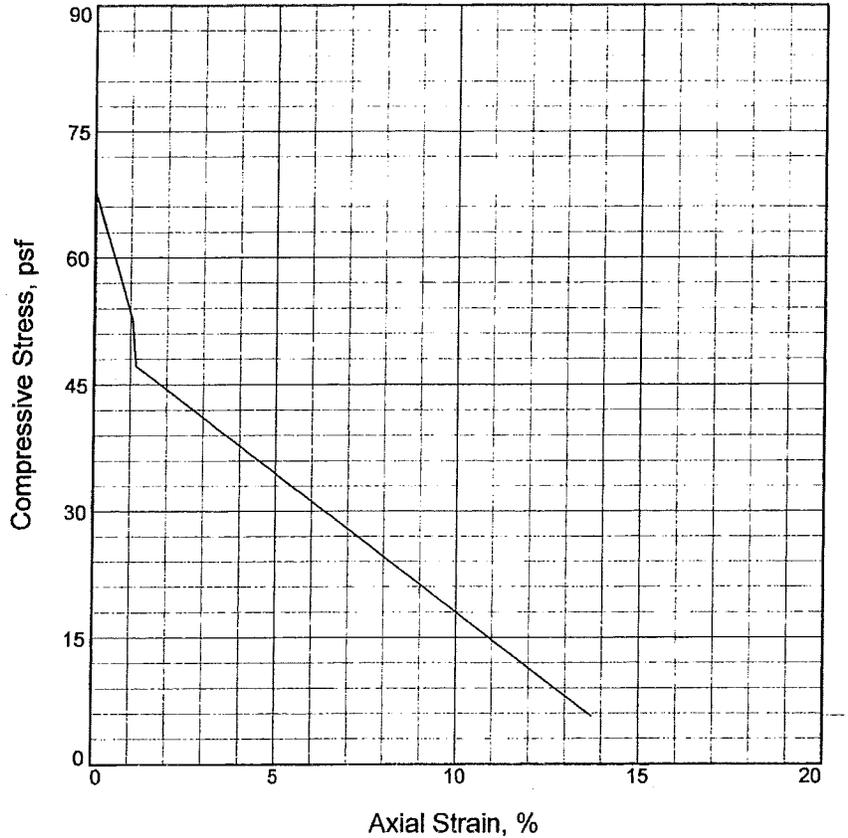
## GeoSystems Consultants, Inc.

Plate \_\_\_\_\_

**Tested By:** E. Drew

**Checked By:** K. Nordeng

# UNCONSOLIDATED UNDRAINED TEST



Sample No.	1		
Fail. Stress, psf	68		
Ult. Stress, psf			
Cell pressure, psi	2160		
Strain rate, in./min.	0.030		
Water content, %	80.3		
Wet density, pcf	91.2		
Dry density, pcf	50.6		
Saturation, %	93.4		
Void ratio	2.2957		
Specimen diameter, in.	2.850		
Specimen height, in.	5.180		
Height/diameter ratio	1.82		

**Description:**

LL =      PL =      PI =      GS= 2.67      Type: Remolded

Project No.: 06G419  
 Date Sampled: 5/1/2006  
 Remarks:

**Client:** Urban Engineers, Inc.

**Project:** Pier 84 South

**Source of Sample:** B-5      **Depth:** 40.0-42.0

**Sample Number:** ST-01 Remolded

UNCONSOLIDATED UNDRAINED TEST

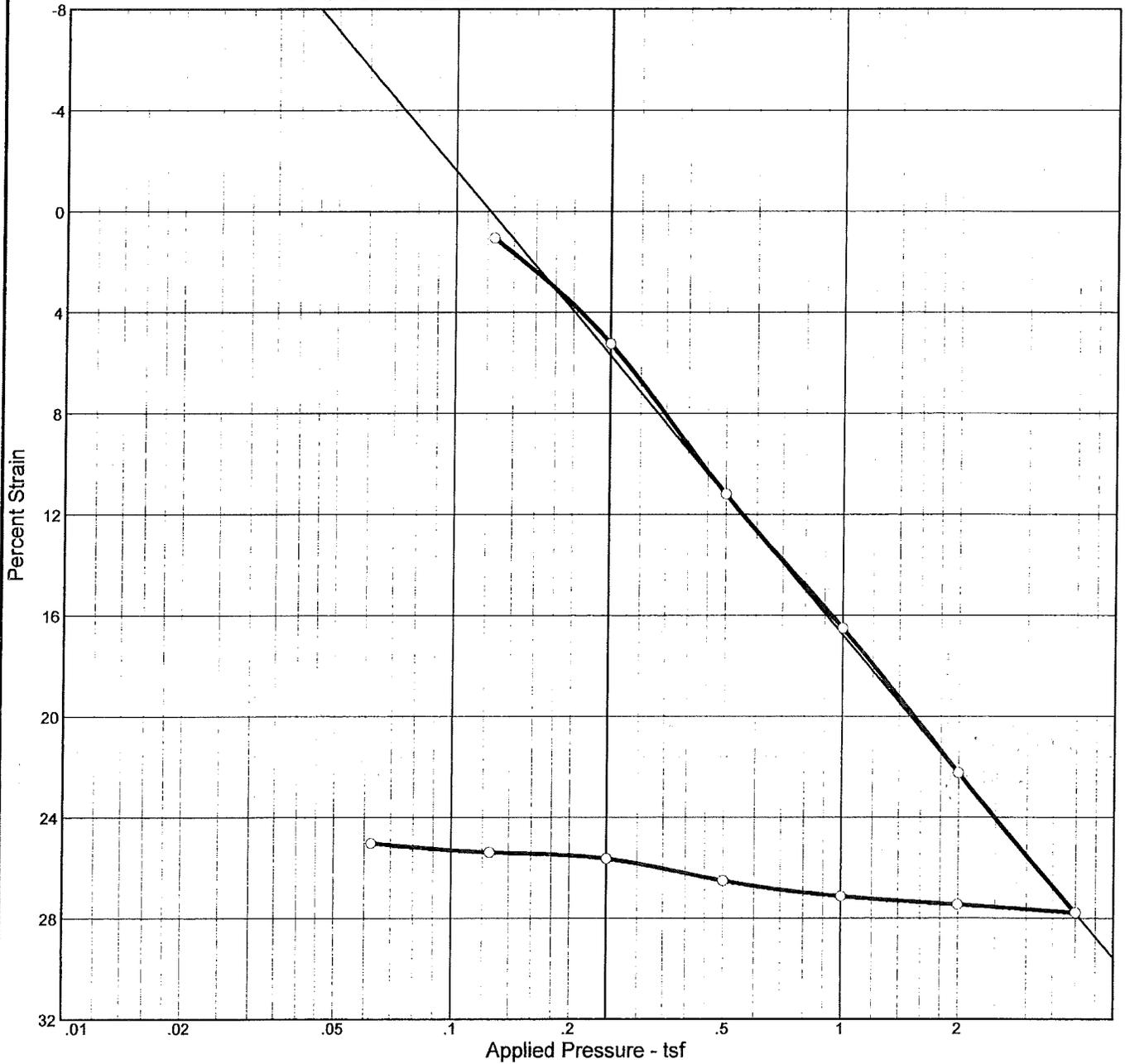
## GeoSystems Consultants, Inc.

Plate \_\_\_\_\_

Tested By: E. Drew

Checked By: K. Nordeng

# CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P <sub>c</sub> (tsf)	C <sub>c</sub>	C <sub>r</sub>	Initial Void Ratio
Saturation	Moisture									
85.7 %	81.0 %	47.3	65	37	2.67		0.22	0.65	0.05	2.524

<b>MATERIAL DESCRIPTION</b>								<b>USCS</b>	<b>AASHTO</b>
Greenish brown fat clay								CH	A-7-6(42)

<b>Project No.</b> 06G419 <b>Project:</b> Pier 84 South <b>Source:</b> B-5	<b>Client:</b> Urban Engineers, Inc.  <b>Sample No.:</b> ST-01 <b>Elev./Depth:</b> 40.0-42.0	<b>Remarks:</b>          <div style="text-align: right;">Plate</div>
<b>GeoSystems Consultants, Inc.</b> <b>Fort Washington, Pennsylvania</b>		

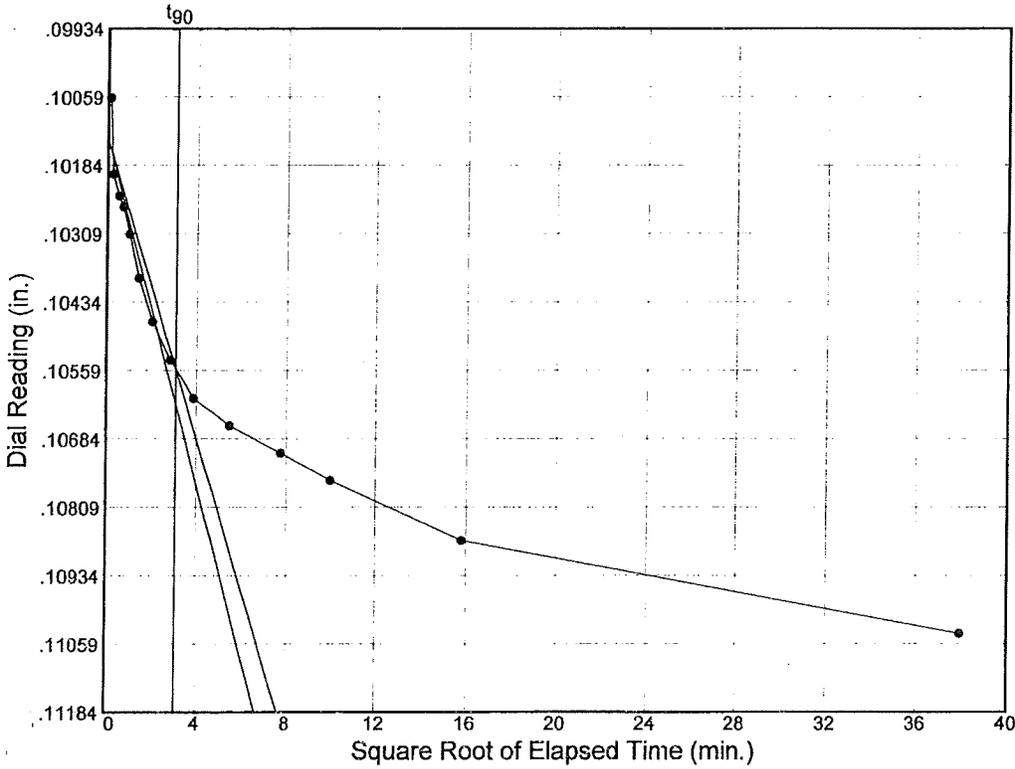
# Dial Reading vs. Time

Project No.: 06G419  
Project: Pier 84 South

Source: B-5

Sample No.: ST-01

Elev./Depth: 40.0-42.0



Load No.= 1

Load= 0.13 tsf

$D_0 = 0.10136$

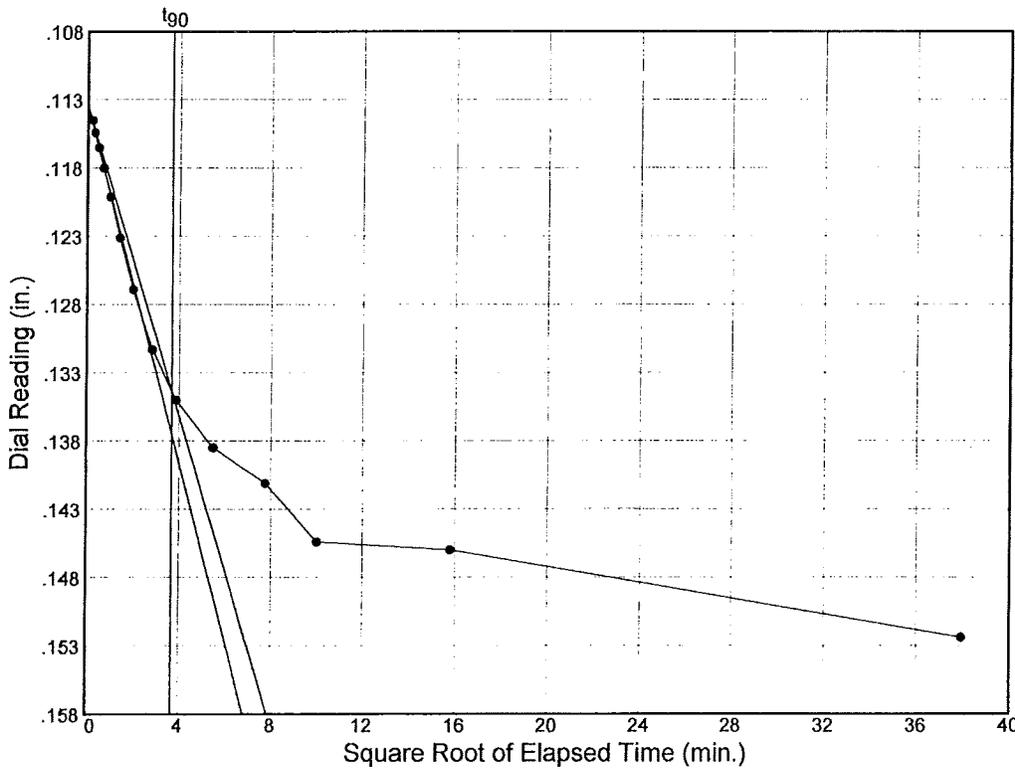
$D_{90} = 0.10556$

$D_{100} = 0.10603$

$T_{90} = 9.40 \text{ min.}$

$C_v @ T_{90}$

0.89 ft.<sup>2</sup>/day



Load No.= 2

Load= 0.25 tsf

$D_0 = 0.11338$

$D_{90} = 0.13436$

$D_{100} = 0.13669$

$T_{90} = 13.64 \text{ min.}$

$C_v @ T_{90}$

0.58 ft.<sup>2</sup>/day

Plate

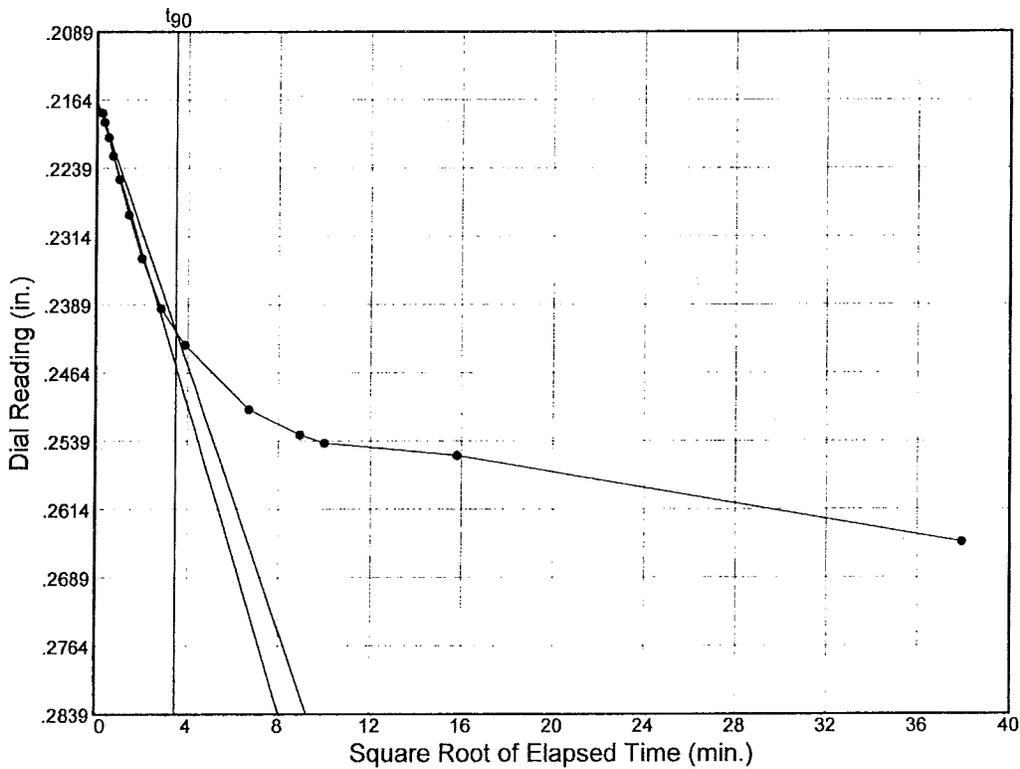
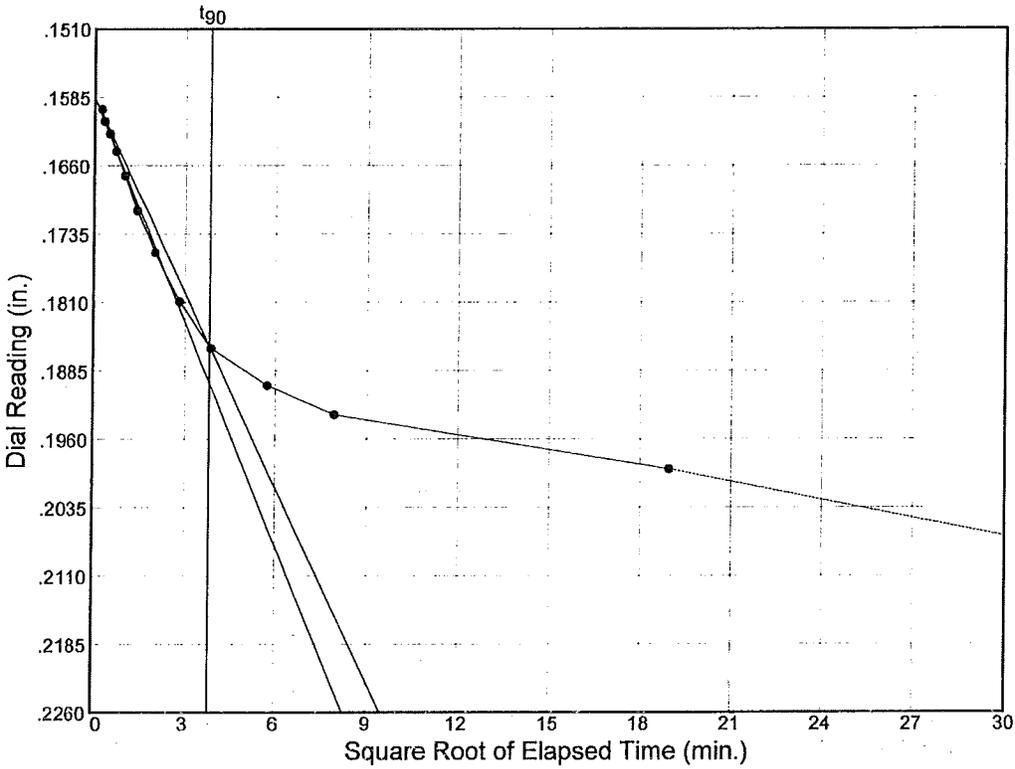
# Dial Reading vs. Time

Project No.: 06G419  
 Project: Pier 84 South

Source: B-5

Sample No.: ST-01

Elev./Depth: 40.0-42.0



Plate

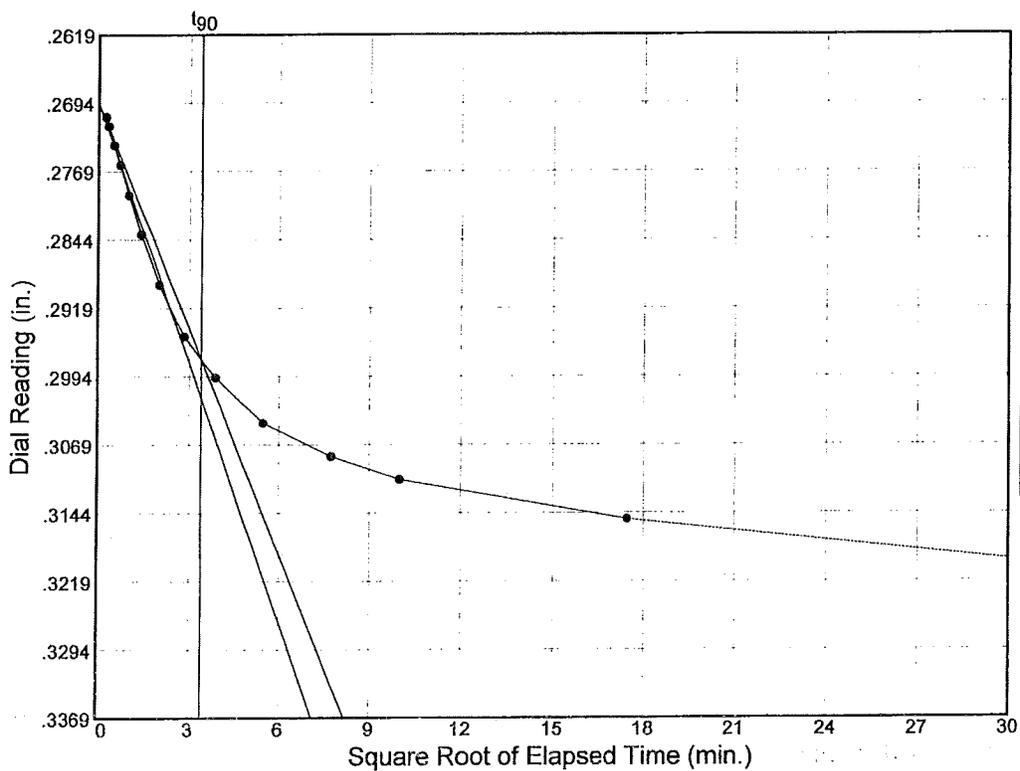
# Dial Reading vs. Time

Project No.: 06G419  
Project: Pier 84 South

Source: B-5

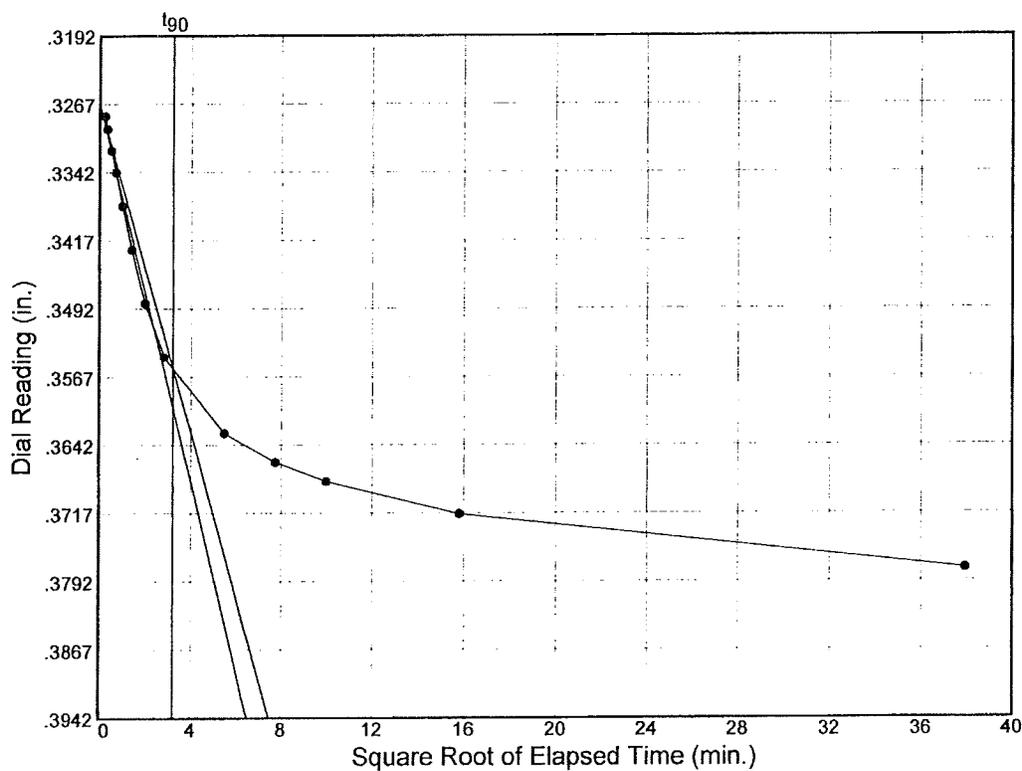
Sample No.: ST-01

Elev./Depth: 40.0-42.0



Load No.= 5  
Load= 2.00 tsf  
 $D_0 = 0.26943$   
 $D_{90} = 0.29748$   
 $D_{100} = 0.30060$   
 $T_{90} = 11.60 \text{ min.}$

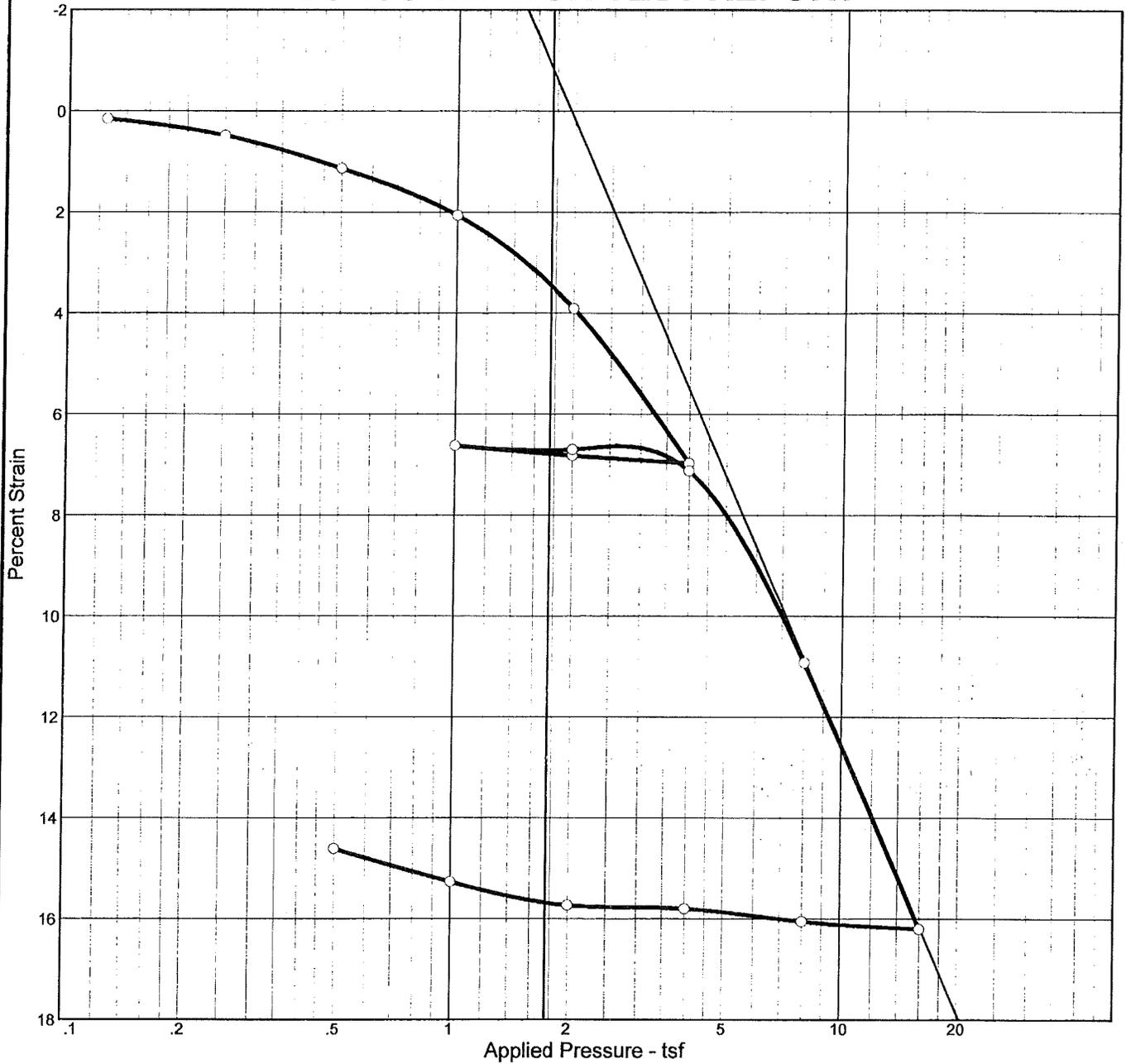
$C_v @ T_{90}$   
0.48 ft.<sup>2</sup>/day



Load No.= 6  
Load= 4.00 tsf  
 $D_0 = 0.32672$   
 $D_{90} = 0.35572$   
 $D_{100} = 0.35894$   
 $T_{90} = 10.32 \text{ min.}$

$C_v @ T_{90}$   
0.46 ft.<sup>2</sup>/day

# CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P <sub>c</sub> (tsf)	C <sub>c</sub>	C <sub>r</sub>	Initial Void Ratio
Saturation	Moisture									
97.2 %	41.8 %	77.1	46	12	2.63		3.55	0.38	0.02	1.130

<b>MATERIAL DESCRIPTION</b>								<b>USCS</b>	<b>AASHTO</b>
Grayish brown silt								ML	A-7-5(13)

Project No. 06G419	Client: Urban Engineers, Inc.	Remarks:
Project: Pier 84 South		
Source: B-4	Sample No.: ST-02      Elev./Depth: 46.0-47.5	
<b>GeoSystems Consultants, Inc.</b> <b>Fort Washington, Pennsylvania</b>		Plate

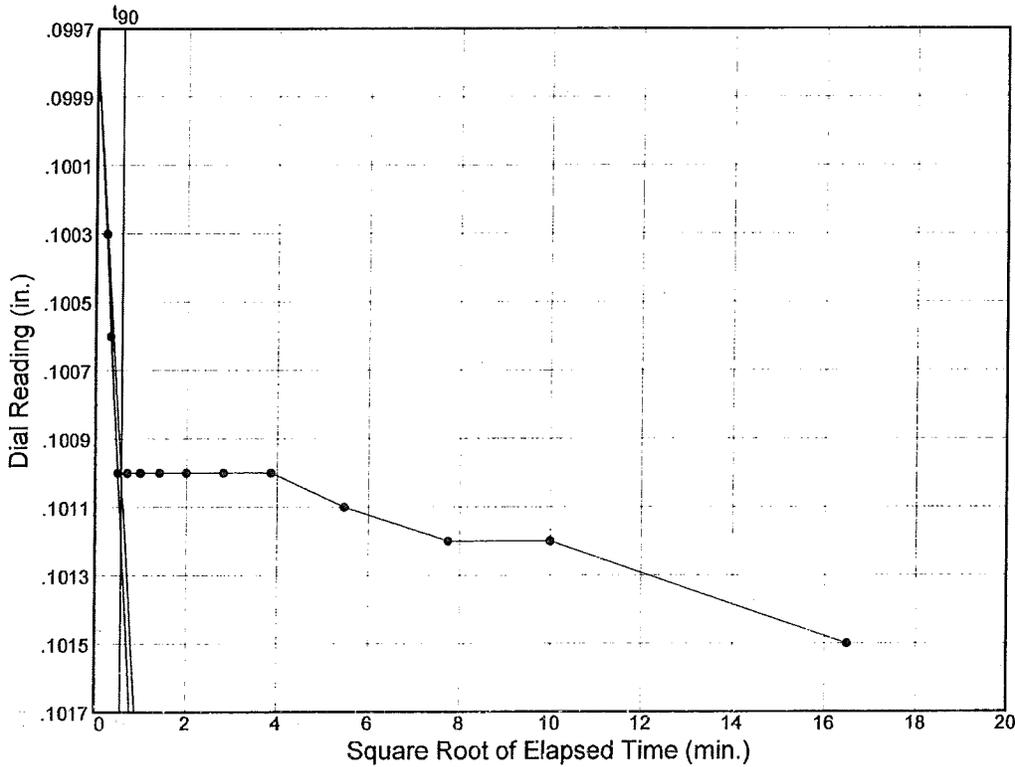
# Dial Reading vs. Time

Project No.: 06G419  
Project: Pier 84 South

Source: B-4

Sample No.: ST-02

Elev./Depth: 46.0-47.5



Load No.= 1

Load= 0.13 tsf

$D_0 = 0.09977$

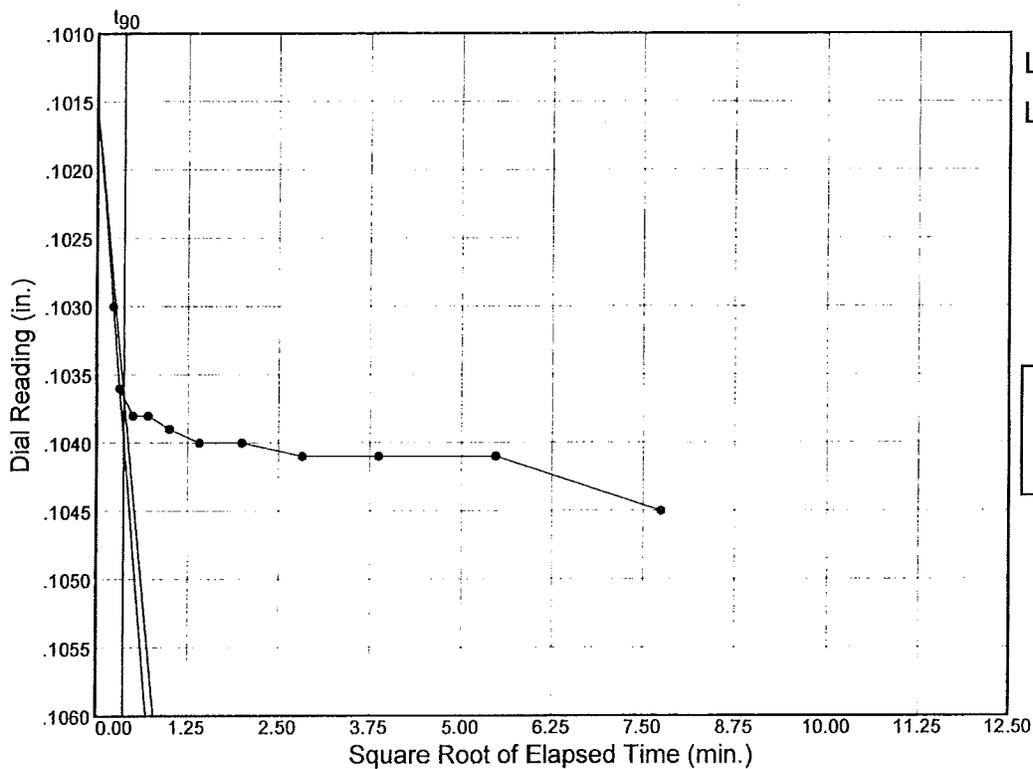
$D_{90} = 0.10100$

$D_{100} = 0.10114$

$T_{90} = 0.32 \text{ min.}$

$C_v @ T_{90}$

26.20 ft.<sup>2</sup>/day



Load No.= 2

Load= 0.25 tsf

$D_0 = 0.10155$

$D_{90} = 0.10366$

$D_{100} = 0.10390$

$T_{90} = 0.14 \text{ min.}$

$C_v @ T_{90}$

59.92 ft.<sup>2</sup>/day

Plate

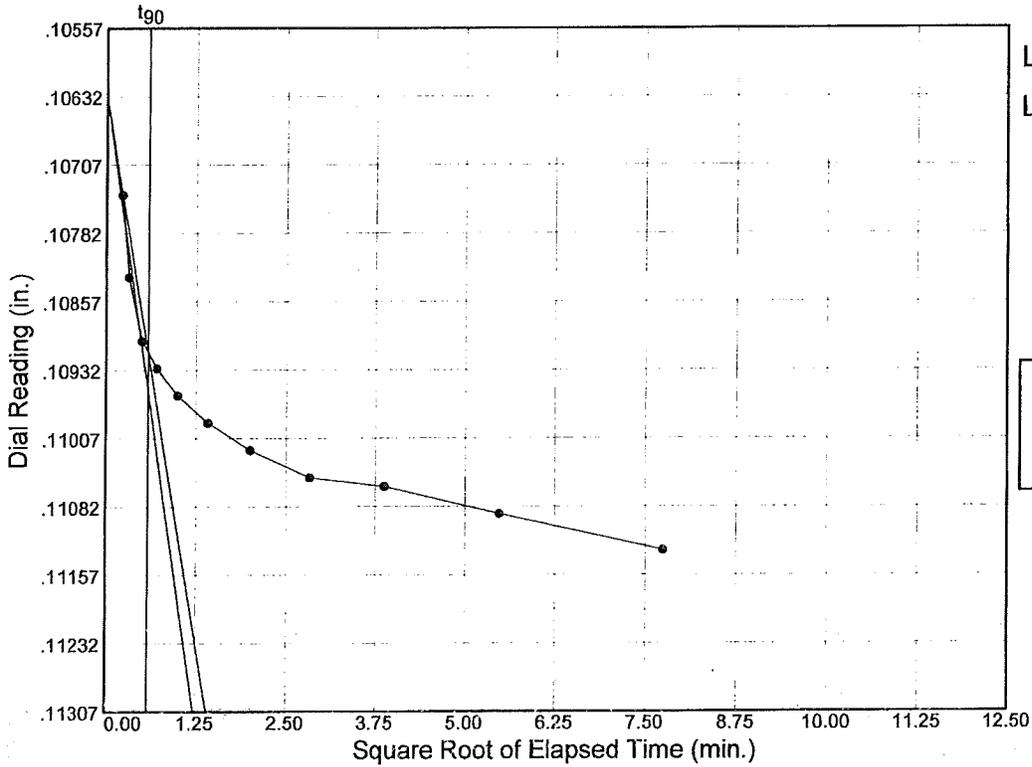
# Dial Reading vs. Time

Project No.: 06G419  
 Project: Pier 84 South

Source: B-4

Sample No.: ST-02

Elev./Depth: 46.0-47.5



Load No.= 3

Load= 0.50 tsf

$D_0 = 0.10632$

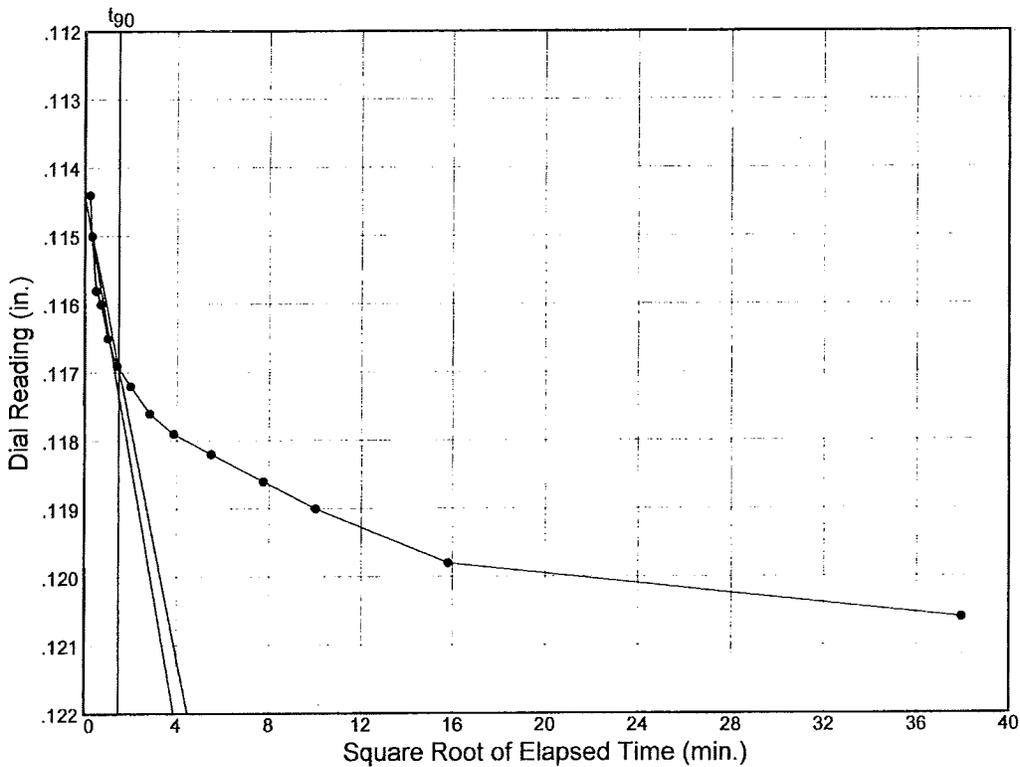
$D_{90} = 0.10912$

$D_{100} = 0.10943$

$T_{90} = 0.34 \text{ min.}$

$C_v @ T_{90}$

24.46 ft.<sup>2</sup>/day



Load No.= 4

Load= 1.00 tsf

$D_0 = 0.11442$

$D_{90} = 0.11694$

$D_{100} = 0.11722$

$T_{90} = 2.23 \text{ min.}$

$C_v @ T_{90}$

3.69 ft.<sup>2</sup>/day

Plate

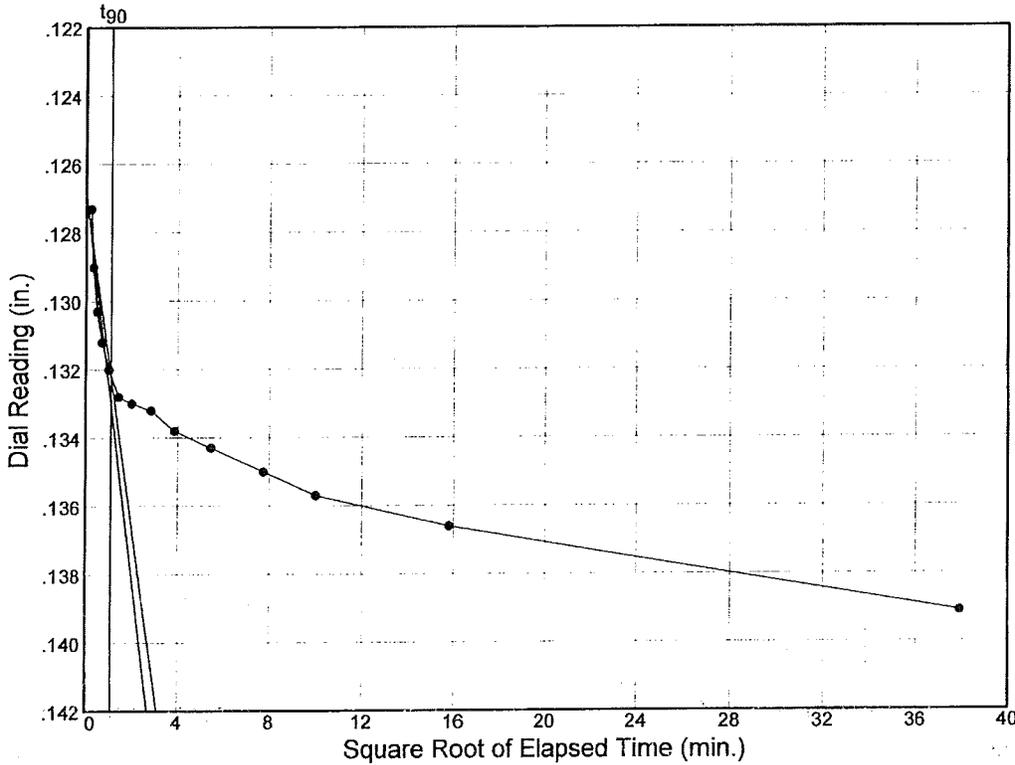
# Dial Reading vs. Time

Project No.: 06G419  
Project: Pier 84 South

Source: B-4

Sample No.: ST-02

Elev./Depth: 46.0-47.5



Load No.= 5

Load= 2.00 tsf

$D_0 = 0.12688$

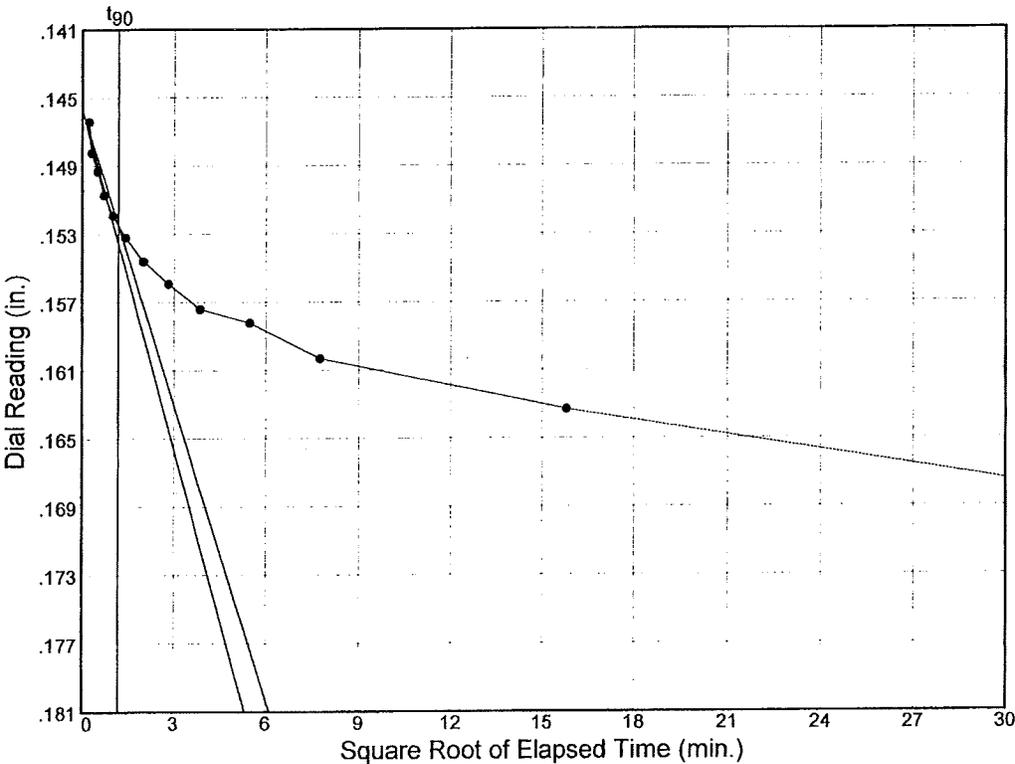
$D_{90} = 0.13216$

$D_{100} = 0.13275$

$T_{90} = 1.18 \text{ min.}$

$C_v @ T_{90}$

6.79 ft.<sup>2</sup>/day



Load No.= 6

Load= 4.00 tsf

$D_0 = 0.14565$

$D_{90} = 0.15247$

$D_{100} = 0.15322$

$T_{90} = 1.39 \text{ min.}$

$C_v @ T_{90}$

5.44 ft.<sup>2</sup>/day

Plate

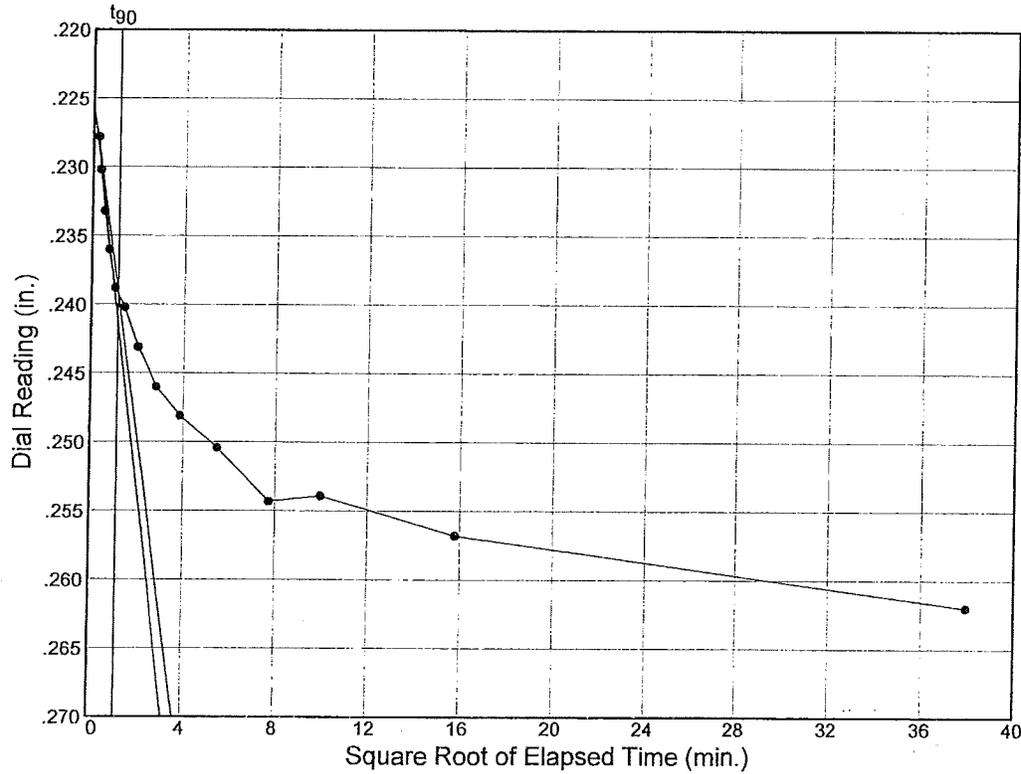
# Dial Reading vs. Time

Project No.: 06G419  
Project: Pier 84 South

Source: B-4

Sample No.: ST-02

Elev./Depth: 46.0-47.5



Load No.= 12

Load= 16.00 tsf

$D_0 = 0.22558$

$D_{90} = 0.23925$

$D_{100} = 0.24077$

$T_{90} = 1.28 \text{ min.}$

$C_v @ T_{90}$

4.93 ft.<sup>2</sup>/day