SECTION 314116 – SHEET METAL PILING BULKHEAD

PART 1 - GENERAL

1.1 DESCRIPTION

A. Design, furnish, install and test the metal sheet pile bulkhead(s) at the locations and to the criteria indicated on the ATM Shoreline and Boat Ramp Permit Submittal (dated 30 November 2023) and specified herein. Test piles will be placed in locations that can be incorporated into the work.

1.2 REFERENCES

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

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.5M/D1.5	(2020; Errata 1 2022) Bridge Welding Code ASTM INTERNATIONAL (ASTM)

AMERICAN SOCIETY TESTING MATERIAL(ASTM)

ASTM A572/A572M	(2021) Standard Specification for Grade 50 High-Strength Low-Alloy Columbium-Vanadium Structural Steel Sheet Piling Conforming to the Required Contents of Columbium, Vanadium, Titanium, and Nitrogen.
ASTM A6/A6M	(2023) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A328/A328M	(2013; R 2018) Standard Specification for Steel Sheet Piling
ASTM A690/A690M	(2013a; R 2018) Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments
ASTM D4945	(2017) Standard Test Method for High-Strain Dynamic Testing of Deep Foundations

ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

1.3 BASIS OF BID

A. Sheet pile bulkhead:

1. Basis of Design:
   a. Nucor Section: SKZ 20
   b. Width: 28.50-in
   c. Height: 16.00-in
   d. Thickness: 0.315-in
   e. Cross Sectional Area: 6.00-in^2/ft
   f. Weight (Single Pile): 48.24-lb/ft
   g. Weight (Wall Area): 20.31-lb/ft^2
   h. Section Modulus: 31.69-in^3/ft
   i. Moment of Inertia: 253.51-in^4/ft

B. Contractor’s Geotechnical Consultant
   1. Hire the services of an independent, Registered Professional Geotechnical Engineer (RPGE), experienced in soil mechanics and Sheet Pile design, analysis and installations. The Contractor’s Geotechnical Consultant must be independent of the Contractor and must have no employee or employer relationship which could constitute a conflict of interest:
      a. Provide supplemental geotechnical investigation along areas of existing waterway bank (land & waterside) sufficient to establish design parameters for Project design parameters.
      b. Utilizing the supplemental geotechnical investigation, evaluate sheet pile basis-of-design indicated in Project Documents for suitability to meet shown Project parameters. If basis-of-design sheet pile is insufficient, select appropriate sheet pile section.
      c. Based on Contractor's preferred sheet pile installation method (impact vs vibratory) hammer, develop installation parameters including but not limited to hammer requirements, blows per foot/inch, penetration rate, and expected embedment length to meet project requirements. For a vibratory hammer, provide driveability analysis (pre-installation modeling) of vibratory parameters including frequency and amplitude/eccentric moment. Additionally, provide refusal parameters including drive time, movement, and trigger points for switching to impact hammer if necessary.
      d. Provide a full-scale sheet pile test with data monitoring on penetration, stresses, and performance. Based on obtained test data, modify production sheet pile installation parameters accordingly. Test sheet pile can be used as production sheet pile if approved by the RPGE and accepted by the Contracting Officer.
      e. Provide submittal to Contracting Officer containing data from Items a through d above for approval.
      f. Upon approval, immediately proceed with production sheet pile installation to meet project requirements.

g. RPGE to provide continuous full-time monitoring of production sheet pile installation with installation parameter adjustments made if required to meet changing field conditions. Monitoring to include VDA (Vibratory Driving Analyzer) for minimum of 5% (or as specified by the RPGE) of sheet pile installations. For non-VDA monitored sheet pile installations, monitor and record the following parameters, but not be limited to:
   1) Alignment & Verticality
   2) Penetration Rate/Speed
   3) Frequency
   4) Amplitude
   5) Centrifugal Force/Driving Force
   6) Ground Vibration for sheet pile installations adjacent to structures

h. RPGE to evaluate/interpret monitoring data and provide a written report to the Contracting Officer identifying acceptable sheet pile installations and unacceptable conditions along with a corrective action plan, if needed.

i. RPGE to provided anticipated short and long term pile head lateral deflections under final project conditions. If required, RPGE to define backfill compaction limitations necessary to prevent excessive lateral load from being introduced into sheet piles.

j. Heads of sheet piles to be surveyed prior to and after backfill installations. Deviations from expected values to be addressed by RPGE along with a corrective action plan, if needed and approved by the Contracting Officer.

C. Unit Prices

1. Steel Sheet Piling

a. Payment

Payment for sheet piling quantities will be made at the applicable contract price per linear foot for furnished and installed sheet piling. Payment will cover all cost of furnishing, handling, storing and installing piling including placing, driving, cutting holes and other materials, and work incident thereto.

b. Measurement

The length of sheet piling installed [and removed] will be measured to the nearest tenth of a linear foot. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total length of piling indicated for that location and the length of piling installed below the point of cut-off.

c. Unit of Measure

Linear foot.

2. Cut-Offs

a. Payment

When pilings which have not been driven to penetration depths shown are directed to be cut off, except for cut-offs due to excessive battering, a lump sum payment

will be made for cutting off each piling.

b. Measurement

An additional sum will be paid for each linear foot of the portion cut off and measured for payment. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total lengthof piling shown on the plans for that location and the length of piling installed below the point of cut-off at the rate of 50 percent of the applicable contract unit price.

c. Unit of Measure

Linear foot.

3. Splices

a. Payment

The Contractor furnished pilings which have been installed and are pulled at the direction of the Contracting Officer and found to be in good condition will be paid for at the applicable contract unit price for furnishing and installing the pilings in their initial position plus the applicable contract unit price for the cost of pulling.

b. Measurement

When such pulled pilings are redriven, an additional amount equal to 50 percent of the applicable contract unit price for furnishing and driving the pilings will be paid for redrivingthe pilings. This additional price constitutes payment for redriving only. The cost of furnishing, initial driving, and pulling the pilings is to be paid for as specified.

When pilings are pulled and found to be damaged no payment will be made for the initial furnishing and driving or for the pulling ofsuch pilings. Pilings replacing damaged pilings will be paid for at the applicable contract unit prices.

c. Unit of Measure

Linear foot.

1.4 ESTIMATED QUANTITIES

A. Provide fixed unit prices and estimate total quantities of sheet piling to be furnished by the Contractor for bidding purposes. Installed quantities will consist of all piling including fabricated sections driven between the required top and bottom elevations of pilings plus any additions thereto resulting from changes in alignment as provided in paragraph DRIVING. Removed quantities will consist of the lengths of piling pulled from below the ground level.

1.5 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Submittals

Supplemental Geotechnical Consultant Qualifications and Report.

Bulkhead layout drawings including cap and accessories.

SD-02 Preconstruction Submittals Installation

Procedures

Contractor’s Geotechnical Consultant Documentations

Testing Agency Qualifications

Instrumentation and Monitoring Program Report

SD-03 Shop Drawings

Metal Sheet Piling

Pile Splicing

Pile Placement

As-Driven Survey

Pile Shoe

SD-04 Product Data

Pile Driving Equipment

Delivery, Storage, and Handling

Pulling and Redriving

Interlocked Joint Strength in Tension Test Procedures

SD-05 Design Data

Procedure for Insufficient Pile Length

SD-06 Test Reports

Materials Tests

Interlocked Joint Strength in Tension Test

SD-07 Certificates

Pile Shoe

Welding Certifications

Steel Plant Certificate

SD-08 Closeout Submittals

Pile Driving Record

1.6 DELIVERY, STORAGE, AND HANDLING

Conform all delivery, storage, and handling of materials to the requirements specified herein.

Develop and submit plans for the delivery, storage, and handling of piles. Submit delivery storage, and handling plans for piles at least 30 days prior to delivery of piles to the job site.

A. Delivery and Storage

Materials delivered to the site must be new and undamaged and must be accompanied by certified test reports. Provide the manufacturer's logo and mill identification mark on the sheet piling as required by the referenced specifications. Store and handle sheet piling in the manner recommended by the manufacturer to prevent permanent deflection, distortion or damage to the interlocks; as a minimum, support on level blocks or racks spaced not more than 10 feet apart and not more than 2 feet from the ends. Storage of sheet piling should also facilitate required inspection activities and prevent damage to coatings and corrosion protection prior to installation.

B. Handling

Lift piles to ensure that the maximum permissible curvature is not exceeded. Holes may be burned above the cutoff length for lifting piles into the leads. If there is evidence of pile damage during driving due to the holes, Contracting Officer may forbid the burning of holes. Do not damage piles when dragging piles across the ground or barge deck.

Inspect piles for excessive curvature and for damage before transporting them from the storage area to the driving area and immediately prior to placement in the driving leads. Curvature in the pile must be measured with the pile laying on a flat surface and is the distance between the pile at the mid-length of the pile and the flat surface. Straightness of the sections of piles must conform to AWS D1.5M/D1.5 – Section 3.5.1.1. Piles having excessive curvature will be rejectd.

C. Damaged Piles

Inspect each pile for straightness and structural damage before transporting them to the project site and immediately prior to placement in the driving leads. Bring any damage to the attention of the Contracting Officer. Piles which are damaged during delivery, storage,or handling to the extent they are rendered unsuitable for the work, in the opinion of the Contracting Officer, will be rejected and removed from the projectsite, or may be repaired, if approved, at no cost to the Government.

Any pile damaged by reason of internal defects or by improper driving must be corrected by one of the following methods approved by the Engineer for the pile in question:

a. The pile is withdrawn, if practicable, and replaced by a new and,if necessary, longer pile.
b. One or more replacement piles are driven adjacent to the defective pile.
c. A Pile Dynamic Analysis and/or low integrity testing must be performed by the Contractor's Geotechnical Consultant to assess the structural integrity of the driven pile(s).

A pile driven below the specified butt elevation must be corrected by one of the following methods approved by the Engineer:

a. The pile is spliced (if approved).
b. A sufficient portion of the footing is extended down to properly embed the pile.

A pile driven out of its proper location or out of plumb as approved by the Engineer, must be corrected by one of the following methodsapproved by the engineer:

a. One or more replacement piles are driven next to the pile in question.
b. As directed by the structural engineer.

1.7 MATERIAL CERTIFICATES

A. For each shipment, submit certificates identified with specific lots prior to installing piling. Include in the identification data piling type, dimensions, chemical composition, mechanical properties, section properties, heat number, and mill identification mark.

PART 2 PRODUCTS

2.1 METAL SHEET PILING

Submit detail drawings for sheet piling, including fabricated selections, showing completed piling dimension and details, driving sequence and location of installed piling.

a. Include in the drawing details of top protection, special reinforcing tips, tip protection, lagging, splices, fabricated additions to plain piles, cut-off method, corrosion protection, and dimensions of templates and other temporary guide structures for installing piling. Provide details of the method for handling piling to preventpermanent deflection, distortion or damage to piling interlocks.

b. Metal sheet piling must be hot-rolled steel sections conforming to ASTM A572 Gr 50, Type and interlocked joint strength in tension to be determined by the design.

A. Interlocks

The interlocks of sheep piling must be free-sliding, provide a swing angle suitable for the intended installation but not less than 5 degrees when interlocked, and maintain continuous interlocking when installed.

B. General Requirements

Provide sheet piles with minimum section modulus, moment of inertia, shape, and size as indicated. Fabricated tees, wyes and cross pieces must be fabricated of piling sections with a minimum web thickness matching the standard pile section. Provide sheet piling with standard lifting holes. Metalwork fabrication for sheet piling must be as specified.

2.2 APPURTENANT METAL MATERIALS

Provide metal plates, shapes, bolts, nuts, rivets and other appurtenant fabrication and installation materials conforming to manufacturer’s standards.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

Requirements for material tests, workmanship and other measures for quality assurance must be as specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Provide manufacturer’s steel plant certificate for Government review and approval.

A. Materials Tests

Submit certified materials tests reports showing that sheet piling and appurtenant metal materials meet the specified requirements, for each shipment and identified with specific lots prior to installing materials.

Material test reports must meet the requirements of ASTM A572, Gr 50. Perform materials tests conforming to the following requirements. Sheet piling and appurtenant materials must be tested and certified by themanufacturer to meet the specified chemical, mechanical and section property requirements prior to delivery to the site. Testing of sheet piling for mechanical properties must be performed after the completion of all rolling and forming operations. Testing of sheet piling must meet the requirements of ASTM A572, Gr 50.

2.4 PILE DRIVING EQUIPMENT

Submit complete descriptions of sheet piling driving equipment including hammers, extractors, protection caps and other installation appurtenances, prior to commencement of work. Descriptive information includes manufacturer's name, model numbers, capacity, rated energy, hammer details, cushion material, helmet, and templates. Provide pile driving equipment conforming to the following requirements. Submit descriptions of pile driving equipment, including hammers, power packs, driving helmets, hammer cushions, pile cushions, leads,

extractors, jetting equipment, and preboring equipment at least 30 days prior to commencement of work

A. Driving Hammers

Hammers must be steam, air, or diesel drop, single-acting, double-acting, differential-acting, or vibratory or press-in type. The driving energy of the hammers must be as recommended by the manufacturer for the piling weights and subsurface materials to be encountered. Repair damage to piling caused by use of a pile hammer with excess delivered force or energy.

B. Jetting Equipment

Jetting will not be permitted.

PART 3 EXECUTION

3.1 PRELIMINARY WORK

A. Pile Length Markings

Mark each pile prior to driving with horizontal lines at one-foot intervals. Mark the interval number on pile every 5 feet from pile tip.

3.2 EARTHWORK

Perform in accordance with Section 31 00 00 EARTHWORK. Pre-excavation will not be permitted. Backfill as indicated.

3.3 INSTALLATION

A. Placing and Driving

1. Placing

Submit a written description of the site specific pile installation procedure for Government review and approval. Pile placement installation drawings and details must also be provided.

Any excavation required within the area where sheet pilings are to be installed must be completed prior to placing sheet pilings. Pilings properly placed and driven must be interlocked throughout their length with adjacent pilings to form a continuous diaphragm throughout the length or run of piling wall.

2. Driving

Submit records of the completed sheet piling driving operations, including a system of identification which shows the disposition of approved piling in the work, driving equipment performance data, piling penetration rate data, piling dimensions and top and bottom elevations of installed piling. Prior to driving pilings in water, paint a horizontal line on both sides of each piling at a fixed distance from the bottom so that it will be visible

above the water line after installation. This line must indicate the profile of the bottom elevation of installed pilings and potentialproblem areas can be identified by abrupt changes in its elevation. Drive pilings with the proper size hammer and by approved methods so as not to subject the pilings to damage and to ensure proper interlocking throughout their lengths.

a. Maintain driving hammers in proper alignment during driving operations by use of leads or guides attached to the hammer.

b. Employ a protecting cap in driving when using impact hammers to prevent damage to the tops of pilings. Remove and replace pilings damaged during driving or driven out of interlock at the Contractor's expense.

c. Drive pilings without the aid of a water jet.

d. Take adequate precautions to ensure that pilings are driven plumb. Where possible, drive Z-pile with the ball end leading. If an open socket is leading, a bolt or similar object placed in the bottom of the interlock will minimize packing material into it and ease driving for the next sheet. If at any time the forward or leading edge of the piling wall is found to be out-of-plumb in the plane of the wall the piling being driven must be driven to the required depth and tapered pilings must be provided and driven to interlock with theout-of-plumb leading edge or other approved corrective measures must be taken to insure the plumbness of succeeding pilings. The maximum permissible taper for any tapered piling must be 1/8 inch per foot of length.

e. Pilings in each run or continuous length of piling wall must be driven alternately in increments of depth to the required depth or elevation. No piling will be driven to a lower elevation than those behind it in the same run except when the pilings behind it cannot be driven deeper. Incrementally sequence driving of individual piles such that the tip of any sheet pile must not be more than 4 feet below that of any adjacent sheet pile. When the penetration resistance exceeds five blows per inch, the tip of any sheet pile must not be more than 2 feet below any adjacent sheet pile. If the piling next to the one being driven tends to follow below final elevation it may be pinned tothe next adjacent piling.

f. If obstructions restrict driving a piling to the specified penetration, the obstructions must be removed or penetrated with a chisel beam. If the Contractor demonstrates that removal or penetration is impractical, make changes in the alignment of the piling structure as directed to ensure the adequacy and stability of the structure. Pilings must be driven to depths shown and must extend up to the elevation indicated for the top of pilings. A tolerance of +2 / -0 inches above the indicated top elevation will be permitted. Pilings must not be driven within 100 feet of concrete less than 7 days old.

g. Pre-augering or spudding of piles will not be permitted.

B. Cutting-Off and Splicing

Pilings driven to refusal or to the point where additional penetration cannot be attained and are extending above the required top elevation in excess of the specified tolerance must be

cut off to the required elevation. Pilings driven below the required top elevation and pilings damaged by driving and cut off to permit further driving must be extended as required to reach the top elevation by splicing when directed at no additional cost to the Government. Submit procedure for insufficient pile length. Provide pile splicing information and details for Government review and approval prior to installation in the field.

a. Pilings adjoining spliced pilings must be full length unless otherwise approved. Splicing of pilings must be as indicated. Ends of pilings to be spliced must be squared before splicing to eliminate dips or camber. Pilings must be spliced together with concentric alignment of the interlocks so that there are no discontinuities, dips or camber at the abutting interlocks. Spliced pilings must be free sliding and able to obtain the maximum swing with contiguous pilings. Welding of splices must conform to the requirements of manufacturer instructions. Shop and field welding, qualification of welding procedures, welders, and welding operators must be in accordance with AWS D1.1/D1.1M. Submit welding certifications for all welders and welding operators for Government review and approval.

b. The tops of pilings excessively battered during driving must be trimmed when directed, at no cost to the Government. Piling cut-offs will become the property of the Contractor and must be removed from the site.

c. Cut holes in pilings for bolts, rods, drains or utilities in a neat and workmanlike manner, as shown or as directed. Use a straight edge in cuts made by burning to avoid abrupt nicks. Bolt holes in steel piling must be drilled or may be burned and reamed by approved methods which will not damage the surrounding metal. Holes other than bolt holes must be reasonably smooth and the proper size for rods and other items to be inserted. Do not use explosives for cutting.

C. Inspection of Driven Piling

Perform continuous inspection during pile driving. Inspect all piles for compliance with tolerance requirements. Bring any unusual problems which may occur to the attention of the Contracting Officer. Inspect the interlocked joints of driven pilings extending above ground. Pilings found to be out of interlock must be removed and replaced at the Contractor's expense.

D. Pulling and Redriving

Submit the proposed method of pulling sheet piling, prior to pulling any piling. Pull, as directed, selected pilings after driving to determine the condition of the underground portions of pilings. Any piling so pulled and found to be damaged, to the extent that its usefulness in the structure is impaired, must be removed and replaced at the Contractor's expense. Pilings pulled and found to be in satisfactory condition must be redriven when directed.

E. Testing Agency Qualifications

Engage an independent testing agency qualified according to ASTM E329 for testing indicated, as documented according to ASTM D4945, and approved by the Contracting

Officer.

F. Survey Data

After the driving of each pile group is complete and before superimposed concrete is placed, provide the Contracting Officer with an as-driven survey showing actual location and top elevation ofeach pile. Submit an as-driven survey showing actual location and top elevation of each pile within 7 calendar days of completing the pile installation. Do not proceed with placing concrete until the Contracting Officer has reviewed the survey and verified the safe load for the pile group driven. Present a survey in such form that it gives deviation from plan location in two perpendicular directionsand elevations of each pile to nearest half inch. Survey must be prepared and certified by a land surveyor licensed in South Carolina.

3.4 REMOVAL

The removal of sheet pilings must consist of pulling, sorting,cleaning the interlocks, inventorying and storing previously installed sheet pilings as shown and directed.

A. Pulling

The method of pulling piling must be approved. Provide pulling holes in pilings, as required. Extractors must be of suitable type and size. Exercise care during pulling of pilings to avoid damaging piling interlocks and adjacent construction. If the Contracting Officer determines that adjacent permanent construction has been damaged during pulling, the Contractor will be required to repair this construction atno cost to the Government. Pull pilings one sheet at a time. Pilings fused together must be separated prior to pulling, unless the Contractor demonstrates, to the satisfaction of the Contracting Officer, that the pilings cannot be separated. The Contractor will not be paid for the removal of pilings damaged beyond structural use due to proper care not being exercised during pulling.

B. Sorting, Cleaning, Inventorying and Storing

Pulled pilings must be sorted, cleaned, inventoried and stored bytype into groups as:

a. Piling usable without reconditioning.
b. Piling requiring reconditioning.
c. Piling damaged beyond structural use.

3.5 INSTALLATION RECORDS

Maintain a pile driving record for each sheetpile driven. Indicate on the installation record: installation dates and times, type and size of hammer, rate of operation, total driving time, dimensions of driving helmet and cap used, blows required per foot for each foot of penetration, final driving resistance in blows for final 6 inches, pile locations, tip elevations, ground elevations, cut-off elevations,and any reheading or cutting of piles. Record any unusual pile driving problems during driving. Submit complete records to the Contracting Officer.

3.6 PRECONSTRUCTION CONDITION SURVEY

Perform preconstruction condition survey of structures and utilities within 200 feet of the pile driving activity. Perform outreach to the owner of the structures 28 days before performing the preconstruction condition survey. The Contractor must obtain written permission from the owner of the structure prior to accessing the structure. The preconstruction condition survey must include video and photographic documentation of the exterior and interior of above ground structures and of the interior of underground structures. Video documentation must be in high definition, and show existing conditions and highlight, where possible, existing cracks, deteriorated concrete, exposed and corroded reinforcement, cracked or broken brick or mortar, and other signs of distress. For utilities, perform the survey when the greatest extent of the interior is exposed. Provide supplementary artificial lighting as needed. The video must include annotation with location and structure nomenclature which describes any areas of distress over the video and time code superimposed on the video. Photographs must be accompanied by sketches or descriptions that indicate the location and direction of each photograph. For each structure surveyed, provide a Pre-Construction Condition Survey Report following completion of the survey. The report must contain all documentation associated with the survey including DVD copies. In the report, include notes, sketches, photographs, and videos. Provide general information, such as location details and structure type, as well as particular information on materials, condition, existing damage, aperture and persistence of cracks, and disrepair observed during visual survey. Provide a graphical depiction of locations of damage or other features of concern. Submit the Preconstruction Condition Survey Reports no later than 28 days before the commencement of pile driving activity. Accept responsibility for damages to existing adjacent or adjoining structures created by pile driving work, and repair any damages to these structures without cost to the Government.

END OF SECTION 314116