ITEM 9000-0001 TEMPORARY COFFERDAM

DESCRIPTION – This work is design, furnishing, placing, maintaining, and removing a temporary cofferdam for river wall grout injection repairs as indicated and as directed.

MATERIAL –

Provide certification or laboratory test results verifying material properties. For used steel, the salvage design values from AASHTO Guide Design Specification for Bridge Temporary Works (AASHTO Guide Spec) may be used as an alternate to testing to determine grade of steel. Materials need not be new but must be in serviceable condition as determined by the Engineer. Temporary material used does not have to be from a Bulletin 15 source, but must meet the following:

a. Structural Steel - AASHTO M 270M/270 (ASTM A709M/A709) Grade 250(Grade 36), Grade 345(Grade 50) or Grade 345W(Grade 50W)
b. Steel Sheet Piling - ASTM A328M/A328, ASTM A572M/A572
c. Steel H-Piles - AASHTO M 270M/270 (ASTM A709M/A709), Grade 250(Grade 36)
d. Wood Lagging - Rough Cut Species in AASHTO Guide Spec Appendix A and AASHTO Construction Handbook for Bridge Temporary Works Appendix C
e. Cement - AASHTO M85 and AASHTO M240
f. Pre-Stressing Steel - ASTM A416 Grade 270
g. Welding Wire Fabric - AASHTO A55 (ASTM A185)
h. Reinforcement Bars - AASHTO M 31M/31 (ASTM A615M/A615), AASHTO 42M/M42 (ASTM A616M/A616), Grade 420 (Grade 60)
i. Geomembrane – PennDOT Pub 408 Section 736.1
j. Fine Aggregate – PennDOT Pub 408 Section 703.1
k. Sand Bags – Woven polypropylene or polyethylene material
l. Geotextile, Class 4, Type A – PennDOT Pub 408 Section 735
m. Other Material - In accordance with applicable Sections of PennDOT Publication 408

DESIGN –

Design the temporary cofferdam in accordance with AASHTO LRFD Bridge Design Specifications and Design Manual, Part 4 Specifications, current FHWA guidelines and AASHTO Guide Spec. Design temporary cofferdam to a minimum height of 2 feet above the normal water elevation as shown on the Contract Plans. Submit four (4) sets of design calculations and four (4) sets of completed detailed drawings, signed and sealed by a Professional Engineer, registered in the Commonwealth of Pennsylvania to the City of Philadelphia for review. Include in the design calculations all material properties, design loads, and design assumptions. Include geotechnical report for additional borings. Include on the completed detailed drawings all design dimensions, limits of work, elevations, material, member sizes and construction sequence. Provide cutoff elevation of steel and wooden components to be left in place. Include specific installation procedures and testing requirements as part of the submittal. Allow 14 days for the review by the City of Philadelphia.

The following soil parameters are based on borings that were drilled behind the river wall. It is recommended that the Contractor obtain soil parameters from additional locations as required for design of the temporary cofferdam.

1. Soil parameters:

   1.a Effective angle of friction ___0°____

   1.b Moist unit weight of soil _100 pcf___

   1.c Saturated unit weight of soil _105 pcf___

   1.d Effective cohesion _200 psf_____

   1.e Static groundwater level at elevation __(Average) 9.5 feet___

   1.f Undrained shear strength of cohesive soil _N/A__

   1.g Shear strength for rock mass _15 tsf____

Provide other soil/rock properties with test data, needed in the design of the temporary cofferdam

Ensure that all components stay within the legal right-of-way unless an easement is obtained by the Contractor.

CONSTRUCTION –

In accordance with PennDOT Pub 408 Section 203.3(i) and as follows:

Install temporary cofferdam in accordance with applicable sections of Publication 408. All steel and wooden components may remain in place to pavement subgrade or 2 feet below finish grade, whichever is higher elevation. Treated wood is not required unless it is within 6 feet of finish grade and is to remain in place. Pressure treat with chromate copper arsenate (CCA) to refusal. Finish grade is defined as top of pavement when a roadway is behind the temporary excavation support and protection system. Have a Professional Engineer, registered in the Commonwealth of Pennsylvania, certify that the temporary cofferdam has been installed as shown on the Professional Engineer's signed and sealed drawings. Submit the certification to the Representative within 3 working days of completion of the system.

Remove temporary cofferdam to a minimum of 3 feet below the finished mudline after the completion of each Contract, and without damage to the river wall. Continue dewatering operations until the temporary cofferdam is removed or cut to the required depth. Restore disturbed areas, including watercourse beds, to original conditions. Dispose of unsuitable and surplus material in suitable waste areas obtained, as specified in PennDOT Pub 408 Section 105.14.

MEASUREMENT AND PAYMENT – Lump Sum.

Includes geotechnical investigation, working drawings, installation, maintenance, and removal.

ITEM 9000-0002 FILTER BAG INCLUDING DEWATERING PUMPS

DESCRIPTION - This work is the furnishing, installing, maintaining and removal of dewatering pumps and the furnishing, installing, maintaining and disposing of a Sediment Filter Bag (bag) as shown on the Drawings.

MATERIAL –

Sediment Filter Bag. Provide 10 oz/yd geotextile, Class 4, listed in PennDOT Pub 408 Section 735.1. Construct 15' x 15' (plus or minus 3") bag using heat-bonded seam or 401 lock chain stitch seam with a 216 lbs. minimum breaking strength, tested in accordance with ASTM-D4632. Label each bag indicating maximum flow rate of bag in gallons per minute. Provide No. 57 Coarse Aggregate listed in PennDOT Pub 408 Section 703.2 for platform and Class R-3 Rock listed in PennDOT Pub 408 Section 850.2(a) for slope protection on streambank.

CONSTRUCTION –

As shown on the Standard Drawings and as follows:

a. Sediment Filter Bags: Use filter bags on low volume dewatering operations not to exceed 1000 gallons per minute. Pump flow rate not to exceed 50% of maximum flow rate indicated on bag label. Double clamp bag firmly to pump discharge hose. Monitor and evaluate entire pumping operation to assure that bag continues to function properly. Replace bag when contained silt reduces flow to approximately 50% of rate of initial bag discharge, or when directed by the Inspector-in-Charge. Dispose of sediment in a manner satisfactory to the Inspector-in-Charge. Restore area as specified in PennDOT Pub 408 Section 105.14.
b. Dewatering Pumps: Be responsible for providing adequately sized dewatering pump(s) as necessary to maintain a dry construction site.

Ensure the dewatering pumping system is properly maintained and that a responsible operator is on hand while the pump(s) are operating. Provide a stand-by pump at the pumping location. Maintain the temporary pump system in operable condition until receipt of written acceptance of this work. Remove all components of the pumping system and restore area to original condition as directed.

Comply with all Federal, State and local codes and regulations related to the operation of the dewatering pump system.

Place dewatering pump system in service at least 24 hours before starting any work in or around the stream.

MEASUREMENT AND PAYMENT - Each.

Includes replacement and disposal of filter bag and contained sediment as required. Includes maintenance and replacement of dewatering pumps as required. Includes relocation as required. No separate or additional payment will be made for this work.

ITEM 9000-0003 TEMPORARY PROTECTIVE FENCE

DESCRIPTION – This work is furnishing, installing, and maintaining temporary protective fencing within the project limits for sedimentation traps and basins and for existing trees, shrubs, vegetated wetland areas, and archaeological sites, as indicated.

MATERIAL –

In accordance with PennDOT Pub 408 Section 811.2 and as follows:

a. Fence – Acceptable, undamaged temporary plastic mesh fencing or other acceptable, highly visible, weather resistant, easily maintained fencing that provides a substantial barrier.

b. Fence Feet – For locations where paved surfaces, concrete or hardscape exists, concrete or concrete filled plastic fence feet can be used in lieu of driving posts into the hard surfaces to stabilize the temporary caution fence.

CONSTRUCTION –

In accordance with PennDOT Pub 408 Section 811.3 and as follows:

Protect the existing vegetated wetland areas, sedimentation traps, and basins directly adjacent to areas disturbed by construction as indicated and directed. Conduct a field observation with the Project Manager and environmental consultant prior to clearing operations to verify extent of protection. Place and maintain temporary protective fence as directed to protect designated areas. Remove fence after completion of project.

MEASUREMENT AND PAYMENT – Linear Foot.

ITEM 9000-0004 GROUT INJECTION REPAIR

DESCRIPTION – This work is the furnishing and injecting undermined areas with grout as indicated.

MATERIAL –

a. Grout: A mixture of Type II Portland cement, 7" minimum slump, 6 ± 1% of air entrainment proportioned with fine aggregate and water to provide a pumpable mixture. The minimum 28-day strength shall be 3,500 psi.
   1. Cement – PennDOT Pub 408 Section 701
   2. Water – PennDOT Pub 408 Section 720
   3. Aggregate – PennDOT Pub 408 Section 703.1 and add the following:
      Use a well graded aggregate which can be pumped. Use pozzolan as a substitute.
   4. Air Entrainment – PennDOT Pub 408 Section 711.3

b. Geotextile: Class 4, Type C geotextile – PennDOT Pub 408 Section 735

c. Rigid Barrier: Timber in accordance with PennDOT Pub 408 Section 1031 or other material approved by Engineer

d. 4" PVC Pipe: PennDOT Pub 408 Section 610.1(a)4

e. Debonding Material: Fabric in accordance with ASTM D5261. Grab strength shall meet ASTM D4632 and Trapezoidal Tear Strength shall meet ASTM D4533.

EQUIPMENT –

Concrete Pump - Capable of delivering up to 25 yd^3/hr.

DESIGN –

Design the rigid barrier system in accordance with AASHTO LRFD Bridge Design Specifications and Design Manual, Part 4 Specifications, current FHWA guidelines and AASHTO Guide Specifications. Design rigid barrier system for temporary conditions, including the lateral pressure from pumping and curing of grout. The rigid barrier must prevent grout from entering the river.

Submit four (4) sets of design calculations and four (4) sets of completed detailed drawings, signed and sealed by a Professional Engineer, registered in the Commonwealth of Pennsylvania to the City of Philadelphia for review. Include in the design calculations all material properties, design loads, and design assumptions. Include on the completed detailed drawings all design dimensions, limits of work, elevations, material, member sizes and construction sequence. Provide cutoff elevation components to be left in place. Include specific installation

procedures including the spacing of the injection ports and testing requirements as part of the submittal. Allow 14 days for the review by the City of Philadelphia.

CONSTRUCTION –

Remove all loose and unstable material, silt and other debris along the bottom of undermined areas prior to installing rigid barrier system or filling void beneath river wall with grout.

Place debonding material around exposed portions of piles to protect them and to prevent the grout from adhering to the piles. Install in accordance with manufacturer's recommendations.

Install rigid barrier prior to placing scour protection. Place geotextile between the ground surfaces or existing structure and scour protection as indicated on contract drawings.

Pump grout into undermined areas using approved pumping equipment ensuring not to overfill or cause excessive pressure build-up in the void cavity.

Measure materials by volume as they are fed into the mixer. Use quantity of water as required to produce a slurry having consistency suitable for pumping. Minimum mixing time is one (1) minute. If agitating continuously, slurry may be held in the mixer or agitator for a period not exceeding two (2) hours if the temperature is below 70 degrees F and for a period not exceeding one and one half hours at higher temperatures. If there is a lapse in a pumping operation, re-circulate the slurry through the pump or through the mixer drum (or agitator) and pump.

MEASUREMENT AND PAYMENT – Cubic Yard

Geotextile, rigid barrier and debonding material are incidental to this item.

Scour protection to be paid for separately.

ITEM 9000-0005 MASONRY REPOINTING, TYPE A

DESCRIPTION – This work is cleaning and repointing of existing masonry joints of the type indicated above the existing mud line.

MATERIAL –

In accordance with PennDOT Pub 408 Section 665.2 and as follows:

Color to match existing mortar; to be approved by the City of Philadelphia. Placing mortar is to be completed in dry conditions using a temporary cofferdam.

CONSTRUCTION – In accordance with PennDOT Pub 408 Section 665.3(a).

MEASUREMENT AND PAYMENT – In accordance with PennDOT Pub 408 Section 665.4.

TEMPORARY COFFERDAM is paid for separately.

ITEM 9000-0006 REMOVAL OF VEGETATION

DESCRIPTION – This work is the removal of vegetation growing out of the front face of the river wall. This work also involves temporary removal and resetting of the existing river wall masonry stones as necessary to completely remove vegetation.

MATERIAL –

Existing river wall stones are to be temporarily removed and reset. Stones damaged during construction will be replaced at no additional cost to the City of Philadelphia. Replacement stones shall match the type, size and color of the existing stones and shall be approved by the City of Philadelphia.

CONSTRUCTION –

Prior to commencement, verify the locations of vegetation removal indicated in the field with the Engineer. Submit the proposed procedure for temporary removal and resetting of the masonry stones to the City of Philadelphia for approval. Include proposed equipment information, location, and temporary placement of the stones in the submittal. Allow 14 days for the review by the City of Philadelphia.

Temporarily remove the masonry stones as needed at the locations of vegetation removal. Remove the vegetation growing out of the river wall for the width of the river wall from Station -1+00 to 12+00F. Reset the masonry stones and fill remaining voids with mortar in accordance with MASONRY REPOINTING, TYPE A.

No construction equipment is permitted within a horizontal distance of five (5) feet from the front face of the existing wall.

Removal and resetting of the river wall stones is to be completed in dry conditions using a temporary cofferdam.

MEASUREMENT AND PAYMENT – Lump Sum

TEMPORARY COFFERDAM is paid for separately.

ITEM 9000-0007 REMOVAL OF PORTION OF WALL

DESCRIPTION – This work is the removal and satisfactory disposal of the existing portion of stone masonry river wall. This work also includes reusing the existing façade and cap stones on the proposed section of wall.

MATERIAL –

In accordance with PennDOT Pub 408 Section 1018.2 and as follows:

Existing façade and cap stones are to be reused. The City of Philadelphia will approve existing stones to be reused; stones damaged during construction will be replaced at no additional cost to the City of Philadelphia. Replacement stones shall match the type, size, and color of the existing stones and shall be approved by the City of Philadelphia.

CONSTRUCTION –

In accordance with section 1018.3 and as follows:

Submit a plan to the City of Philadelphia showing or describing the demolition and removal methods to be used for the removal of the portion of the existing stone masonry river wall as indicated. The plan, along with any design calculations and the equipment to be used, must be signed and sealed by a Professional Engineer registered in the Commonwealth of Pennsylvania. Do not proceed with this demolition work until the plan has been reviewed and accepted. Within the plan provide methods for the protection and safety of the general public and public utilities.

No construction equipment is permitted within a horizontal distance of five (5) feet from the front face of the wall.

All demolition and removal of the existing portion of stone masonry wall is to be completed in dry conditions using a temporary cofferdam.

If the removal area does not coincide with new construction, satisfactorily backfill the area where the existing river wall was removed, as specified in PennDOT Pub 408 Section 202.3(f).

Take all necessary measures when demolishing the existing wall so as to not damage the existing façade and cap stones. Façade and cap stones are to be reused for the construction of the proposed wall replacement as indicated.

Remove existing timber piles located within the limits of wall removal to an elevation so not to be incorporated or in contact with the proposed footings as indicated on the Contract Drawings.

After construction of the proposed wall, reset the existing façade and cap stones as indicated. Align the reset stones with the existing stones on the adjacent portions of river wall. Once reset, repoint the reused stones per MASONRY REPOINTING, TYPE A.

If not otherwise indicated, the City of Philadelphia will not retain structure, or parts of structures. Remove and dispose of the structure, or parts of the structure, in a satisfactory manner.

MEASUREMENT AND PAYMENT – Lump Sum

REMOVAL OF PORTION OF WALL includes designing, furnishing, and installing any devices or equipment necessary to complete the work, removal of the portion of wall, and disposal of waste material. Resetting the existing façade and cap stones after the proposed wall is installed is also included.

When removal area coincides with excavation area of new construction, the pay limit for removal extends one (1) foot horizontally beyond the outer limits of the structure being removed.

The City of Philadelphia will pay for backfilling of voids below the indicated elevation of the bottom of proposed footings for new construction as specified in PennDOT Pub 408 Section 1001.4(f).

TEMPORARY COFFERDAM is paid for separately.

ITEM 9000-0008 TIMBER PILE REPAIR

DESCRIPTION – This work is the installation of the timber pile structural repair and protection system.

MATERIAL –

All products shall be delivered, stored, and handled according to the manufacturer's recommendations. Materials shall be clearly labeled and delivered in factory-sealed containers with manufacturing dates and shelf lives easily identifiable. Materials shall be stored in a protected area free of moisture and UV exposure, with temperatures between 45°F (7°C) and 90°F (32°C).

Acceptable timber pile repair systems include the following:

- Denso
  9710 Telge Road
  Houston, Texas 77095
  (888) 821-2300
  www.densona.com
  Product: FX-70 Structural Piling Repair and Protection System
- Five Star Products, Inc.
  60 Parrott Drive
  Shelton, CT 06484-4733 USA
  (203) 336-7900
  www.fivestarproducts.com
  Product: Five Star Pileform F Fiberglass Jackets with High Flow Pile Jacket Epoxy Grout LPL_HF

Or an approved equal.

CONSTRUCTION –

Timber pile repair systems shall be installed at the locations indicated on the Contract Drawings and additional locations where the piles exhibit deterioration at the discretion of the Engineer.

Installation of the timber pile repair system including surface preparation is to be completed in-the-dry.

Consult with the Engineer before making structural repairs, to confirm the stability of the structure during the restoration process.

The surface of the substrate must be at least 40°F (4.44°C) prior to application.

All pile surfaces to be covered with jackets should be thoroughly cleaned of marine growth, laitance, debris, oil, grease, dirt, and any other deleterious material that could prevent proper bonding. Prepare timber surface by high-pressure water blasting or other mechanical means to achieve a sound surface, free of all contaminants. Fiberglass jacket surfaces must be sound, clean,

and free of all contaminants that could impair product adhesion or performance. Fiberglass jacket placement should not proceed until pile cleaning has been approved by the Engineer.

Verify ambient, water, and surface temperatures are between 40°F (4°C) and 90°F (32°C) with the multi-purpose marine epoxy grout and non-shrink underwater grout.

If spacers were not installed during jacket fabrication, install spacers in the field in accordance with the Contract Drawings.

Place a bead of tongue-and-groove adhesive into the female portion of the tongue and groove connection of the fiberglass jacket. Place the fiberglass jacket around the pile to be repaired and insert the tongue into the epoxied groove. Provide temporary external bracing (i.e. ratchet straps) as needed.

Install, self-tapping screws at 6” on center to secure the tongue and groove connection during epoxy curing. Install temporary external bracing to support jacket while placing grouts.

Install Multi-Purpose Marine Epoxy Grout into the base of the jacket to create a bottom seal and allow curing for a minimum of 12 hours.

For piles exhibiting less than 25% cross-sectional area loss, fill remaining jacket with Multi-Purpose Marine Epoxy Grout. For piles exhibiting more than 25% cross-sectional area loss, fill remaining jacket with Non-Shrink Underwater Grout, leaving 4” of the jacket unfilled at the top, and allow grout to cure for a minimum of 12 hours before filling top 4” of the jacket with Multi-Purpose Marine Epoxy Grout and allow curing for a minimum of 12 hours.

Create a slight bevel at the top and bottom of the jacket using mixed trowel grade epoxy with an equal part of oven dried rounded silica filler.

Remove temporary external bracing.

MEASUREMENT AND PAYMENT – Each

ITEM 9000-0009 CONCRETE WASHOUT STATION

DESCRIPTION – This work is the installation and maintenance of a concrete washout station.

MATERIAL –

a. Geomembrane: PennDOT Pub 408 Section 736

b. Compost Filter Sock: 24" diameter, PennDOT Pub 408 Section 867

c. Stakes: 2"x2"x3'-0" wooden stakes

CONSTRUCTION –

The concrete washout station is to be installed per Pennsylvania Department of Environmental Protection (PADEP) guidelines.

Place a suitable impervious geomembrane on the existing ground at the location of the washout station prior to installing the compost filter socks per PennDOT Pub 408 Section 867. Install the concrete washout station on flat grade for optimum performance. Stake compost filter socks in the manner recommended by the manufacturer around the perimeter of the geomembrane as to form a ring with the ends of the sock located at the upslope corner. Take care to ensure continuous contact of the compost filter sock with the geomembrane at all locations.

18" diameter filter sock may be stacked onto double 24" diameter filter socks in a pyramidal configuration for added height.

All concrete washout stations should be inspected daily. Damaged or leaking washout should be deactivated and repaired or replaced immediately. Remove accumulated materials when they reach 50% capacity. Replace geomembrane with each cleaning of the washout station.

MEASUREMENT AND PAYMENT – Each

ITEM 9000-0010 COLLAPSED DRAINAGE PIPE REPAIR

DESCRIPTION – This work is the removal and satisfactory disposal of the collapsed portion of the drainage pipe and installation of a new portion of drainage pipe, as indicated.

MATERIAL –

a. Pipe: 12” Ductile iron pipe (DIP), ASTM A716.

b. Non-Shrink Grout: PennDOT Pub 408 Section 1080.2(c).

c. Sleeve: Galvanized steel, 3/8” thick.

d. Class C Cement Concrete (concrete collar): PennDOT Pub 408 Section 1001.

CONSTRUCTION –

Remove the collapsed portion of the drainage pipe as indicated to a distance such that the remaining portion of the existing pipe is sound. The limits of removal for the existing drainage pipe must be approved by the City of Philadelphia prior to removal. Cut the existing drainage pipe vertically at the limit of removal.

Removal of the portion of drainage pipe is to be completed in dry conditions using a temporary cofferdam.

Use extreme caution during removal operations to avoid damaging portions of the drainage pipe to remain. Repair or replace any portion of existing drainage pipe damaged or removed beyond the indicated limits as directed by the City at no additional cost to the City.

Match the invert elevations of the new portion of pipe and existing remaining pipe at the interface location. Install the new portion of pipe at a grade that matches the grade of the existing pipe. Install the concrete collar as indicated and in accordance with PennDOT Pub 408 Section 1001.

Install the galvanized steel sleeve and non-shrink grout at the new river wall stem location as indicated.

MEASUREMENT AND PAYMENT – LF

Excavation and backfill paid for separately.

ITEM 9000-0011 TREATED TIMBER BEARING PILES
ITEM 9000-0012 TIMBER TEST PILES

DESCRIPTION – This work is furnishing and the driving of new, not previously used test piles and bearing piles. The following definitions apply.

(a) Test Pile: A pile driven to verify the capability of the pile hammer, determine driving characteristics, and establish the predetermined pile tip elevation, before driving production piles. Test piles may also be used to perform pile load tests.

(b) End Bearing Pile: A pile that develops bearing capacity primarily by embedment of the lower portion in dense or hard bearing stratum such as soft or decomposed bedrock, or hard or dense soil.

MATERIAL –

Furnish timber piles in accordance with ASTM D25 and the following:

1. Species: Southern Yellow Pine, Douglas Fir, or Western Larch only.
2. Butt Circumference: Not less than 38 inches measured 3 feet from butt (i.e., 12" diameter).
3. Tip Circumference: Not less than 25 inches (i.e., 8" diameter).
4. Peeling: Clean peeled only.
5. Straightness: No bends in two directions. A straight line from the center of the butt to the center of the tip shall lie entirely within the body of the pile.

Furnish piles pressure-treated in accordance with the requirements of AWPA C3-03, Use Category System UC-4, Fresh and Groundwater Contact. The minimum amount of preservative to be retained in the piles shall be in accordance with the AWPA requirements for UC-4 and the approved wood species used for the pile.

~~Certify as specified in Section 106.03(b)3. Provide timber piles of either Southern Pine, Douglas Fir, or Western Larch; cut from live, sound, and solid trees; free from reverse bends and large unsound knots.~~

~~Timber piles are to be clean-peeled and pressure-treated. Pressure treat according to AASHTO M133 pressure process. Use preservatives of either creosote oil or creosote coal-tar solution. Retain a minimum preservative amount of 10 pounds per cubic foot of wood if treated by the empty-cell process. Furnish an affidavit, giving treatment details, obtained from the treating company.~~

Use timber piles with minimum 1-inch thick sapwood at the butt end and at least 1 inch of clean wood between any two inner bark strips. Do not use timber piles with a defect or combination of defects that will impair the strength of timber piles more than the largest knot.

Measure the timber pile circumference or diameter under the bark. The butt diameter shall be equal to 12 inches measured 3 feet from the butt. The tip diameter shall not be less than 8 inches.

The timber piles shall have no bends in two directions. A straight line from the center of the butt to the center of the tip shall lie entirely within the body of the pile.

Provide timber piles with acceptable metal points, firmly attached to the piles, in full contact with the pile tips.

CONSTRUCTION –

(a) Equipment. Use pile-driving equipment of an acceptable type, weight, and capacity. Use air compressors of sufficient capacity to provide 25% more air than shown in the manufacturer's specifications for air-driven hammers.

Acceptance of the pile hammer and driving equipment will not relieve the Contractor's responsibility for properly driving piles, in satisfactory condition, to the driving resistance and tip elevations indicated or directed.

Do not use capblocks or cushions containing asbestos.

1. **Hammers.** Use either drop-steam, air, diesel, or hydraulic actuated pile-driving hammers. Use hammers capable of developing at least 7,000 foot-pounds per blow for timber piles and not less than 12,000 foot-pounds per blow for other types of piles, unless otherwise allowed.

   Equip closed-end diesel hammers with a dial gage for measuring pressure in the bounce chamber. Provide a hose for the gage long enough to enable reading at ground level. Calibrate the dial gage to allow for losses in the gage hose. Verify the accuracy of the calibrated dial gage to allow for losses in the gage hose. Verify the accuracy of the calibrated dial gage both during driving of the test piles and, when directed, during driving of the bearing piles. Ensure that cylinder lift occurs when the bounce chamber pressure is consistent with the maximum energy given in the hammer specifications. Do not use closed-end diesel hammers that do not attain cylinder lift at the maximum energy bounce chamber relationship given in the hammer specifications.

   Equip hammers with a suitable drive head or anvil that accurately and securely holds the top of the pile in correct position, with reference to the hammer, and that distributes the blows from the ram over the entire top area of the pile or mandrel.

   Within reasonable limits, use the optimum type and size of hammer for the indicated pile and subsurface conditions at the structure site. The Structure Control Engineer will verify the capability of the hammer to properly drive the piles from driving records of test piles at each substructure unit, at locations indicated or directed. If information from indicated soundings, dug test pits, and auger or test borings is used to analyze subsurface conditions, refer to Section 102.05 for conditions pertaining to use of this information.

Use a hammer of a type and size that enables piles to be driven to any driving resistance without pile damage due to driving stresses.

An estimate of the point of impending damage, due to driving stresses, in piles will be made from a wave equation analysis for the hammer, drive head size, type of capblock, cushion material, and length of pile in the leads to be used, or by observations during the test-pile driving operation. The point of impending damage in steel piles or shells is defined as a driving stress of 100% of the yield point of the pile material, as estimated from a wave-equation analysis, or a lesser value if the strength of the pile or shell is governed by the strength of the splice. The Structure Control Engineer will reject hammers that cause damage in steel piles at any driving resistance.

Acceptance of a hammer relative to driving stress damage will not relieve the Contractor's responsibility for piles damaged because of misalignment of the leads, failure of capblock or cushion material, failure of splices, malfunctioning of the hammer, or other improper construction methods. The Structure Control Engineer will reject piles damaged for these reasons, if it is determined that the damage impairs the strength of the completed pile installation.

At least 21 calendar days before driving test piles, submit the hammer's operating specifications and pile information for review and acceptance on the Pile Hammer Data form, CS-5.

Measure inlet pressures for double-acting and differential-acting air or steam hammers, using a needle gage at the head of the hammer when driving test piles and, if directed, when driving bearing piles. As an alternative to periodic measurements with a needle gage, develop a pressure versus speed calibration for the driving conditions at the site.

If a hammer is used for timber piles for which the Maximum Permissible Driving Resistance (MPDR) is less than 20 blows per 1 inch, do not drive piles beyond MPDR if piles do not reach bedrock. Although point bearing is discouraged, if piles are required to reach bedrock or into very dense stratum for capacity, do not use a hammer with MPDR less than 20 blows per 1 inch. Size the hammer so that MPDR is approximately 20 blows per 1 inch.

2. **Leads.** Construct pile driver leads to allow free movement of the hammer. Hold the leads in true vertical or inclined positions, as required, by guys or stiff braces to ensure support of the pile during driving. Provide leads of sufficient length so a follower will not be necessary under normal conditions. With the Structure Control Engineer's approval, drive bearing piles around cofferdams, or in areas where headroom is limited, without leads.

(b) Piles.

1. **General.** Do not drive piles until the excavation is complete in the areas the piles are to occupy, unless otherwise allowed by the Structure Control Engineer. Do not drive piles within 25 feet of uncured concrete.

Use test piles and bearing piles of the types or sizes indicated. The City may omit any or all test or bearing piles. Furnish each timber pile, steel shell for cast-in-place concrete piles, or steel beam pile of the full length indicated and in one continuous unit, unless otherwise allowed by the Structure Control Engineer. If a pile is too short for the intended purposes, extend it to the length directed, as specified below (part (d)).

2. **Driving Test Piles.** Unless otherwise indicated, drive test piles in one continuous operation, except for splicing, so that they can be incorporated into the permanent work. Drive piles to absolute refusal for point and end bearing piles and end of driving criteria for friction piles, unless otherwise indicated or directed. If test piles extend above ground for the open bent, Abutment on Mechanically Stabilized Earth Wall, or Integral Abutment construction, drive each pile with butt within 2 inches of the location indicated.

3. **Driving Bearing Piles.** Do not drive bearing piles until the Structure Control Engineer has established the predetermined pile tip elevation and driving resistance from representative test piles or pile load tests.

   Drive piles plumb or to the batter indicated. Drive piles to absolute refusal for point and end bearing piles and end of driving criteria for friction piles, or to the predetermined pile tip elevation and to the driving resistance established from test piles or pile load tests.

   Unless otherwise indicated, the predetermined pile tip elevation is considered approximate in order to allow for variations in the locations or strength of the stratum from which the pile obtains its primary capacity. The limit of the approximation is established from pile load tests or test piles.

   Drive bearing piles for a given structure, bridge, or foundation unit with the same hammer, under the same operating conditions, and with the same type and size of capblock and cushion material used to drive the test piles or load test piles.

   Redrive piles raised by the driving of adjacent piles to the required driving resistance and tip elevation.

   The Structure Control Engineer will reject driven piles with a deviation of more than 2 inches in 10 feet, from vertical or from the batter indicated. Do not drive the piles with their tops more than 6 inches out of the indicated position after driving. If piles extend above ground for open bent construction, Abutment on Mechanically Stabilized Earth Wall construction, or Integral Abutment construction, drive each pile with the butt within 2 inches of the location indicated and the longitudinal axis of the pile within 15^{o} of the orientation indicated for the length of the pile.

   In full-depth footings, enclose piles that are driven closer to the edges of footings than indicated. Extend far enough to obtain the indicated encasement. Add additional reinforcement, as directed.

4. **Absolute Refusal and End of Driving Criteria.**

4.a Absolute Refusal. For steel point bearing and end bearing piles, absolute refusal is reached when the driving resistance attains an average of 20 blows per 1 inch, or more. The total number of blows required to calculate the average driving resistance specified for absolute refusal is determined from test pile driving results. Minimum blow requirements are as follows:

Case 1. Piles Required to Be Driven to Absolute Refusal into Sound, Well Defined Bedrock (Point Bearing Piles). After the pile tip reaches the predetermined elevation of the intended bearing stratum, and after penetration becomes 1/4 inch or less for five consecutive blows, absolute refusal is reached if the penetration for five additional blows is less than 1/4 inch.

Case 2. Piles Required to Be Driven to Absolute Refusal into Soft or Decomposed Bedrock, or Dense or Hard Soil Strata (End-Bearing Piles). After the pile tip reaches the predetermined elevation of the intended bearing stratum, and after the penetration becomes 1/2 inch or less for ten consecutive blows, absolute refusal is reached if the penetration for ten additional blows is 1/2 inch or less. After the pile tip enters the intended bearing stratum, if an unreasonably large number of blows is required to increase the driving resistance from 10 blows per 1 inch to 20 blows per 1 inch, the Structure Control Engineer may waive the requirement for driving to absolute refusal.

Case 3. Piles Which Attain Absolute Refusal Above Predetermined Pile Tip Elevations. If hard driving is encountered because of dense strata or because of obstructions located above the bearing stratum identified by a predetermined pile tip elevation, absolute refusal is not reached until the Structure Control Engineer determines that the total number of blows, as the average driving resistance specified for absolute refusal, indicates that further driving will not advance the pile through the dense strata or obstructions.

The Structure Control Engineer will determine the acceptability of bearing piles that do not achieve absolute refusal and capacity at the predetermined pile tip elevation for piles intended to bear in soft or decomposed bedrock. If bearing piles are determined unacceptable, continue driving piles to ensure absolute refusal is obtained in accordance with Case 2 Absolute Refusal. The Structure Control Engineer will contact the BDTD if the continued driving exceeds the criteria provided in the Pile Hammer Approval Letter.

The Structure Control Engineer will determine the acceptability of bearing piles that attain absolute refusal above the predetermined pile tip elevation. If bearing piles are determined unacceptable, drive additional piles at locations directed. If the additional piles also fail to reach the predetermined pile tip elevation, and if directed, drive additional test piles to determine whether the predetermined pile tip elevation may have to be adjusted. Perform test borings and pile load tests, if directed. If the predetermined pile tip elevation cannot be adjusted, and if directed, change the type and size of pile. Perform augering, predrilling, spudding, pre-excavation, or jetting, if directed.

If bearing piles attain absolute refusal above the predetermined pile tip elevation due to freezing resulting from discontinuous driving, the Structure Control Engineer will reject the piles.

4.b End of Driving Criteria. For steel friction piles, end of driving criteria is reached when the required resistance is attained and the pile tip reaches the predetermined elevation of the intended bearing stratum. Determine the required resistance based on the plan factored axial resistance and confirm pile capacity by dynamic load testing. A pile driving analyzer is to be used to confirm that the end of driving criteria, (i.e. hammer stroke, required resistance, pile tip elevation, pile stress and blow count) have been attained.

If friction piles reach the required resistance above the predetermined pile tip elevation due to freezing resulting from discontinuous driving, the Structure Control Engineer will reject the piles.

If friction test piles do not reach the required resistance at the predetermined pile tip elevation (or after redrive, if redrive is specified), splice a 10-foot extension and continue driving until the required resistance is attained. The Structure Control Engineer will set the revised pile tip elevation(s) based on the test pile results. If the required resistance is still not attained after the additional 10 feet of driving depth, the Structure Control Engineer is to contact BDTD to review geotechnical information and recommend further actions.

5. Timber Piles. Avoid injury to timber piles during storage and handling. Protect timber pile butts with metal bands, collars, or other devices to prevent splitting, excessive brooming, or other damage to the pile.

Do not break the surface of treated timber piles and do not use cant-hooks, dogs, or pike-poles.

Apply three brush coats of hot creosote oil to all bolt holes, cuts, daps, or chamfers of timber piles made subsequent to the treatment as well as abrasions of the surface before driving and to tops of timber piles after cutoffs for impregnation treatment.

Furnish timber piles with sufficient length, including the complete removal of material damaged by driving.

Drive timber piles to a maximum bearing value of 28 tons as determined by the wave equation.

6. Splicing Piles. For timber test piles, use the lengths indicated. If indicated lengths are insufficient, extend by splicing, as required. Do not use timber pile sections less than 5 feet long.

Splice or extend steel piles during the driving operation with the Structure Control Engineer's approval. Inspect driven steel shells using a safe light attached to a cord long enough to reach the entire pile length.

Make thin-wall shell splices and end-closure connections with full perimeter welds or with other acceptable methods that keep the shells watertight after being driven.

Splice thick-wall steel shells by welding using full penetration butt welds and acceptable backing bars, using acceptable sleeves with full perimeter fillet welds, or using another accepted design. Provide splices developing the yield strength of the shell based on the indicated shell thickness. If the shell thickness exceeds the required indicated thickness, base the splice strength on the indicated shell thickness, unless a stronger splice is needed to resist driving forces.

7. **Damaged Piles**. Remove piles showing damage due to improper driving, if the damage would impair the strength of the completed pile and if the pile cannot be rebuilt or extended. Backfill the resulting hole if it interferes with other construction. Drive another pile as close as possible to the required location within the indicated distance from the edges of the footing. Fill damaged steel shells left in place with concrete.

8. **Pile Tip Reinforcement.** Attach pile tip reinforcement of the necessary types and sizes to bearing piles at locations indicated. Use pile tip reinforcement for test piles and test load piles representative of the bearing piles for which tip reinforcement is indicated. Use prefabricated or cast steel tips as an alternate to the indicated tip reinforcement. Submit details, including method of attaching, for acceptance. Heavy duty pile tips have an area of at least 2.0 times the pile area and steel prongs to penetrate rock.

~~(c)~~**9. Cutting Off Piles.** After piles have been driven and accepted, cut them off at the indicated top elevations, perpendicular to their axis, unless otherwise directed. Cut off timber piles that support timber caps or grillage, to conform to the plane of the bottom of the superimposed structure.

~~(d)~~**10. Rebuilding or Extending Piles.** Rebuild or extend by splicing piles driven below the indicated top of pile elevations, or piles cut off after being driven, if the Structure Control Engineer approves. However, do not splice pile reinforcement, unless allowed in writing by the City.

Splice, rebuild, or extend timber piles using suitable timber, as indicated or as accepted.

~~(e)~~**11. ~~Pile Load Tests.~~** ~~If pile load tests are required, the proposal will specify the detailed requirements.~~

Dynamic Pile Load Tests. Conduct dynamic testing on the specified pile(s) at each substructure as indicated or as directed. Conduct dynamic testing during the entire length of piles driven and during the time piles are restruck, if restrike is indicated. The purpose of dynamic testing is to provide the Department with supplemental information for evaluating pile hammer performance, driving stresses, potential pile damage and bearing capacities.

Provide dynamic pile load testing with equipment and accessories conforming to ASTM D4945. The same hammer and equipment must be used for the dynamic pile load testing on

the test piles or production piles or both.

11.a Qualifications. Submit qualifications for acceptance. Do not begin dynamic testing until qualifications are accepted. Perform the dynamic testing with a Professional Engineer and workforce experienced in dynamic testing meeting the following qualifications and submitting proper documentation:

- The dynamic testing operator must have a minimum of 3 years of experience that demonstrates successful performance on at least three projects in similar geotechnical conditions and pile type with the use of high-strain dynamic pile testing. Include a brief description of each project and the name and phone number of the owner's representative knowledgeable in each project listed.

- Furnish the full name and license number of a Professional Engineer registered in the State, having at least 5 years of experience in the performance of dynamic testing of driven piles, who is responsible for the work performed and preparing test reports. Do not use only the company names of consultants or manufacturers to meet the requirements of this section; use the names of the personnel.

2.b Submittals. Submit proposed methods of documentation and reports for acceptance. Include the format of the electronic template for the submission of pile driving records. As the tests are completed, provide electronic output records from the dynamic pile load testing with data to correlate the records with the respective pile and driving records. Submit records within 24 hours of testing. Record signals on approved electronic media. Perform supplementary office analyses on piles dynamically tested, as directed. Include an interpretive report that summarizes pertinent field data, to determine pile tip elevations, pile capacity, soil resistance distribution, dynamic soil properties of shaft and toe quake and damping resistances and driving stresses throughout the pile for each substructure unit. Evaluate and report the pile capacity versus plan factored axial resistances, maximum measured driving stress, hammer system efficiency, and pile structural damage/integrity. Submit a preliminary report within 48 hours of dynamic pile load testing. Submit a complete report with the information according to ASTM D4945, signed and sealed by a Professional Engineer licensed in the State, to the Representative within 5 days of testing.

2.c Dynamic Pile Load Testing. Perform dynamic pile load testing only if the Representative is present for witnessing during the entire time piles are driven, redriven or restruck. Notify the Representative of a tentative schedule for testing at least 21 calendar days before starting the tests. Notify the Representative of a firm date at least 48 hours before starting the tests but give the notice between start of work on Monday and noon of the following Friday. Do not schedule dynamic testing on Saturdays, Sundays, or Holidays without prior approval from the Representative. Perform dynamic testing according to ASTM D4945. Drill the necessary holes in the pile to fasten a pair of transducers and a pair of accelerometers. Drive the pile while testing until ordered to stop by the Representative. Remove the transducers and accelerometers after the dynamic testing is completed. Submit a repair procedure to the Representative to seal holes drilled in the pile if that section is to be incorporated into the structure.

(f) Bearing Value of Piles. If piles are not required to be driven to absolute refusal for point and end bearing piles or end of driving criteria for friction piles, the Structure Control Engineer will determine driving resistances, tip elevations, and safe bearing values from pile load tests, pile driving analyzer tests, or wave equation analysis of the test pile-driving results.

1. **Static Pile Load Test:** The product of a resistance factor of 0.8 times the pile load test result is greater than or equal to the plan factored axial resistance as indicated.

2. **Pile Driving Analyzer:** The product of a resistance factor of 0.65 times the ultimate pile capacity as established by pile driving analyzer or CAPWAP analysis is greater than or equal to the plan factored axial resistance as indicated.

3. **Wave Equation:** The product of a resistance factor of 0.5 times the wave equation predicted ultimate pile capacity result is greater than or equal of the plan factored axial resistance as indicated.

   For predicting pile capacity using wave equation and pile driving analyzer, a maximum permissible driving stress of 90% of the steel yield should be used.

(g) Pile Log. A detailed and accurate record will be kept during the driving of piles, showing the pile numbers, types, sizes, actual lengths before driving, sound lengths after driving, driving dates, lengths in footings, penetration rates, model of the hammer, capblock material, capblock inspection dates, rebuilt lengths, extended lengths, and final pay lengths.

(h) Welding. Weld splices, pile tip reinforcement, or metal end-closures as specified in Section 1105.03(m) for the type and position of the welding required.

MEASUREMENT AND PAYMENT –

ITEM 9000-0011 TREATED TIMBER BEARING PILES – Linear foot
ITEM 9000-0012 TIMBER TEST PILES – Lump sum

Includes Dynamic Pile Load Test. Applies if dynamic testing is performed while driving the entire length of pile, including restrike if indicated. No additional time or payment will be made for the following:

- Testing that is unable to be completed or is terminated by the Contractor before driving the entire length of the pile, as determined.
- Work determined to be unsatisfactory due to improper driving methods, inadequate equipment and materials, or unacceptable splice or tip welding.
- Cost for interruptions, delays, time lost due to malfunction, breakdown of equipment, or inclement weather.
- Additional testing done without the prior approval of the Representative.
- Costs associated with replacing a hammer rejected due to unacceptable performance, inadequate capacity based on the dynamic pile load testing results, or if the Contractor should choose to replace an already accepted hammer. These costs include, but are not limited to, transporting the replacement hammer to the job site,

unloading and setup, additional analyses and submissions, additional dynamic pile load tests required for the replacement hammer acceptance, lost production time, etc. Before driving piles with the new hammer, the Contractor must submit the operating specifications for acceptance of the proposed hammer as specified in Section 1005.3(a)1.