Bid Addendum 02

CLARKNEXSEN

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Raleigh, NC 27601
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Project: Visitor Center and Underwater Archaeology Building at the Fort Fisher Historic Site

SCO #: 16-16311.02A

Date: June 17, 2022

Comm #: Clark Nexsen #7173-B

Prepared by: CN

This ADDENDUM is to be a part of the contract documents and modifies and takes precedence over the original bid documents, as noted below and in any attached documents. Original items of the plans and specifications that have been modified, amended, voided, or suspended through previous addendums, shall remain in effect. It is the responsibility of the Bidder to notify and/or distribute this ADDENDUM to those sub-bidders who have received prints or digital files. The Bidder is to acknowledge receipt of this ADDENDUM in the space provided on the Bid Form.

DRAWING MODIFICATIONS – VISITOR CENTER & UNDERWATER ARCHAEOLOGY

1. *CU101 – UTITLITY PLAN– a) Corrected sanitary sewer lateral pipe sizes; b) Added pavement patch areas.*
2. *CU201 – UTILITY PROFILES – Corrected sanitary sewer lateral pipe sizes.*
3. *CU501 – UTILITY DETAILS – Revised "Reduced Pressure Principle Assembly Backflow Preventer Detail" to reflect Full Flow Ball Shutoff Valves.*
4. *CU502 – UTILITY DETAILS - Revised pump station vents to place them 3' above the base flood elevation for the Visitor Center and UAB.*
5. *L201 – SITE LANDSCAPING PLAN – Revised quantities of plant materials.*
6. *AE512 – SECTION DETAILS – RE: Details D1 & D2, Revised Metal stud framing and added a bent plate on the edge of the roof deck.*
7. *AS101 – ARCHITECTURAL SITE PLAN – Corrected Keynote 6 to include "NIC" in reference to Exhibit Rail.*
8. *AE101U – UNDERWATER ARCHEOLOGY FIRST FLOOR PLAN – Revised Keynote 41*
9. *AE102U – UNDERWATER ARCHAEOLOGY ROOF PLAN – Added downspouts at Columns UA/U4 and UA/U6. Re: AE101U.*

10. *AE403U – UNDERWATER ARCHAEOLOGY ENLARGED PLANS – Added details and note clarifications at Details A1, A2, A4, B1, and B3.*
11. *EP601 – PANELBOARD SCHEDULES – a) Revised Conduit sizes in Panel R3 circuits 36,38,40 & 42 to be 1-1/4"; b) Allocated circuit R4:10 to Grinder Pump Alarm Panel in panel schedule.*
12. *ES101 – ELECTRICAL SITE PLAN - Added circuit U-P2:12 to Grinder Pump Alarm Panel on plan.*
13. *ES102 – ELECTRICAL SITE PLAN – a) Two keynote 5 tags on ductbank labeled D1/E-002E have been deleted; b) Added circuit R4:10 to Grinder Pump Alarm Panel on plan.*
14. *EP601U – PANELBOARD SCHEDULES - Allocated circuit U-P2:12 to Grinder Pump Alarm Panel in panel schedule.*

PROJECT MANUAL MODIFICATIONS – VISITOR CENTER & UNDERWATER ARCHAEOLOGY

1. *Specifications – Volume 4a, PHASE 2 TABLE OF CONTENTS – a) Added Section 221113 – FACILITY WATER DISTRIBUTION PIPING; b) Added Section 221343 – FACILITY PACKAGED SEWAGE PUMPING STATIONS.*
2. *Specifications – Volume 4c – PHASE 2 TABLE OF CONTENTS –Added Section 270001 – DATA COMMUNICATIONS*
3. *Specification Section 003132, Volume 1, GEOTECHNICAL DATA – a) Paragraph 1.1.B - Included Geotechnical Investigation Report by Terracon dated December 20, 2019; b) Paragraph 1.1.C - Soil Investigation Report by Fred D. Smith, dated July1, 2019 is included in the Geotechnical Report referenced in part a) above as Appendix D; c) Paragraph 1.1.D -A Wetland Delineation Report by Terracon, dated September 9, 2019, is included; d)*
4. *Specification Section 012300, Volume 1, ALTERNATES, Page 012300-2, 3.1.B.1 and 3.1.B.2, Alternate No. 2: Fencing and Gate at the UAB Utility Yard, corrected reference to Sheet L201 to L101.*
5. *Specification Section 031000, Volume 3a, CONCRETE FORMING AND ACCESSORIES, Page 2, Paragraph 2.2.B - added clarification regarding form liners for board-formed concrete.*
6. *Specification Section 064023, Volume 3a, INTERIOR ARCHITECTURAL WOODWORK – Added section that includes Wood stair treads, risers, and landings (WD2); Wood Base (WB1); and Slat Wall System (SWD1).*

7. *Specification Section 071326, Volume 3a, SELF-ADHERING SHEET WATERPROOFING, Page 7, Paragraph 3.5.A – Deleted requirement for a Manufacturer's Field Representative.*
8. *Specification Section 072100, Volume 3a, THERMAL INSULATION, Page 1, Paragraphs 1.2.B– Deleted reference to 042000, UNIT MASONRY.*
9. *Specification Section 081743, Volume 3b, FIBERGLASS REINFORCED POLYESTER DOORS & FRAMES, Page 1, Paragraph 1.2.B – Deleted reference to 042000, UNIT MASONRY ASSEMBLIES.*
10. *Specification Section 084113, Volume 3b, ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS, Page 3, Paragraph 1.7.a – Deleted NACC Certification requirement.*
11. *Specification Section 095113, Volume 3b, ACOUSTICAL PANEL CEILINGS, Page 7, Paragraph 2.10.B – Added section for exposed extruded aluminum perimeter trim. Re: C2/AE520.*
12. *Specification Section 221113, Volume 4a, FACILITY WATER DISTRIBUTION PIPING – Added section is its entirety.*
13. *Specification Section 221343, Volume 4a, FACILITY PACKAGED SEWAGE PUMPING STATIONS – Added Section in its entirety.*
14. *Specification Section 270001, Volume 4c, DATA COMMUNICATIONS – Added Section in its entirety.*

DRAWING MODIFICATIONS – EARTHWORKS AND FORTIFICATION EXHIBIT

1. *G1011E – LIFE SAFETY PLAN – Added portable fire extinguishers at the sallyport (crossover) and the bombproof.*
2. *AS400E – FORTIFICATION EARTHWORKS RECONSTRUCTION EXHIBIT PLANS AND SECTIONS – a) Added notes and section reference for Dune Protection Rails on Details C1 and C3; b) Revised Section A5 at bottom of precast culvert and added detail reference A4/AS401E.*
3. *AS401E – FORTIFICATION EARTHWORKS RECONSTRUCTION EXHIBIT ENLARGED PLANS AND SECTION DETAILS – a) Detail A4, Deleted waterproofing membrane & protection board on culvert bottom and added crushed stone and vapor barrier; b) Detail A1, Added note re: sod stakes/spikes at lintel assembly.*
4. *AS402E - FORTIFICATION EARTHWORKS RECONSTRUCTION EXHIBIT ENLARGED PLANS AND SECTION DETAILS - Detail A1, Added note re: sod stakes/spikes at lintel assembly.*

5. *AS403E – FORTIFICATION EARTHWORKS RECONSTRUCTION EXHIBIT SECTIONS AND DETAILS – a) Architectural details for slab and heavy timber post foundation have been revised to coordinate with structural; b) Drain has been removed; c) Waterproofing and board has been eliminated from below slab and around post footings; d) Section detail added for "treated wood sand dune protection rails.*
6. *E002E – EARTHWORKS ELECTRICAL SITE PLAN – a) Revised Conduit ID 1 in Underground Conduit and Cable Schedule to be 1-1/4"; b) Ductbank and 2ND handhole for conduit related to the Honor Walk pedestals have been grayed out since the will be installed in the VC and UAB building package.*

PROJECT MANUAL MODIFICATIONS – EARTHWORKS AND FORTIFICATION EXHIBIT

1. *Specifications, Volume 2, PHASE 1 TABLE OF CONTENTS – Updated Table of Contents to reflect the addition/revisions of multiple sections.*
2. *Specification Section 055000, Volume 2, METAL FABRICATIONS – Added section in its entirety.*
3. *Specification Section 061063, Volume 2, EXTERIOR ROUGH CARPENTRY – Page 1, Paragraph 1.2.A – Added Subparagraph 3 to include Exterior Wood Steps and Railings in this section.*
4. *Specification Section 061300, Volume 2, HEAVY TIMBER CONSTRUCTION – a) Paragraph 1.1.A.1- added round wood poles to section; b) Added 1.2.B under Definitions; c) Inserted a new Paragraph 2.2, "Round Wood Poles"; d) Added Subparagraph 3.1.D.*
5. *Specification Section 075419, Volume 2, POLYVINYL CHLORIDE (PVC) ROOFING – **Delete** previous Section 075419 and **substitute** this new section included in this addendum in its place. Multiple revisions and clarifications have occurred.*
6. *Specification Section 092216, Volume 2, NON-STRUCTURAL METAL FRAMING – Added section in its entirety.*
7. *Specification Section 099114, Volume 2, EXTERIOR PAINTING (MPI STANDARDS) – Added Section in its entirety.*

REQUEST FOR SUBSTITUTION

No Request for Substitution for this Addendum

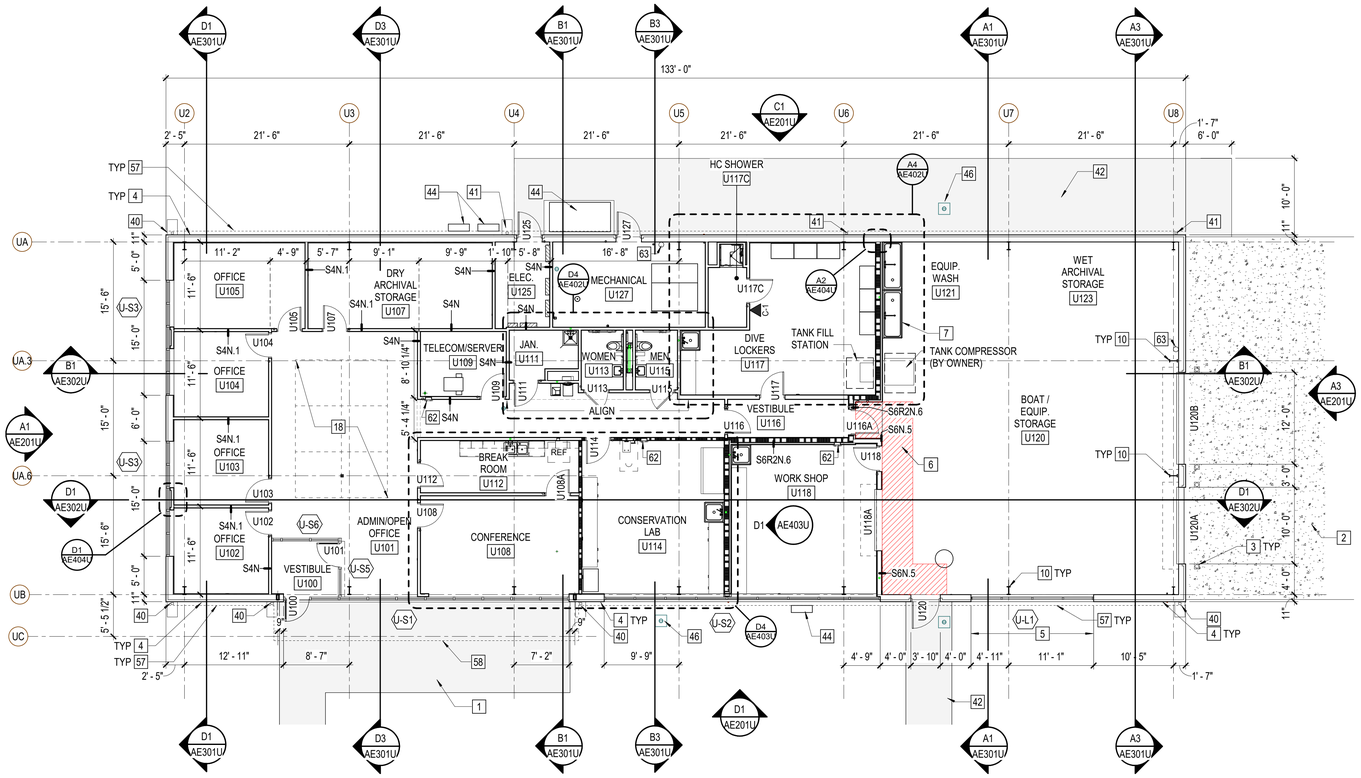
QUESTIONS AND ANSWERS

No Questions and Answers for this Addendum

ATTACHMENTS

No Attachments for this Addendum

END OF BID ADDENDUM 01



C1 UAB FLOOR PLAN

1/8" = 1'-0"

GENERAL NOTES

1. PLAN DIMENSIONS SHOWN ARE TO FACE OF FRAMING MEMBERS AND TO CENTER LINE OF COLUMNS, EXCLUSIVE OF INTERIOR WALLS.
2. ALL INTERIOR DIMENSIONS ARE TO FACE OF STUD OR TO CENTERLINE OF WALL, EXCLUSIVE OF ANY APPLIED FINISH.
3. REFER TO SHEET AE501 FOR THE PARTITION SCHEDULES. ALL INTERIOR PARTITIONS ARE TO BE TYPE S4N UNLESS OTHERWISE NOTED.
4. ALL DIMENSIONS TO BE FIELD VERIFIED PRIOR TO INSTALLATION OF EQUIPMENT / SHELVING / CASEWORK.
5. ANY CONFLICTING INFORMATION BETWEEN THE ARCHITECTURAL DRAWINGS AND THE CIVIL, LANDSCAPE, STRUCTURAL, FIRE PROTECTION, PLUMBING, HVAC, AUDIO VISUAL OR ELECTRICAL DRAWINGS SHALL BE NOTED IN WRITING TO THE ARCHITECT FOR REVIEW AND MUST BE CLARIFIED PRIOR TO COMMENCING THE CONSTRUCTION IN QUESTION.
6. PROVIDE FIRE RETARDANT TREATED WOOD BLOCKING IN METAL STUD PARTITIONS FOR MOUNTING FIXTURES, MILLWORK, SHELVING, HARDWARE, DOOR STOPS AND OTHER EQUIPMENT.
7. VERIFY AND COORDINATE PENETRATIONS THROUGH FLOOR SLABS, ROOF DECK AND PARTITIONS WITH PM&E AND FP DRAWINGS.
8. VERIFY AND COORDINATE FINISH FLOOR ELEVATIONS WITH CIVIL AND STRUCTURAL PRIOR TO COMMENCING CONSTRUCTION. NOTIFY ARCHITECT IN WRITING BEFORE CONSTRUCTION OF ANY CONFLICTS.
9. REFER TO SHEET AE601 FOR DOOR SCHEDULE. REFER TO SHEET AE701 & AE 710 FOR CURTAIN WALL, LOUVER, AND STOREFRONT ELEVATIONS.

KEY NOTES

1 CONCRETE STOOP AND WALK: SEE LANDSCAPE DRAWINGS

2 CONCRETE APRON: SEE CIVIL AND LANDSCAPE DRAWINGS

3 BOLLARD, TYP.

4 INSULATED METAL PANEL SIDING

5 EXTENTS OF LOUVERS

6 DEDICATED EGRESS PATH - OUTLINED AND STRIPED WITH 3" YELLOW STRIPES

7 WASH-DOWN TANKS

10 PRE-ENGINEERED STRUCTURAL FRAME

18 WORKSTATION FURNITURE BY OWNER

40 DOWNSPOUT & SPLASHBLOCK

41 DOWNSPOUT & BOOT (4"x 3" RECTANGULAR LACQUERED CAST IRON DOWNSPOUT BOOT WITH WALL SECURING CLAMP AND HARDWARE) WITH 4" PIPE UNDER SIDEWALK TO DAYLIGHT IN YARD BEYOND

42 SIDEWALK: SEE LANDSCAPE

44 CONDENSING UNIT: SEE MECHANICAL DRAWINGS

46 CLEANOUT: SEE PLUMBING

57 GUTTER ABOVE

58 CANOPY ABOVE

62 SEMI-RECESSED FIRE EXTINGUISHER CABINET

63 FIRE EXTINGUISHER BRACKET

RATED WALL LEGEND

ONE HOUR FIRE RATING

TWO HOUR FIRE RATING

GRAPHIC SCALE(S)

1/8" = 1' - 0" 0 5' 10' 15' 30'

DEPARTMENT OF NATURAL AND CULTURAL RESOURCES

VISITOR CENTER AND UNDERWATER ARCHAEOLOGY BUILDING AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S
KURE BEACH, NC 28449

SCO#: 16-16311-02A
CODE: 41614
ITEM: 4C01

DESIGNER

CLARKNEXSEN

333 FAYETTEVILLE STREET, SUITE 1000
RALEIGH, NORTH CAROLINA 27601
919·828·1876

CLARK NEXSEN LICENSE NUMBER: C-1028
PROFESSIONAL SEAL

SUBMITTAL

APRIL 29, 2022

BID SET

REVISIONS

2	06/17/22	ADDENDUM 2

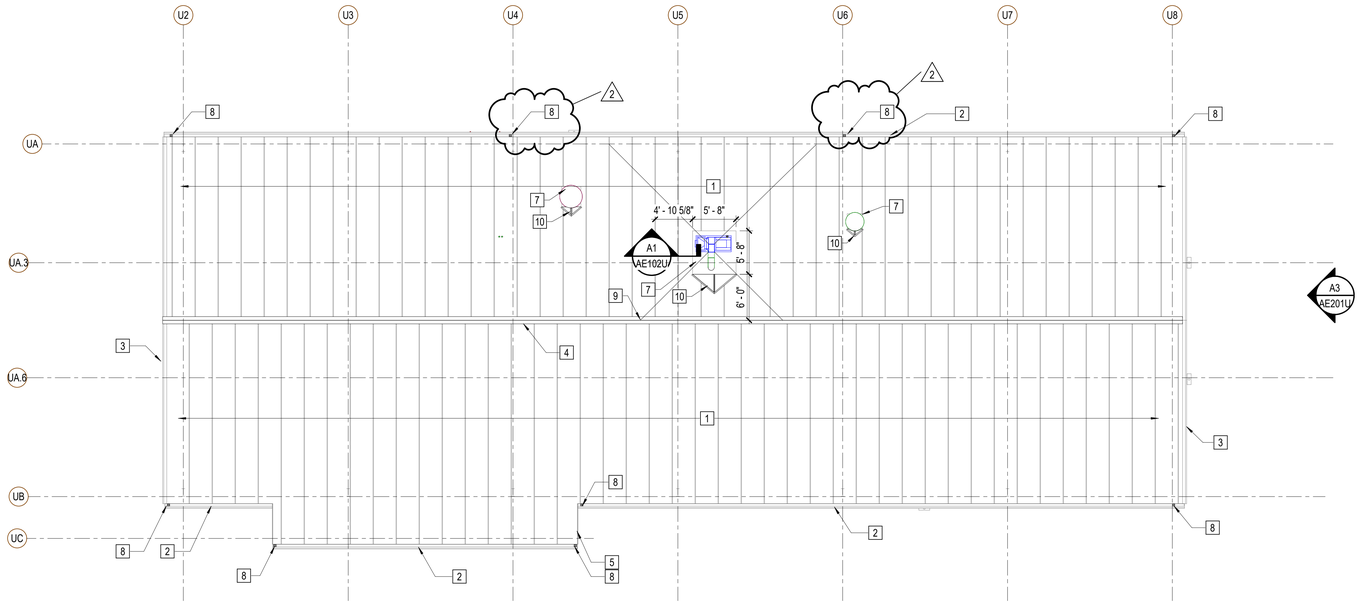
SHEET

UNDERWATER ARCHAEOLOGY FIRST FLOOR PLAN

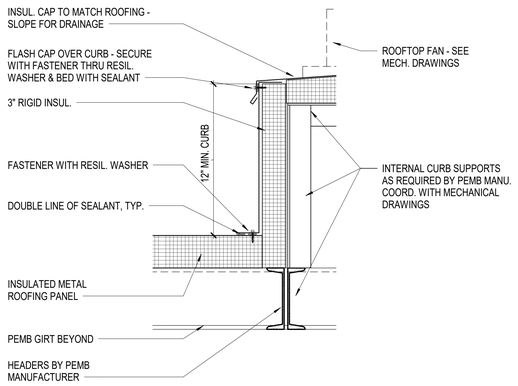
AE101U

DESIGN: DLF
DRAWN: DLF
REVIEW: DLF

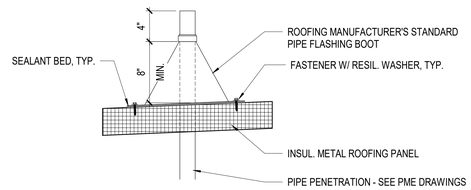
CN 7173-B



C1 ROOF PLAN
1/8" = 1'-0"



A1 UAB - ROOF CURB
1 1/2" = 1'-0"



A2 UAB TYPICAL ROOFING PIPE PENETRATION
1 1/2" = 1'-0"

GENERAL NOTES

1. METAL PANEL ROOF IS DESIGNED TO A SLOPE OF 2:12.
2. COORDINATE WITH MECHANICAL AND PLUMBING DRAWINGS FOR LOCATION OF ROOF PENETRATIONS THAT MAY NOT BE SHOWN ON THIS DRAWING. SEE DETAIL A2/AE102U FOR TYPICAL VENT-THROUGH-ROOF DETAIL.
3. ALL ROOF MOUNTED EQUIPMENT WITH CURBS SHALL HAVE METAL ROOFING CRICKETS INSTALLED TO MAINTAIN POSITIVE SLOPE TO ROOF DRAINS.
4. ALL ROOF EDGE GUTTERS AND DOWNSPOUTS ARE TO BE PROVIDED BY THE ROOFING MANUFACTURER TO MATCH THE ROOFING.

KEY NOTES

1	INSULATED METAL PANEL ROOFING
2	GUTTER BY ROOFING MANUFACTURER
3	RAKE FASCIA BY ROOFING MANUFACTURER
4	RIDGE CAP TO MATCH BY ROOFING MANUFACTURER
5	FLAT RAKE FASCIA AT CANOPY
7	FUME HOOD EXHAUST FAN & STACK ON 12" ROOF CURB
8	DOWNSPOUT BY ROOFING MANUFACTURER: COORDINATE WITH ELEVATIONS
9	EXHAUST STACK GUY WIRES: 2 TO THE RIDGE; 2 TO THE EAVE SPACED APPROX. 90 DEG. APART
10	MECHANICAL CURB (SEE DETAIL A1/AE102U) WITH SHEET METAL CRICKET TO MATCH ROOFING - MIN. SLOPE OF 1/2" IN 12"

GRAPHIC SCALE(S)

1 1/2" = 1' - 0" 0 3" 6" 9" 1' 2'

1/8" = 1' - 0" 0 5' 10' 15' 30'

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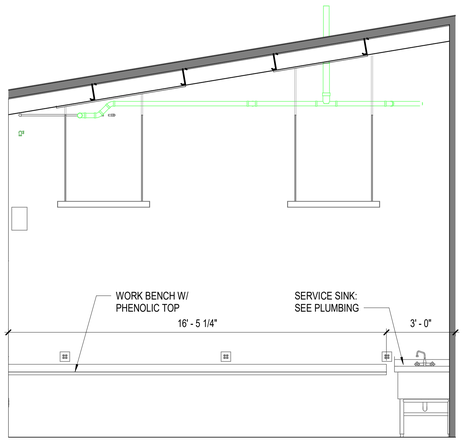
2	06/17/22	ADDENDUM 2

SHEET
UNDERWATER ARCHAEOLOGY ROOF PLAN

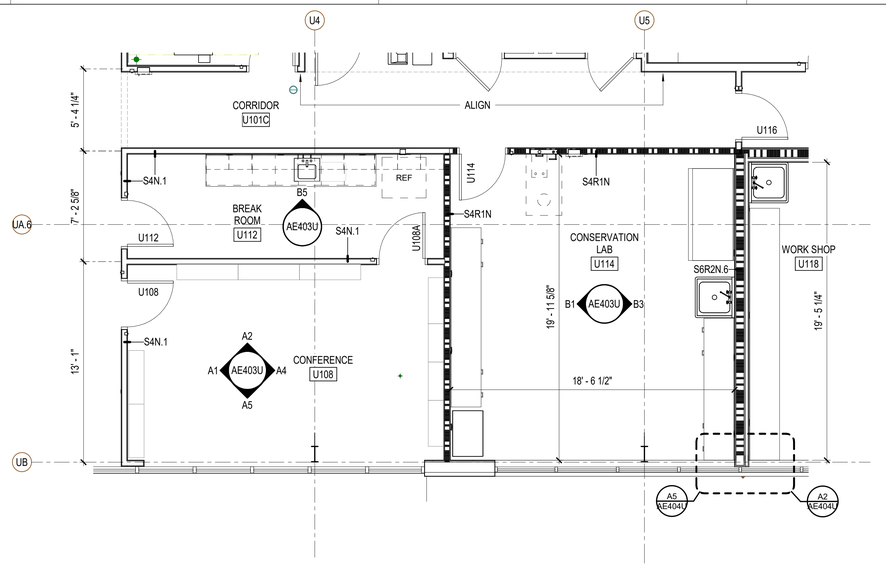
AE102U

DESIGN: DLF
DRAWN: DLF
REVIEW: DLF

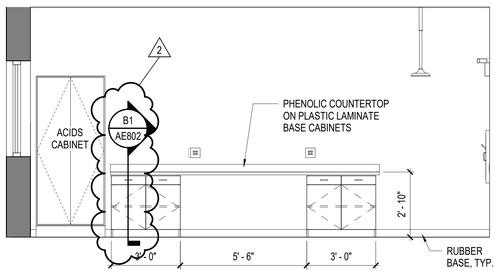
CN 7173-B



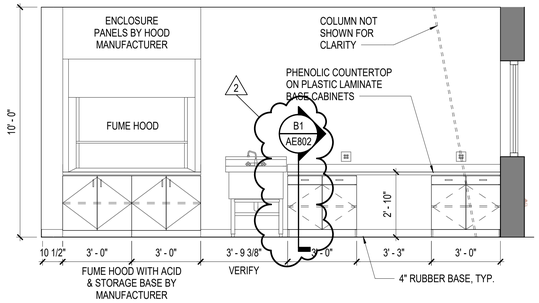
D1 WORK SHOP - WEST
3/8" = 1'-0"



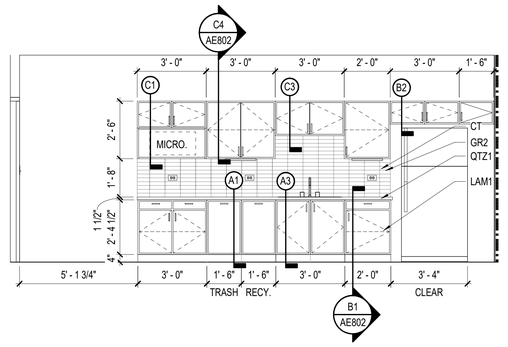
D4 UAB - CONFERENCE/CONSERVATION LAB
1/4" = 1'-0"



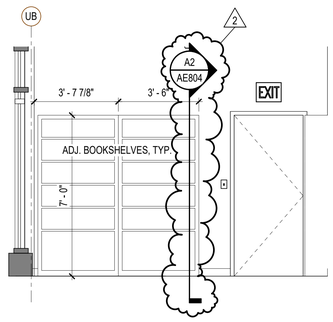
B1 CONSERVATION LAB - WEST
3/8" = 1'-0"



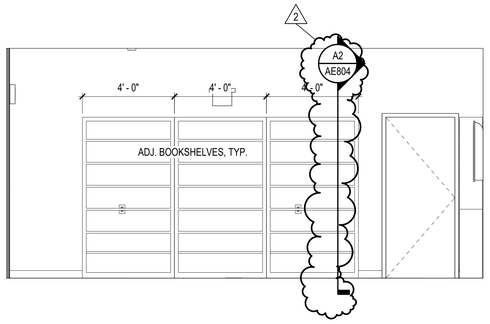
B3 CONSERVATION LAB - EAST
3/8" = 1'-0"



B5 BREAK ROOM - NORTH
3/8" = 1'-0"



A1 CONFERENCE - WEST
3/8" = 1'-0"



A2 CONFERENCE - NORTH
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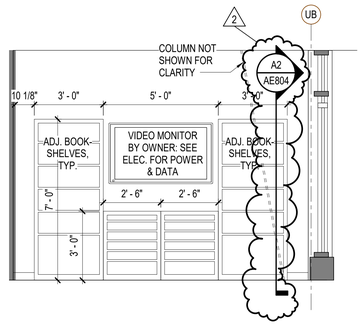
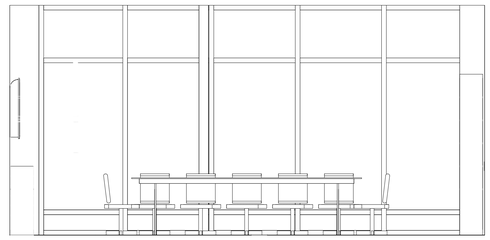


A4 CONFERENCE - EAST
3/8" = 1'-0"



A5 CONFERENCE - SOUTH
3/8" = 1'-0"

GRAPHIC SCALE(S)

1/4" = 1' - 0" 0 1' 5' 10' 15'

3/8" = 1' - 0" 0 1' 2' 3' 4' 5' 10'

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REVISIONS

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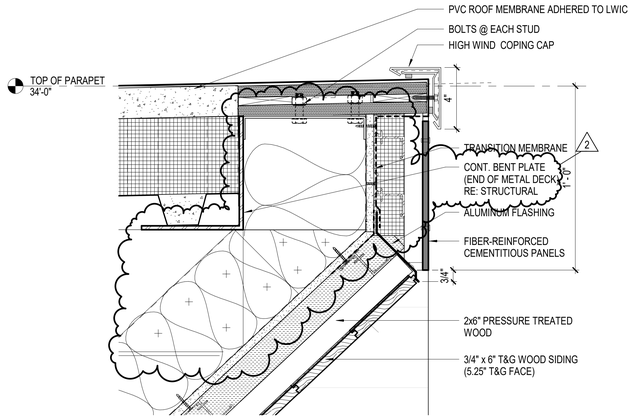
SHEET
UNDERWATER ARCHAEOLOGY
ENLARGED PLANS

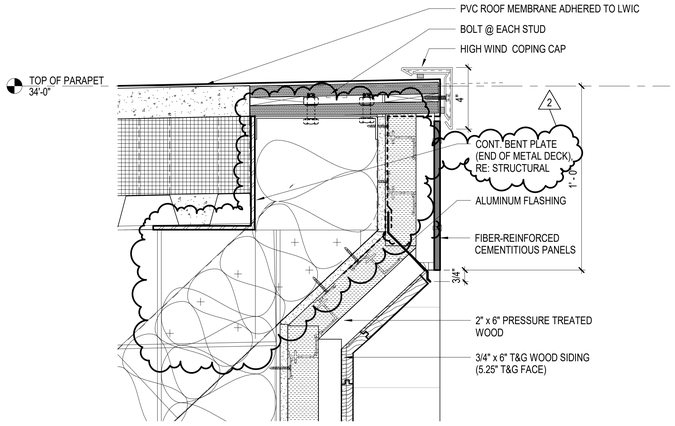
AE403U

DESIGN: DLF
DRAWN: DLF
REVIEW: DLF

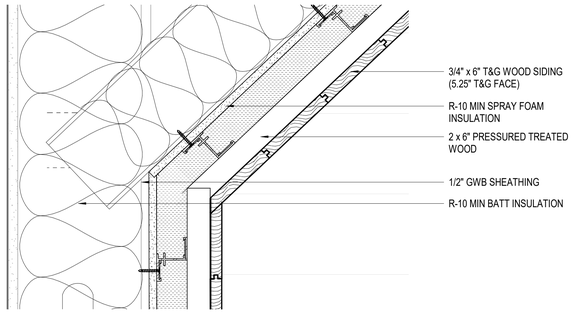
CN 7173-B



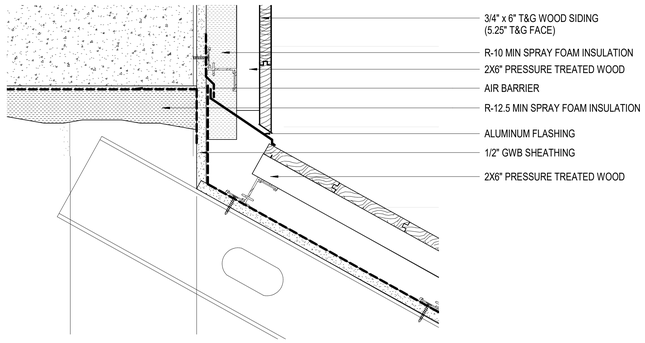
D1 RAINSCREEN DETAIL SOFFIT-FACIA
3" = 1'-0"



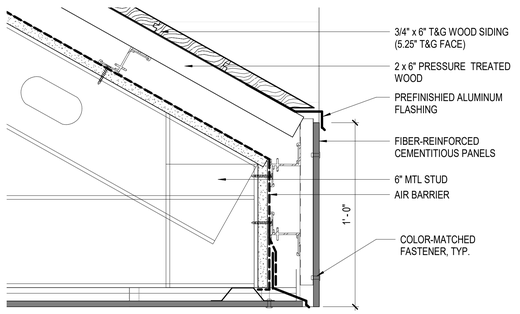
D2 RAINSCREEN DETAIL SOFFIT-FACIA
3" = 1'-0"



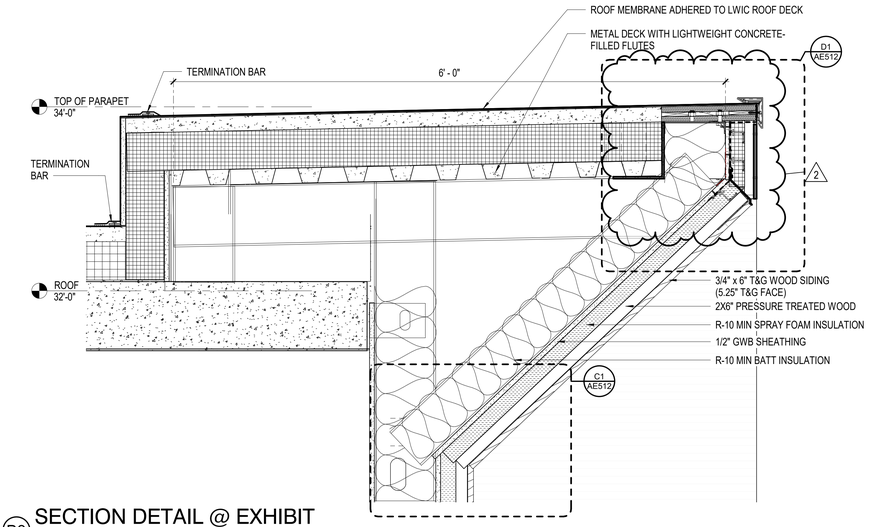
C1 RAINSCREEN DETAIL WALL-SOFFIT
3" = 1'-0"



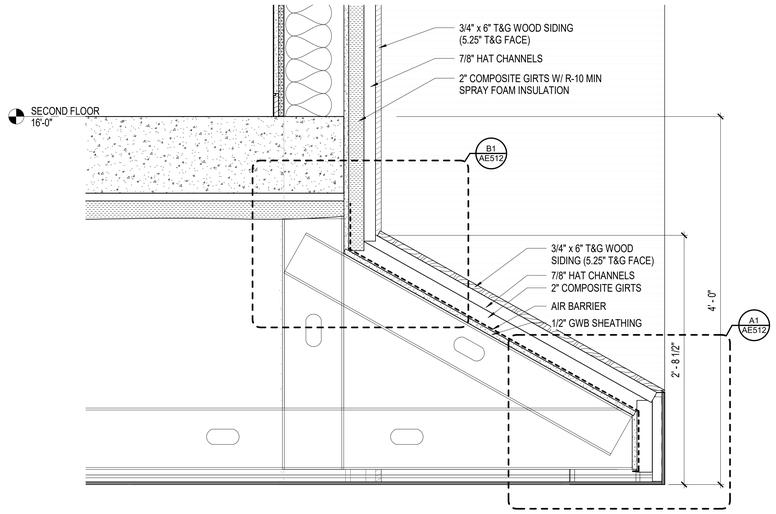
B1 RAINSCREEN DETAIL AT WALL-SILL
3" = 1'-0"



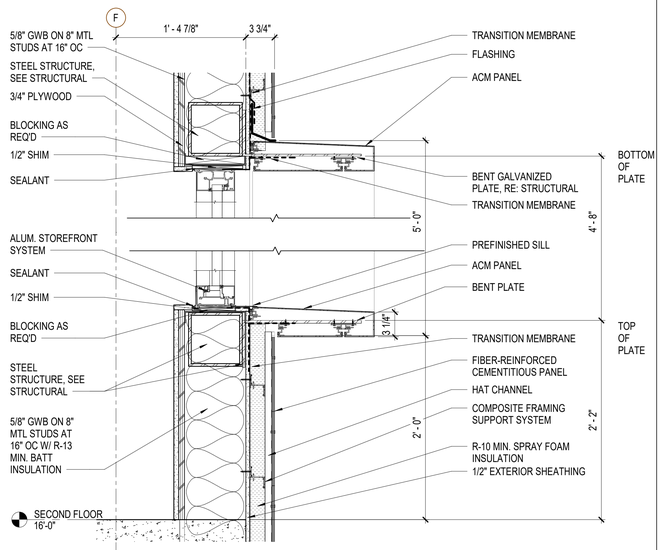
A1 RAINSCREEN DETAIL AT SILL-FASCIA
3" = 1'-0"



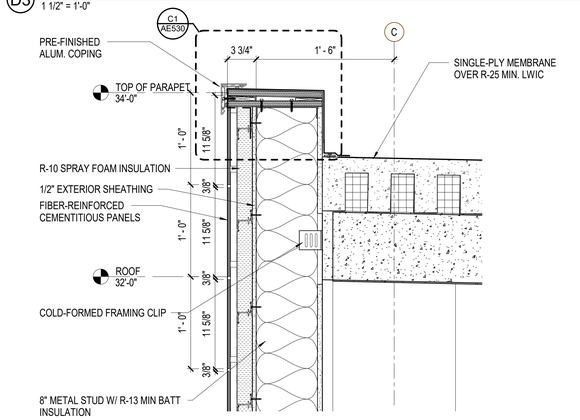
B3 SECTION DETAIL @ EXHIBIT
1 1/2" = 1'-0"



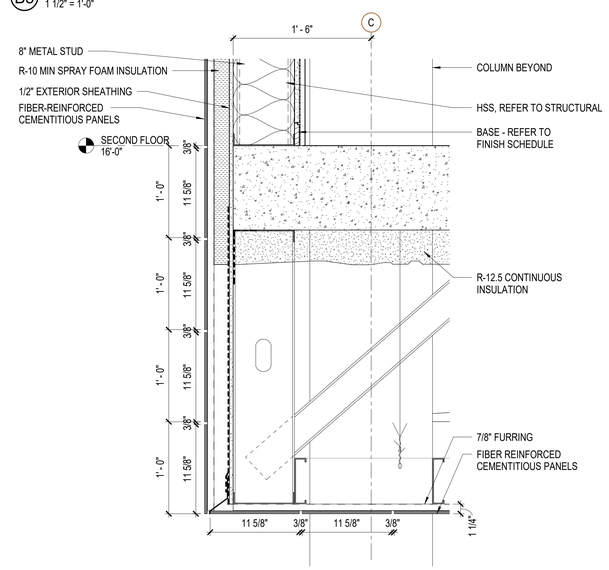
A3 SECTION DETAIL @ EXHIBIT
1 1/2" = 1'-0"



D3 SOUTH WINDOW AT EXHIBIT
1 1/2" = 1'-0"



B5 SECTION DETAIL @ TYP PARAPET
1 1/2" = 1'-0"



A5 SECTION DETAIL @ EXHIBIT
1 1/2" = 1'-0"

GRAPHIC SCALE(S)

3" = 1' - 0" 0 3" 6" 1'

1 1/2" = 1' - 0" 0 3" 6" 9" 1' 2'

DEPARTMENT OF NATURAL
AND CULTURAL RESOURCES

VISITOR CENTER AND UNDERWATER ARCHAEOLOGY BUILDING AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S
KURE BEACH, NC 28449

SCO#: 16-16311-02A
CODE: 41614
ITEM: 4C01

DESIGNER

CLARKNEXSEN
333 FAYETTEVILLE STREET, SUITE 1000
RALEIGH, NORTH CAROLINA 27601
919-828-1876

CLARK NEXSEN LICENSE NUMBER: C-1028
PROFESSIONAL SEAL

SUBMITTAL
APRIL 29, 2022
BID SET

REVISIONS

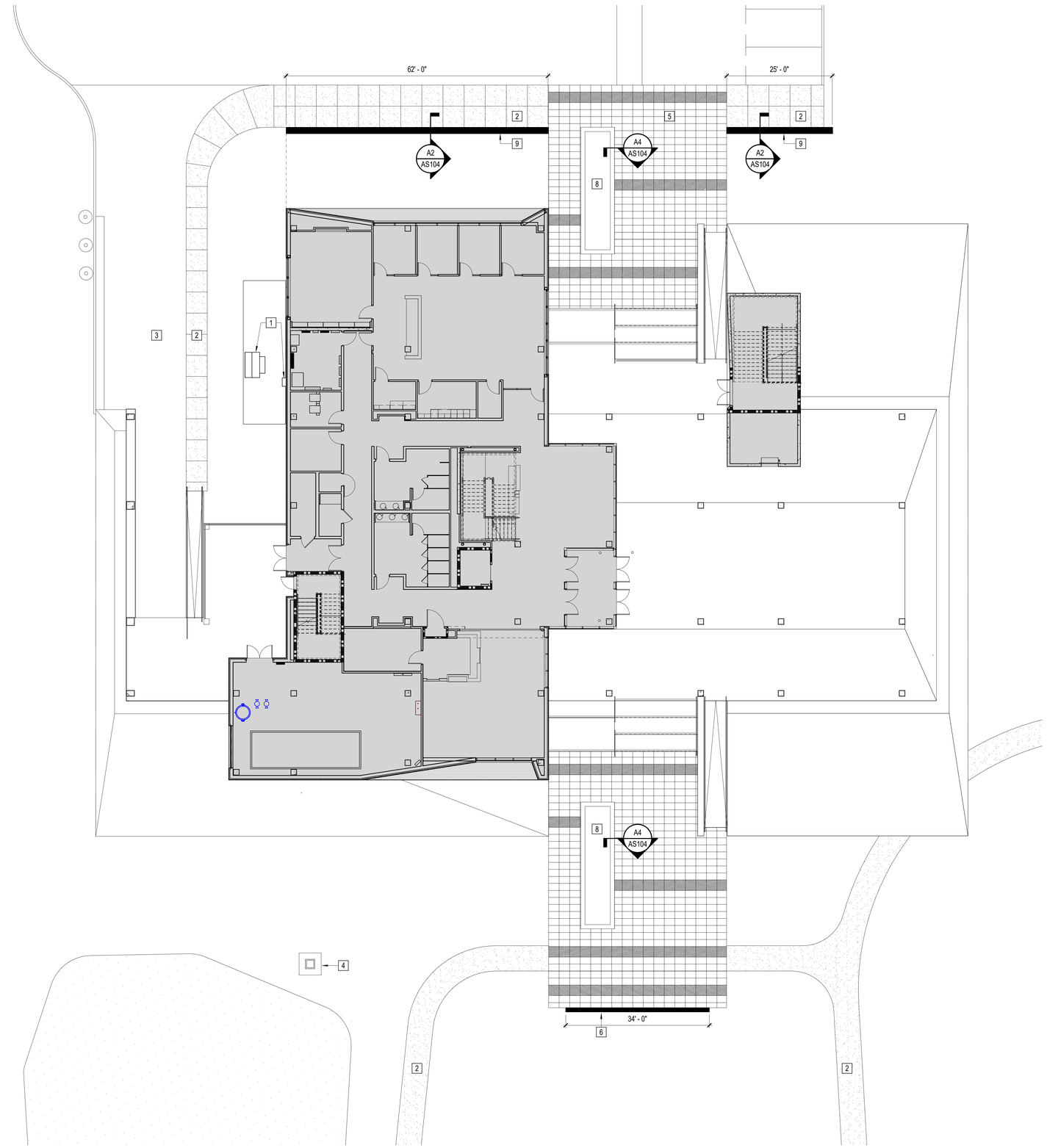
2	06/17/22	ADDENDUM 2

SHEET
SECTION DETAILS

AE512

DESIGN: RMH
DRAWN: RMH
REVIEW: MK

CN 7173-B



A1 SITE PLAN
3/32" = 1'-0"

GENERAL NOTES

1. REFER TO LANDSCAPE SHEETS FOR PAVING, PLANTING, AND GRADING INFORMATION.
2. REFER TO CIVIL DRAWINGS FOR SITE INFORMATION.
3. REFER TO MEP DRAWINGS FOR ANY EQUIPMENT LOCATIONS OUTSIDE OF BUILDING.

KEY NOTES

1 GENERATOR DOCKING STATION, RE: ELECTRICAL

2 CONCRETE SIDEWALK, RE: LANDSCAPE

3 HEAVY DUTY SERVICE YARD, RE: LANDSCAPE

4 PAINT EXISTING WELL ENCLOSURE, COLOR TBD BY ARCHITECT

5 CONCRETE PAVERS, RE: LANDSCAPE

6 EXHIBIT RAIL, NIC — 2

8 RAISED PLANTER SEAT WALL, RE: LANDSCAPE

9 SITE SEAT WALL, SEE SHEET AS104 FOR DETAILS

GRAPHIC SCALE(S)

3/32" = 1' - 0" 0 5' 10' 20' 40'

DEPARTMENT OF NATURAL
AND CULTURAL RESOURCES

VISITOR CENTER AND UNDERWATER ARCHAEOLOGY BUILDING AT THE FORT FISHER STATE HISTORIC SITE

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CLARK NEXSEN LICENSE NUMBER: C-1028
PROFESSIONAL SEAL

SUBMITTAL
APRIL 29, 2022
BID SET

REVISIONS

2	06/17/22	ADDENDUM 2

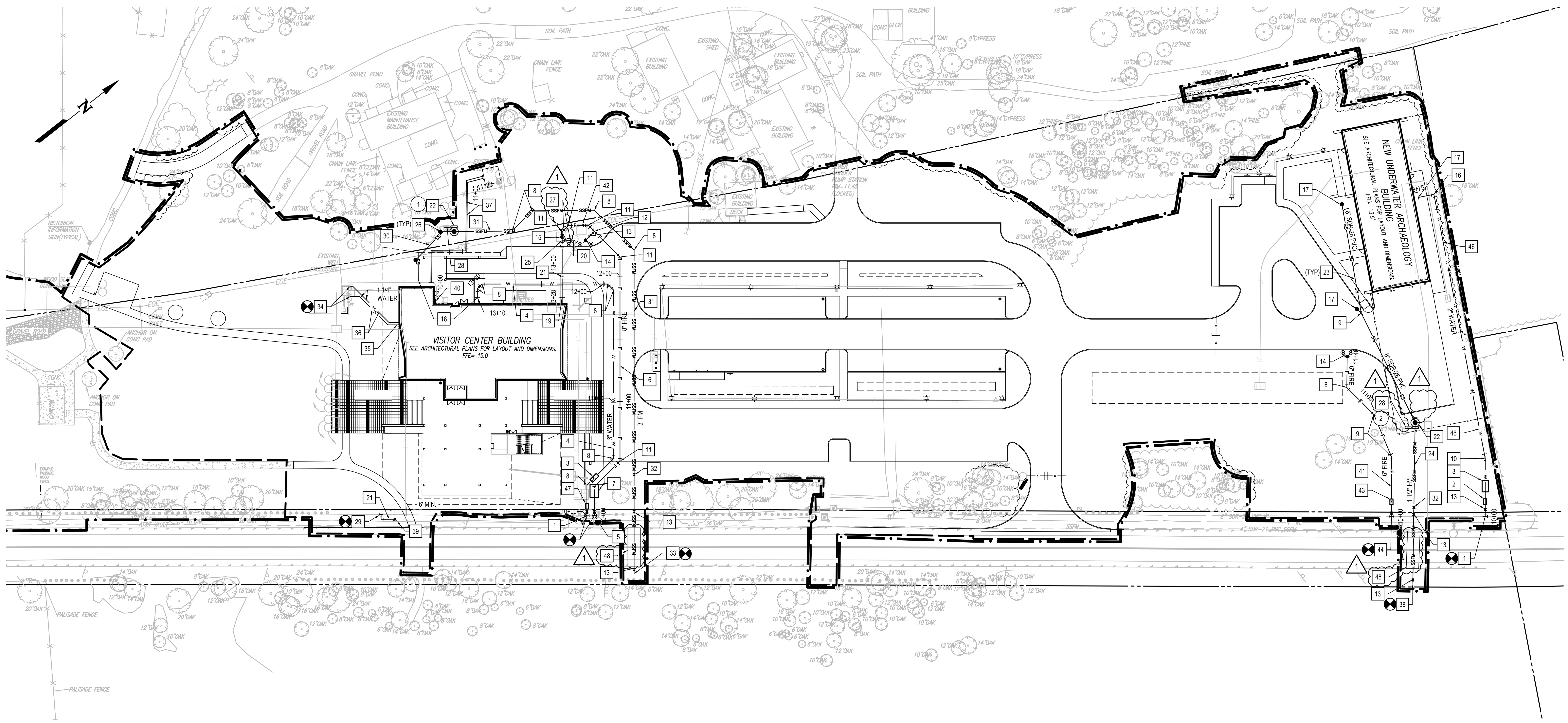
SHEET
ARCHITECTURAL SITE PLAN

AS101

DESIGN: EJ
DRAWN: EJ
REVIEW: MK

CN 7173-B

6/17/2022 8:33:17 AM
C:\Users\RKharkey\Documents\17173_Fort Fisher Visitor's Center A20_RKharkey.rvt



SEE SHEETS ES101 AND ES102
FOR ELECTRICAL SITE WORK

UTILITY NOTES

1. LOCATE THE EXISTING FORCE MAIN WITHIN US HWY 421 RIGHT-OF-WAY AND VERIFY HORIZONTAL AND VERTICAL LOCATION, AND SIZE OF THE FORCE MAIN PRIOR TO CONSTRUCTION.
2. VERIFY THE LOCATION AND SIZE OF THE EXISTING WELL DISCHARGE PIPING PRIOR TO CONSTRUCTION.
3. VERIFY THE LOCATION OF THE EXISTING NON-POTABLE WATER DISTRIBUTION SYSTEM FROM THE EXISTING WELL HOUSE PRIOR TO SITE DEMOLITION .
4. VERIFY THE LOCATION OF THE EXISTING NON-POTABLE WATER FROM THE WELL HOUSE TO THE EXSTING UAB BUILDING PRIOR TO CONSTRUCTION. THE NON-POTABLE WATER SHALL BE RELOCATED AND SERVICE TO THE EXISTING UAB BUILDING RESTORED.
5. RELOCATE OR PROVIDE THE NECESSARY EQUIPMENT, ELECTRICAL, WIRING, AND PIPING TO RESTORE THE OPERATION OF THE EXISTING WELL AND THE NON-POTABLE WATER SYSTEM.
6. DOMESTIC WATER SERVICE PIPING SHALL BE REQUIRED TO HAVE A WARNING TAPE INSTALLED IN THE BACKFILL BETWEEN 6 INCHES AND 24 INCHES BELOW FINISHED GRADE, DIRECTLY OVER PIPING. NON-METALLIC PIPES, SHALL BE IDENTIFIED BY DETECTABLE WARNING TAPES, MINIMUM 2" WIDE, WITH LETTERING TO IDENTIFY BURIED LINES BELOW.
7. PLASTIC SEWER PIPING SHALL BE REQUIRED TO HAVE AN INSULATED COPPER TRACER WIRE OR OTHER APPROVED CONDUCTOR INSTALLED ADJACENT TO AND OVER THE FULL LENGTH OF THE PIPING. ACCESS SHALL BE PROVIDED TO THE TRACER WIRE OR THE TRACER WIRE SHALL TERMINATE AT THE CLEANOUT BETWEEN THE BUILDING DRAIN AND THE BUILDING SEWER. THE TRACER WIRE SIZE SHALL NOT BE LESS THAN 14 AWG AND INSULATION TYPE SHALL BE LISTED FOR DIRECT BURIAL.
8. COORDINATE WATER SERVICE AND FIRE MAIN CONNECTIONS WITH KURE BEACH WATER WORKS.

CONSTRUCTION NOTES

1. CONNECT TO EXISTING 8" WATER WITH 2" CORP STOP AND TAPPING SADDLE.
2. WATER METER AND METER BOX.
3. REDUCED PRESSURE PRINCIPAL BACKFLOW PREVENTER
4. 3" SCHEDULE 40 PVC DOMESTIC WATER SERVICE. SEE SHEET CU201 FOR PROFILE
5. CONNECT TO EXISTING 8" WATER WITH 8" x 8" TAPPING SLEEVE AND VALVE
6. 8" MECHANICAL JOINT DUCTILE IRON FIRE SERVICE. SEE SHEET CU201 FOR PROFILE
7. 8" DOUBLE DETECTOR CHECK BACKFLOW PREVENTER
8. 45° SCHEDULE 40 PVC BEND
9. 22 1/2° SCHEDULE 40 PVC BEND
10. 11 1/4° SCHEDULE 40 PVC BEND
11. 45° MJ DUCTILE IRON BEND
12. 8"x6" MJ DUCTILE IRON TEE
13. GATE VALVE AND VALVE BOX
14. FIRE HYDRANT ASSEMBLY WITH BOLLARDS
15. POST INDICATOR VALVE. PROVIDE TAMPER SWITCH FOR VISITOR CENTER.
16. 90° SCHEDULE 40 PVC BEND
17. FOR CONTINUATION SEE PLUMBING PLAN PE101U
18. FOR CONTINUATION SEE PLUMBING PLAN PE103
19. FOR CONTINUATION SEE FIRE PROTECTION PLAN FP101
20. FIRE DEPARTMENT CONNECTION (FDC)
21. 6" MJ DUCTILE IRON. RESTRAIN ENTIRE LENGTH
22. FIBERGLASS DUPLEX GRINDER PUMP STATION WITH CONTROL PANEL
23. 6" SDR-26 PVC, SLOPE MINIMUM 0F 1.00% (1)
24. 1 1/2" SCHEDULE 40 PVC FORCE MAIN. SEE SHEET CU201 FOR PROFILE
25. 6" x 6" MJ DUCTILE TEE
26. SANITARY CLEANOUT
27. 6" SWING CHECK VALVE AND VAULT

CONSTRUCTION NOTES

28. PUMP STATION VENT
29. CONNECT TO EXISTING 8" WATER WITH 8" x 6" TAPPING SLEEVE AND VALVE
30. 6" SDR-26 PVC SLOPE A MINIMUM OF 1.00% (1)
31. 3" SCHEDULE 40 PVC FORCE MAIN. SEE SHEET CU201 FOR PROFILE
32. FORCE MAIN CHECK VALVE
33. CONNECT 3" FORCE MAIN TO EXISTING 4" FORCE MAIN WITHIN THE RIGHT-OF-WAY. COORDINATE CONNECTION WITH KURE BEACH PUBLIC WORKS. VERIFY FORCE MAIN LOCATION BY LEVEL A UTILITY LOCATION METHODS PRIOR TO CONSTRUCTION.
34. CONNECT TO EXISTING NON-POTABLE WATER.
35. SEE SHEET CU502 FOR SCHEMATIC DIAGRAM OF NON-POTABLE PRESSURE TANK WATER PIPING. SEE SHEET PE103 FOR LOCATION OF PRESSURE TANK.
36. 1 1/4" SCHEDULE 40 PVC NON-POTABLE WATER.
37. CHILLED WATER PIPING AND CHILLED WATER COOLING TOWER, SEE MECHANICAL DRAWING M-401.
38. CONNECT 1 1/2" FORCE MAIN TO EXISTING 4" FORCE MAIN WITHIN RIGHT-OF-WAY. COORDINATE CONNECTION WITH KURE BEACH PUBLIC WORKS. VERIFY FORCE MAIN LOCATION BY LEVEL A UTILITY LOCATION METHODS PRIOR TO CONSTRUCTION
39. FIRE HYDRANT ASSEMBLY
40. WELL NEMA 4X PANEL. CONNECT EXISITNG WELL PUMP TO NEW PANEL AND RECONNECT PRESSURE SWITCH TO THE WELL MATCHING EXISTING ELECTRICAL CONFIGURATION. PRESSURE SWITCH SHALL ENERGIZE THE WELL WHEN LOW PRESSURE IS SENSED AND TURN WELL OFF WHEN PRESSURE IS MET. SEE ELECTRICAL SHEET ES102
41. 6" MJ DUCTILE IRON FIRE SERVICE. SEE SHEET CU201 FOR PROFILE
42. 8"X6" MJ DUCTILE IRON REDUCER
43. 6" DOUBLE DETECTOR CHECK BACKFLOW PREVENTER
44. CONNECT TO EXISTING 8" WATER WITH 8"X6" TAPPING SLEEVE AND VALVE
45. NOT USED (1)

CONSTRUCTION NOTES

46. 2" SCHEDULE 40 PVC DOMESTIC WATER SERVICE. SEE SHEET CU201 FOR PROFILE
47. WATER METER AND VAULT
48. PAVEMENT REPAIR (1)

Know what's **below.**
Call before you dig.

1. CONTRACTOR IS RESPONSIBLE FOR CONTACTING APPROPRIATE PARTIES AND ASSURING THAT EXISTING UTILITIES ARE LOCATED PRIOR TO CONSTRUCTION.
2. CONTRACTOR IS RESPONSIBLE FOR PLACING BARRICADES USING FLAG MEN, ETC. AS NECESSARY TO ENSURE SAFETY TO THE PUBLIC.
3. ALL PAVEMENT CUTS, CONCRETE OR ASPHALT, ARE TO BE REPLACED ACCORDING TO STANDARDS OF THE NORTH CAROLINA DEPARTMENT OF TRANSPORTATION.
4. SHORING SHALL BE ACCORDING TO OSHA TRENCHING STANDARDS PART 1926 SUBPART P, OR AS AMENDED.

GRAPHIC SCALE(S)

1"=40' — 0, 20', 40', 80', 160'

DEPARTMENT OF NATURAL AND CULTURAL RESOURCES

VISITOR CENTER AND UNDERWATER ARCHAEOLOGY BUILDING AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S,
KURE BEACH, NC 28449

SCO #: 16-16311-02A
CODE: 41614
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DESIGNER

CLARKNEXSEN
333 FAYETTEVILLE STREET, SUITE 1000
RALEIGH, NORTH CAROLINA 27601
919·828·1876

CLARK NEXSEN LICENSE NUMBER: C-1028

PROFESSIONAL SEAL

NORTH CAROLINA PROFESSIONAL SEAL 13722 ENGINEER CHRISA C. MITCHELL

SUBMITTAL

APRIL 29, 2022

BID SET

REVISIONS

1	06/16/22	ADDENDUM NO. 2

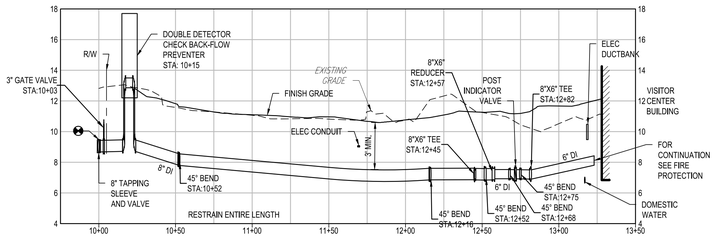
SHEET

UTILITY PLAN

CU101

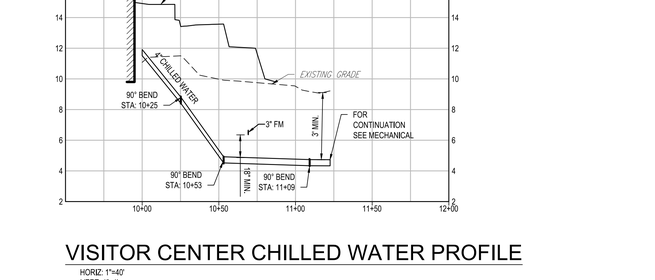
DESIGN: CMM
DRAWN: ZTK
REVIEW: DMP

CN 7173



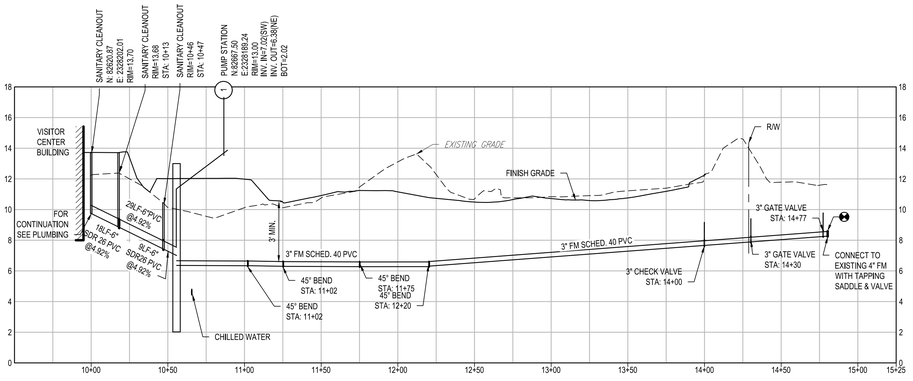
VISITOR CENTER FIRE WATER PROFILE

HORIZ: 1"=40'
VERT: 1"=4'



VISITOR CENTER DOMESTIC WATER PROFILE

HORIZ: 1"=40'
VERT: 1"=4'

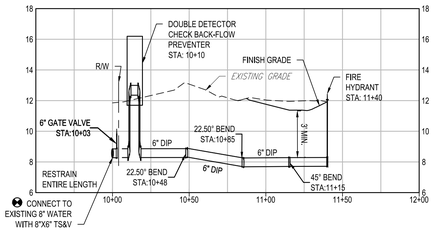


VISITOR CENTER SANITARY PROFILE

HORIZ: 1"=40'
VERT: 1"=4'

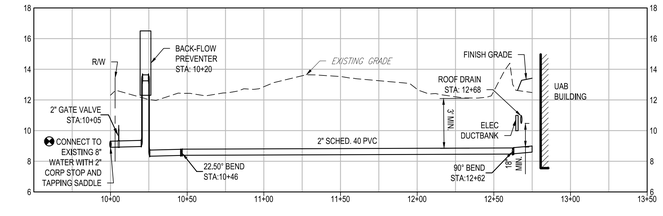
VISITOR CENTER CHILLED WATER PROFILE

HORIZ: 1"=40'
VERT: 1"=4'



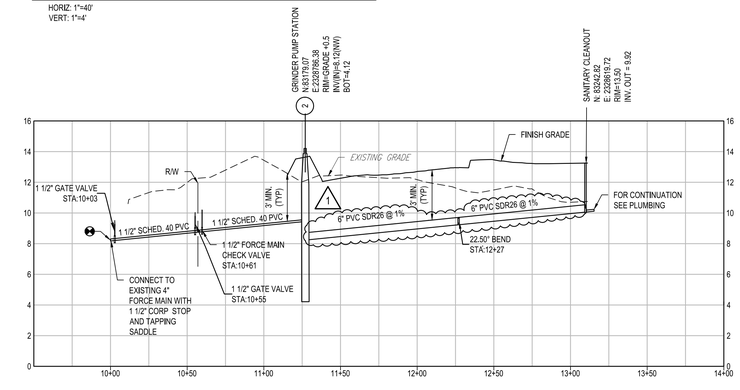
UAB FIRE WATER PROFILE

HORIZ: 1"=40'
VERT: 1"=4'



UAB DOMESTIC WATER PROFILE

HORIZ: 1"=40'
VERT: 1"=4'



UAB SANITARY PROFILE

HORIZ: 1"=40'
VERT: 1"=4'

1 NOTE: ALL UTILITY LINES BELOW GROUND WATER AND FLOODPLAIN BASE FLOOD ELEVATIONS ARE TO BE SEALED, PROTECTED FROM WATER INTRUSION, TESTED AND INSPECTED PRIOR TO COMMISSIONING.

811 Know what's **below.** **Call** before you dig.

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2. CONTRACTOR IS RESPONSIBLE FOR PLACING BARRICADES USING FLAG MEN, ETC. AS NECESSARY TO ENSURE SAFETY TO THE PUBLIC.
3. ALL PAVEMENT CUTS, CONCRETE OR ASPHALT, ARE TO BE REPLACED ACCORDING TO STANDARDS OF THE NORTH CAROLINA DEPARTMENT OF TRANSPORTATION.
4. SHORING SHALL BE ACCORDING TO OSHA TRENCHING STANDARDS PART 1926 SUBPART P, OR AS AMENDED.

GRAPHIC SCALE(S)

1"=40' 0 20' 40' 80' 160'
1"=4' 0 2' 4' 8' 16'

DEPARTMENT OF NATURAL AND CULTURAL RESOURCES

VISITOR CENTER AND UNDERWATER ARCHAEOLOGY BUILDING AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S,
KURE BEACH, NC 28449

SCO #: 16-16311-02A
CODE: 41614
ITEM: 4C01

DESIGNER
CLARKNEXSEN
333 FAYETTEVILLE STREET, SUITE 1000
RALEIGH, NORTH CAROLINA 27601
919-828-1876

CLARK NEXSEN LICENSE NUMBER: C-1028
PROFESSIONAL SEAL

NORTH CAROLINA PROFESSIONAL SEAL 13722 ENGINEER CHRISTOPHER C. MITCHELL

SUBMITTAL
APRIL 29, 2022
BID SET

REVISIONS

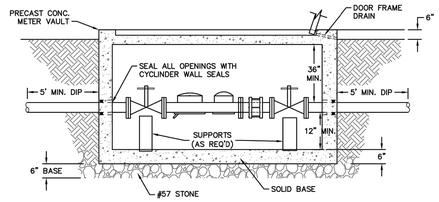
1	06/16/22	ADDENDUM NO. 2

SHEET
UTILITY PROFILES

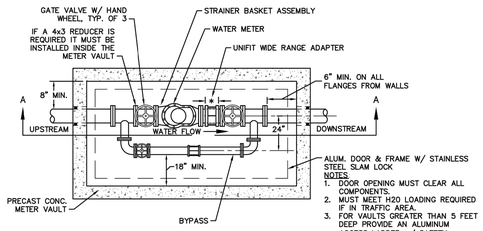
CU201

DESIGN: CMM
DRAWN: ZTK
REVIEW: DMP

CN 7173



METER VAULT SECTION A-A



METER VAULT PLAN

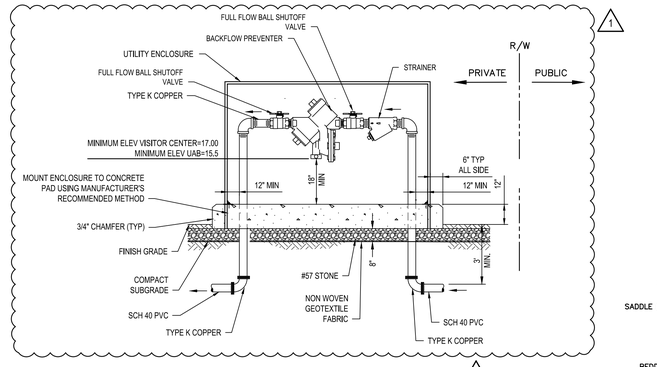
NOTES
1. DOOR OPENING MUST CLEAR ALL COMPONENTS.
2. MUST MEET H20 LOADING REQUIRED IF IN TRAFFIC AREA.
3. FOR VAULTS GREATER THAN 5 FEET DEEP PROVIDE AN ALUMINUM ACCESS LADDER w/ SAFETY EXTENSION AND NON-SKID RUNGS @ 12" o/c ANCHORED TO THE WALL.

Meter Size	By-Pass Size
3"	4"
4"	4"
6"	4"
8"	4"
10"	6"
12"	8"

* UNIFIT WIDE RANGE ADAPTER IS BOLTED DIRECTLY TO METER, ONLY ONE PE-FLG PIECE THAT IS 3 TIMES THE PIPE DIAMETER.

COMMERCIAL WATER SERVICE - 3-INCH AND LARGER METERS

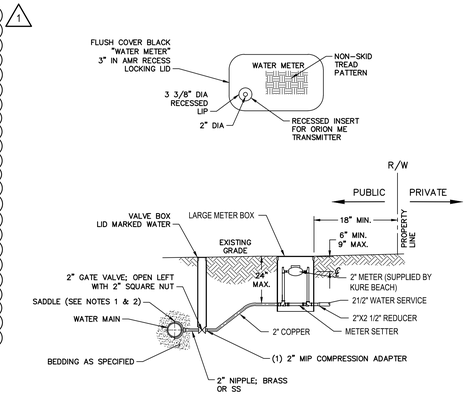
NO SCALE



NOTES:
1. ONLY IN-LINE TESTABLE ASSEMBLIES APPROVED BY THE USC FOUNDATION FOR CROSS CONNECTION CONTROL OR ASSE SHALL BE ACCEPTED.
2. PIPING ABOVE GRADE SHALL BE TYPE K COPPER WITH THREADED, LEAD FREE BRONZE FITTINGS.
3. THE WEATHER ENCLOSURE SHALL BE INSULATED AND HEATED. THE HEATER SHALL BE PROVIDED BY THE ENCLOSURE MANUFACTURER.
4. THE ENCLOSURE SHALL COMPLY TO ASSE 1060.
5. THE ENCLOSURE SHALL HAVE DRAIN PORT SIZED FOR MAXIMUM RPZ DISCHARGE.
6. THE 4" THICK CONCRETE PAD SHALL BE A MINIMUM OF 6" LARGER ON ALL SIDES FROM THE UTILITY ENCLOSURE EXTERIOR WALLS.

REDUCED PRESSURE PRINCIPLE ASSEMBLY BACKFLOW PREVENTER DETAIL

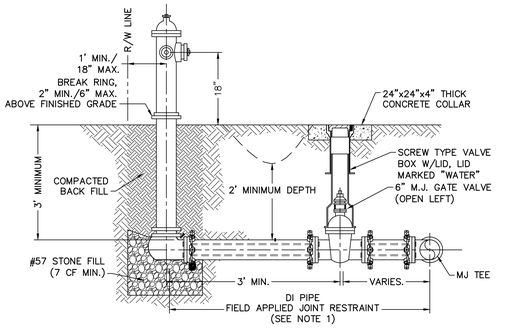
NO SCALE



NOTES:
1. WATER SERVICE SHALL BE INSTALLED PERPENDICULAR TO MAIN AND TERMINATE 18" INSIDE THE RIGHT-OF -WAY WHEN POSSIBLE
2. SERVICE SADDLES ON PVC MAINS SHALL BE WIDE BAND BRASS BODY.
3. METER BOXES SUSCEPTIBLE TO TRAFFIC SHALL CONFORM TO ASTM A48, CLASS 30B AND AASHTO H20 LOAD RATING STANDARDS
4. 3" OF CLEAN FILL IS REQUIRED AROUND SERVICE LINE.
5. SERVICE PIPING AND METER ARE TO BE CENTERED IN THE METER BOX.
6. METER BOX SHALL BE CARLSON 1730-18 BCF-XL OR EQUAL

2" CORPORATION STOP AND TAPPING SADDLE

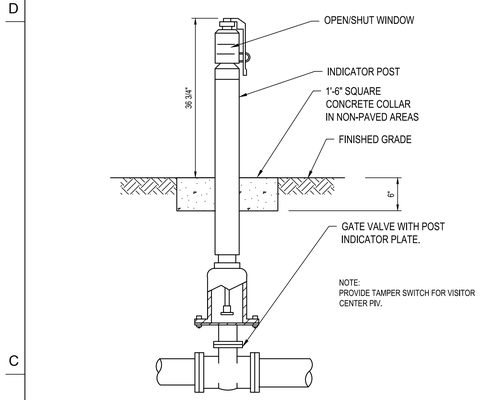
NO SCALE



NOTES:
1. JOINT RESTRAINT SYSTEMS SHALL BE WEDGE ACTION STYLE FOR D.I.
2. WHEN HYDRANT LEGS REQUIRE FULL LENGTH PIPE SECTIONS, OVER BELL RESTRAINT SYSTEM SHALL HAVE 316 STAINLESS STEEL HARNESS AND FASTENERS.
3. HYDRANT SHALL BE PLACED OUTSIDE DITCH LIMITS.
4. MJ TEE SHALL BE RESTRAINED ON EACH SIDE OF THE MAIN PLUS MAIN VALVES, FITTING, OR JOINTS WITHIN 10 FEET OF MJ TEE.
5. TRACER WIRE SHALL EXTEND ALONG HYDRANT LATERAL AND UP TO FINISHED GRADE WITH 2 FEET EXTENDED ABOVE THE BREAK RING OF HYDRANT.

FIRE HYDRANT ASSEMBLY DETAIL

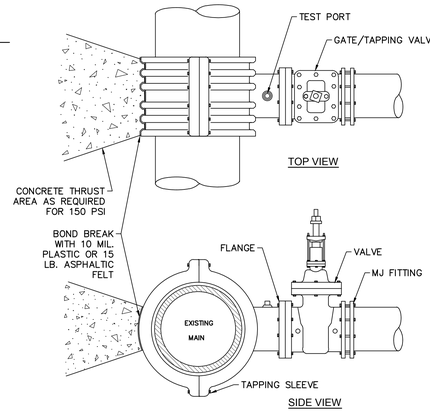
NO SCALE



NOTE:
PROVIDE TAMPER SWITCH FOR VISITOR CENTER PIV.

POST INDICATOR VALVE DETAIL

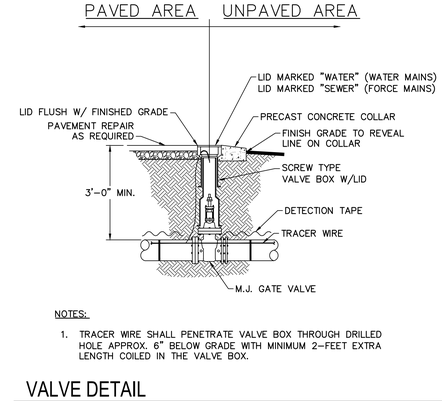
NO SCALE



NOTES:
1. CONCRETE SHALL NOT CONTACT BOLTS OR ENDS OF MECHANICAL JOINT FITTINGS.
2. PIPE & FITTING TO BE WRAPPED IN 10 MIL. PLASTIC OR 15 LB. ASPHALTIC FELT PRIOR TO THRUST BLOCK BEING POURED.
3. TEST PRESSURE SHALL NOT BE APPLIED FOR A MINIMUM OF 7 DAYS AFTER THRUST BLOCK PLACEMENT.

TAPPING SLEEVE AND VALVE DETAIL

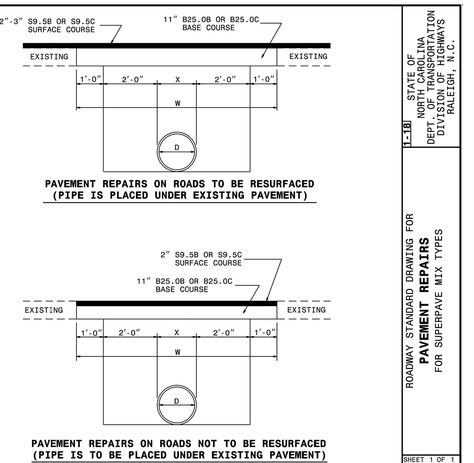
NO SCALE



NOTES:
1. TRACER WIRE SHALL PENETRATE VALVE BOX THROUGH DRILLED HOLE APPROX. 6" BELOW GRADE WITH MINIMUM 2-FEET EXTRA LENGTH COILED IN THE VALVE BOX.

VALVE DETAIL

NO SCALE



PAVEMENT REPAIRS ON ROADS TO BE RESURFACED (PIPE IS PLACED UNDER EXISTING PAVEMENT)

D	X	W
12"	1'-4"	7'-4"
15"	1'-7"	7'-7"
18"	1'-10"	7'-10"
24"	2'-6"	8'-6"
30"	3'-1"	9'-1"
36"	3'-8"	9'-8"
42"	4'-5"	10'-5"
48"	5'-0"	11'-0"

PAVEMENT REPAIRS ON ROADS NOT TO BE RESURFACED (PIPE IS TO BE PLACED UNDER EXISTING PAVEMENT)

ROADWAY STANDARD DRAWING FOR
PAVEMENT REPAIRS
FOR SUPERPAVE MIX TYPES

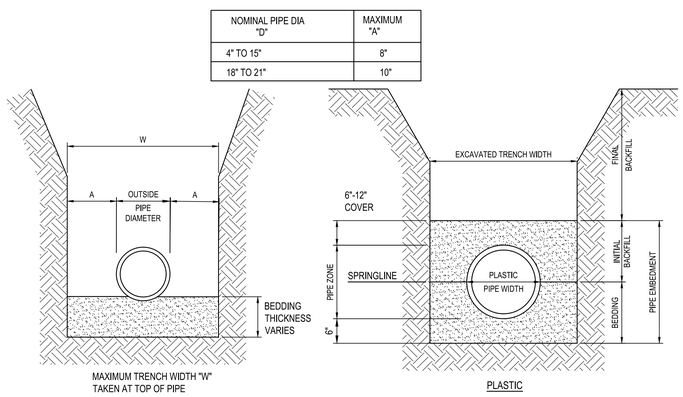
STATE OF NORTH CAROLINA
DEPT. OF TRANSPORTATION
DIVISION OF HIGHWAYS
RALEIGH, N.C.
1-18

SHEET 1 OF 1
654.01

PAVEMENT REPAIRS

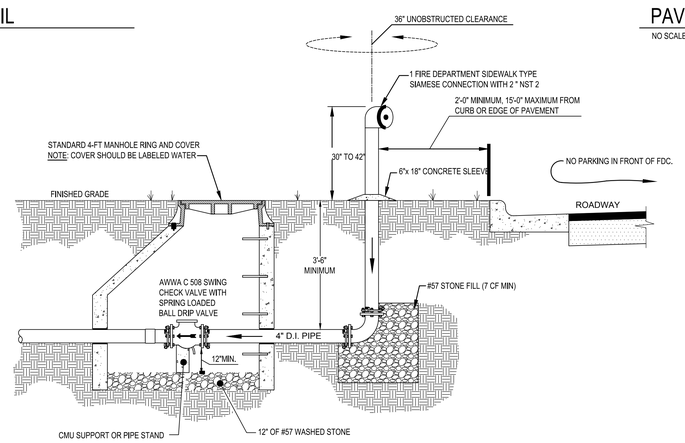
NO SCALE

NOMINAL PIPE DIA "D"	MAXIMUM "A"
4" TO 15"	8"
18" TO 21"	10"



PIPE TRENCH DETAIL

NO SCALE



NOTES:
1. JOINT RESTRAINT SYSTEMS SHALL BE WEDGE ACTION STYLE FOR D.I.
2. FULL LENGTH PIPE SECTIONS, OVER BELL RESTRAINT SYSTEM SHALL HAVE 316 STAINLESS STEEL HARNESS AND FASTENERS.
3. TRACER WIRE SHALL EXTEND ALONG LATERAL AND UP TO FINISHED GRADE WITH 2 FEET EXTENDED ABOVE THE BREAK RING OF HYDRANT.

FIRE DEPARTMENT CONNECTION

NO SCALE

811 Know what's **below.** **Call** before you dig.

1. CONTRACTOR IS RESPONSIBLE FOR CONTACTING APPROPRIATE PARTIES AND ASSURING THAT EXISTING UTILITIES ARE LOCATED PRIOR TO CONSTRUCTION.
2. CONTRACTOR IS RESPONSIBLE FOR PLACING BARRICADES USING FLAG MEN, ETC. AS NECESSARY TO ENSURE SAFETY TO THE PUBLIC.
3. ALL PAVEMENT CUTS, CONCRETE OR ASPHALT, ARE TO BE REPLACED ACCORDING TO STANDARDS OF THE NORTH CAROLINA DEPARTMENT OF TRANSPORTATION.
4. SHORING SHALL BE ACCORDING TO OSHA TRENCHING STANDARDS PART 1926 SUBPART P, OR AS AMENDED.

DEPARTMENT OF NATURAL AND CULTURAL RESOURCES

VISITOR CENTER AND UNDERWATER ARCHAEOLOGY BUILDING AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S.
KURE BEACH, NC 28449

SCO #: 16-16311-02A
CODE: 41614
ITEM: 4C01

DESIGNER

CLARKNEXSEN
333 FAYETTEVILLE STREET, SUITE 1000
RALEIGH, NORTH CAROLINA 27601
919-828-1876

CLARK NEXSEN LICENSE NUMBER: C-1028

PROFESSIONAL SEAL

NORTH CAROLINA PROFESSIONAL SEAL 13722 ENGINEER CHRISTOPHER C. MITCHELL

SUBMITTAL
APRIL 29, 2022
BID SET

REVISIONS

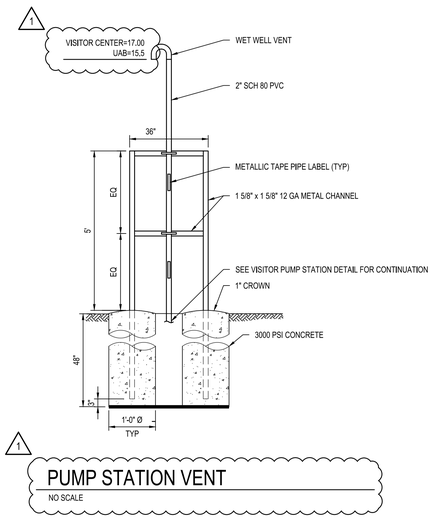
1	06/16/22	ADDENDUM NO. 2

SHEET
UTILITY DETAILS

CU501

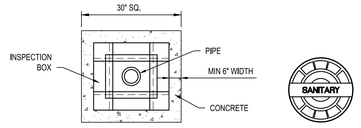
DESIGN: CMM
DRAWN: ZTK
REVIEW: DMP

CN 7173

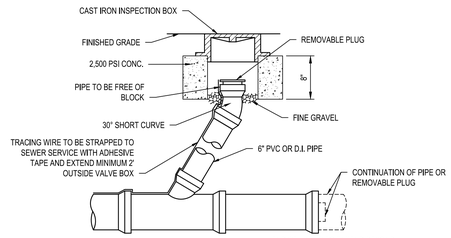


PUMP STATION VENT

NO SCALE



NOTE:
1. CLEANOUT BOX TO BE MARKED SANITARY SEWER.
2. INSPECTION BOX MUST BE RATED FOR H-20 LOADING WHEN LOCATED IN PAVEMENT AREAS.
3. WHEN LOCATED IN CONCRETE PAVEMENT, OMIT CONCRETE COLLAR AND INSTALL INSPECTION BOX IN PAVEMENT SECTION.



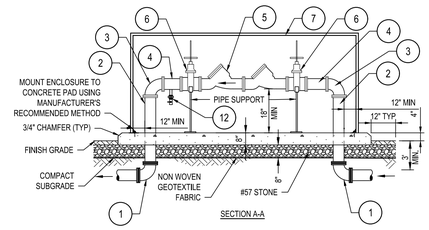
NOTE:
CLEANOUT PIPE MUST BE FREE OF ANY WEIGHT TRANSMITTED BY THE INSPECTION BOX

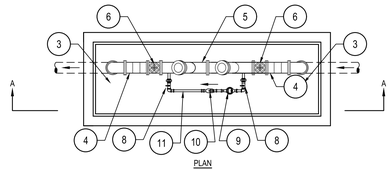
CLEANOUT DETAIL

NO SCALE

FITTING SCHEDULE			
NO.	SIZE (VISITOR)	SIZE (UAB)	DESCRIPTION
1	8"	6"	RESTRAINED MJ DI 90° ELBOW
2	8"	6"	FLANGED TO PLAIN END DI PIPE
3	8"	6"	FLANGED LONG RADIUS DI 90° ELBOW
4	8"	6"	FLANGED DI SPOOL PIPE
5	8"	6"	DOUBLE DETECTOR CHECK
6	8"	6"	OS & Y FLANGED GATE VALVE
7	-	-	UTILITY ENCLOSURE WITH HEAT, PROVIDE LOW TEMP SWITCH
8	3/4"	3/4"	FULL FLOW BRONZE BALL SHUTOFF VALVE
9	3/4"	3/4"	WATER METER - GALLONS
10	3/4"	3/4"	DOUBLE CHECK BACKFLOW
11	3/4"	3/4"	TYPE K COPPER PIPING AND FITTINGS

NOTES:
1. ONLY IN-LINE TESTABLE ASSEMBLIES APPROVED BY THE USC FOUNDATION FOR CROSS CONNECTION CONTROL OR ASSE SHALL BE ACCEPTED.
2. THE TOP OF THE VALVE STEM SHALL BE A MINIMUM OF 6" FROM THE INSIDE TOP OF THE UTILITY ENCLOSURE
3. THIS UTILITY ENCLOSURE SHALL BE HEATED AND INSULATED TO PREVENT FREEZING. THE UNIT HEATERS SHALL BE PROVIDED BY ENCLOSURE MANUFACTURER, AND MUST BE LISTED FOR DAMP/ WET LOCATIONS.
4. THIS ENCLOSURE SHALL HAVE ACCESS DOORS ON EACH SIDE FOR MAINTENANCE.
5. THE CONCRETE PAD SHALL BE 6" LARGER ON ALL SIDES THAN THE UTILITY ENCLOSURE EXTERIOR WALLS.
6. THE ENCLOSURE SHALL COMPLY TO ASSE 1060.



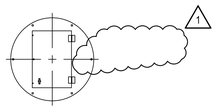


FIRE DOUBLE DETECTOR CHECK BACKFLOW PREVENTER DETAIL

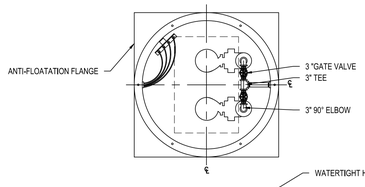
NO SCALE

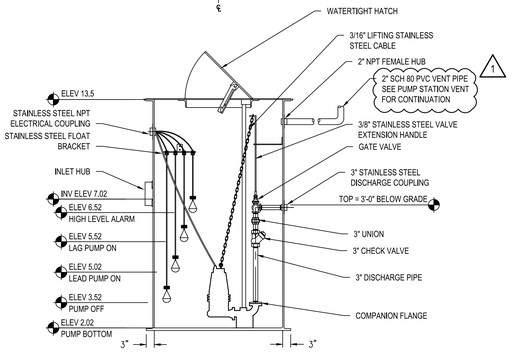
VISITOR CENTER PUMP STATION

1. DUPLEX BARNES SGV3032L 3 HP AT 63 GPM @ 28 TDH, 3450 RPM, 208V, 3 PHASE WITH 4.12" DIAMETER IMPELLER OR EQUAL.
2. 5' DIAMETER X 8.98' DEEP PREFABRICATED FIBERGLASS BASIN WITH RAIL PACKAGE. ALL RAILS AND INTERIOR HARDWARE SHALL BE 304 STAINLESS STEEL. THE BASIN ACCESS TOP AND HATCH SHALL BE ALUMINUM.
3. CONTRACTOR SHALL PROVIDE A BUOYANCY PAD. THE PAD SHALL BE DESIGNED, SEALED AND SIGNED BY A LICENSED PROFESSIONAL ENGINEER.
   SECURE PUMP STATION BASIN TO BUOYANCY PAD PER THE MANUFACTURER'S RECOMMENDATION.
4. PROVIDE NEMA 4X CONTROL PANEL (FIBERGLASS OR STAINLESS STEEL) WITH BATTERY BACKUP FOR ALARM SYSTEM. THE FOLLOWING CONDITIONS SHALL INITIATE THE ALARM SYSTEM.
   a. HIGH WATER
   b. PUMP FAILURE (FLOW FAILURE)
   c. LOSS OF POWER
5. COORDINATE THE LOCATION FOR THE MOUNTING OF THE CONTROL PANEL.
6. THE DESIGN IS BASED ON THE BARNES SGV3032 PUMP WITH CONTROLS AND APPUTENANCES OR APPROVED EQUAL. CONTRACTOR SHALL SUBMIT SHOP DRAWINGS FOR APPROVAL.



HINGED AND LOCKABLE COVER



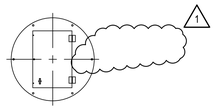


VISITOR CENTER GRINDER PUMP STATION ①

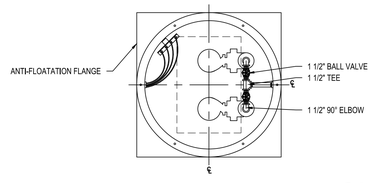
NO SCALE

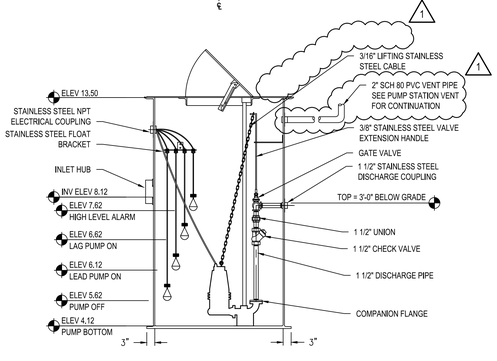
UNDERWATER ARCHAEOLOGY BUILDING PUMP STATION

1. DUPLEX BARNES SGVH2032L 2 HP AT 20 GPM @ 19 TDH, 3450 RPM, 208V, 3 PHASE WITH 3.50" DIAMETER IMPELLER OR EQUAL.
2. 5' DIAMETER X 6.67' DEEP PREFABRICATED FIBERGLASS BASIN WITH RAIL PACKAGE. ALL RAILS AND INTERIOR HARDWARE SHALL BE 304 STAINLESS STEEL. THE BASIN ACCESS TOP AND HATCH SHALL BE ALUMINUM.
3. CONTRACTOR SHALL PROVIDE A BUOYANCY PAD. THE PAD SHALL BE DESIGNED, SEALED AND SIGNED BY A LICENSED PROFESSIONAL ENGINEER.
   SECURE PUMP STATION BASIN TO BUOYANCY PAD PER THE MANUFACTURER'S RECOMMENDATION.
4. PROVIDE NEMA 4X CONTROL PANEL (FIBERGLASS OR STAINLESS STEEL) WITH BATTERY BACKUP FOR ALARM SYSTEM. THE FOLLOWING CONDITIONS SHALL INITIATE THE ALARM SYSTEM.
   a. HIGH WATER
   b. PUMP FAILURE (FLOW FAILURE)
   c. LOSS OF POWER
5. COORDINATE THE LOCATION FOR THE MOUNTING OF THE CONTROL PANEL.
6. THE DESIGN IS BASED ON THE BARNES SGVH2032L PUMP WITH CONTROLS AND APPUTENANCES OR APPROVED EQUAL. CONTRACTOR SHALL SUBMIT SHOP DRAWINGS FOR APPROVAL.



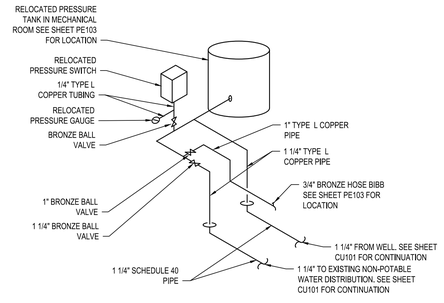
HINGED AND LOCKABLE COVER





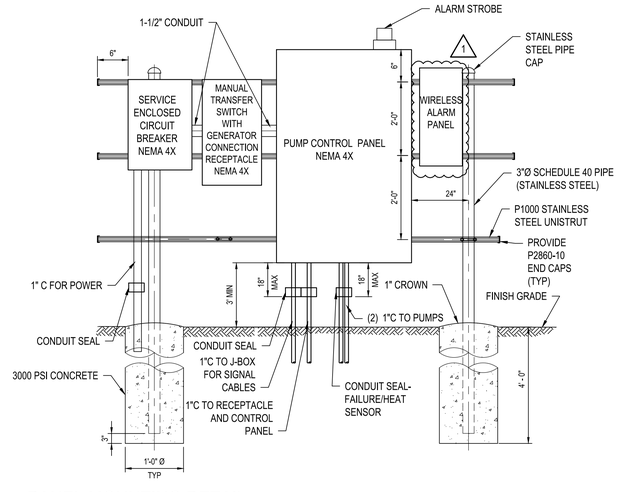
UAB BUILDING GRINDER PUMP STATION ②

NO SCALE



NON-POTABLE WATER PRESSURE TANK DIAGRAM

NO SCALE



PANEL MOUNTING DETAIL

NO SCALE

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DEPARTMENT OF NATURAL AND CULTURAL RESOURCES

VISITOR CENTER AND UNDERWATER ARCHAEOLOGY BUILDING AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S.
KURE BEACH, NC 28449

SCO #: 16-16311-02A
CODE: 41614
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DESIGNER

CLARKNEXSEN

333 FAYETTEVILLE STREET, SUITE 1000
RALEIGH, NORTH CAROLINA 27601
919-828-1876

CLARK NEXSEN LICENSE NUMBER: C-1028

PROFESSIONAL SEAL

SUBMITTAL

APRIL 29, 2022

BID SET

REVISIONS

1	06/16/22	ADDENDUM NO. 2

SHEET

UTILITY DETAILS

CU502

DESIGN: CMM
DRAWN: ZTK
REVIEW: DMP

CN 7173

DISTRIBUTION PANEL MDP SCHEDULE

800 AMP MCB 480Y/277 VOLTS 3PH, 4W, SN MIN. 22 KAIC SURFACE MOUNTED SE RATED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	PANEL M1	2	1/0	150	59.6	16.5	A	7.0	25.2	100	1	1-1/2	PANEL L1	2
3					59.6	16.5	B	4.5	16.3					4
5					59.6	16.5	C	6.6	23.8					6
7	AHU-1 - ELECTRIC HEAT	2-1/2	4/0	225	166.7	20.0	A	48.7	175.8	175	2/0	1-1/2	PANEL SDP	8
9	60 KW				166.7	20.0	B	44.3	160.0				FED VIA XFMR X-SDP (112.5 KVA)	10
11					166.7	20.0	C	45.4	164.1					12
13	ELEVATOR	1-1/4	4	60	34.0	9.4	A	43.3	156.4	300	350	3	AIR-COOLED CHILLER	14
15	25 HP				34.0	9.4	B	43.3	156.4					16
17					34.0	9.4	C	43.3	156.4					18
19	PANEL M2	2-1/2	4/0	225	175.3	48.6	A			100			SPARE	20
21					123.4	34.2	B							22
23					158.8	44.0	C							24
25	PANEL L2	1-1/2	1	100	4.1	1.1	A			100			SPARE	26
27					1.3	0.4	B							28
29					4.5	1.2	C							30
31	BUSSED SPACE						A						BUSSED SPACE	32
33							B							34
35							C							36
37	SURGE PROTECTIVE DEVICE (SPD)	1/2	10	30			A						BUSSED SPACE	38
39							B							40
41							C							42

TOTAL AMPS (CONN. LOAD) A: 702.5 B: 623.1 C: 673.3
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 702.5 B: 623.1 C: 673.3

PANELBOARD OPTIONS:
1. PROVIDE WITH DIGITAL MULTIMETER.
2. PROVIDE 100% RATED MCB.
3. PROVIDE EXTERNALLY MOUNTED SPD.

PANELBOARD NOTES:

LOAD DESCRIPTION	PANEL CONN LOAD		SUBFEED CONN LOAD		FEEDTHRU CONN LOAD	TOTAL LOAD		D.F. MULT.	TOTAL KVA DEMAND	
LIGHTING		KVA	13.6	KVA	KVA	13.6	KVA	1.00	13.6	KVA
RECEPTACLES		KVA	61.1	KVA	KVA	61.1	KVA	NEC	35.6	KVA
MECH EQUIP	130.0	KVA	67.3	KVA	KVA	197.2	KVA	1.00	197.2	KVA
ELECTRIC HEAT	60.0	KVA	132.7	KVA	KVA	192.7	KVA	1.00	192.7	KVA
PUMPS		KVA	21.4	KVA	KVA	21.4	KVA	1.00	21.4	KVA
MISCELLANEOUS		KVA	32.9	KVA	KVA	32.9	KVA	1.00	32.9	KVA
ELEVATOR	28.3	KVA	0.6	KVA	KVA	28.9	KVA	0.80	23.1	KVA
EXTERIOR LIGHTING		KVA	2.6	KVA	KVA	2.6	KVA	1.00	2.6	KVA
EARTHWORKS LTG		KVA	1.4	KVA	KVA	1.4	KVA	1.00	1.4	KVA
		KVA		KVA	KVA		KVA			KVA
		KVA		KVA	KVA		KVA			KVA
		KVA		KVA	KVA		KVA			KVA
TOTALS (CONN. KVA)	218.2	KVA	333.4	KVA	KVA	551.7	KVA		520.3	KVA
TOTALS (CONN. KVA + 20%)	261.9	KVA	400.1	KVA	KVA	662.0	KVA		624.4	KVA
TOTALS (CONN. AMPS)	262.5	AMPS	401.1	AMPS	AMPS	663.5	AMPS		625.9	AMPS
TOTALS (CONN. AMPS + 20%)	315.0	AMPS	481.3	AMPS	AMPS	796.3	AMPS		751.0	AMPS

PANEL M1 SCHEDULE

150 AMP MLO 480Y/277 VOLTS 3PH, 4W, SN MIN. 14 KAIC SURFACE MOUNTED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	AHU-1	3/4	8	40	21.0	5.8	A	3.0	10.8	15	12	1/2	WH-1	2
3	SUPPLY FAN				21.0	5.8	B	3.0	10.8				9 KW	4
5	2 @ 15 HP				21.0	5.8	C	3.0	10.8					6
7	RF-1	3/4	8	40	21.0	2.5	A			15			SPARE	8
9	15 HP				21.0	2.5	B							10
11					21.0	2.5	C							12
13	CHP-1	1/2	12	15	7.6	2.1	A			15			SPARE	14
15	5 HP				7.6	2.1	B							16
17					7.6	2.1	C							18
19	CHP-2	1/2	12	15	7.6	2.1	A			15			SPARE	20
21	5 HP				7.6	2.1	B							22
23					7.6	2.1	C							24
25	EF-1	1/2	12	15	3.4	0.9	A						BUSSED SPACE	26
27	2 HP				3.4	0.9	B							28
29					3.4	0.9	C							30
31	BUSSED SPACE						A						BUSSED SPACE	32
33							B							34
35							C							36
37	BUSSED SPACE						A						BUSSED SPACE	38
39							B							40
41							C							42

TOTAL AMPS (CONN. LOAD) A: 59.6 B: 59.6 C: 59.6
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 59.6 B: 59.6 C: 59.6

PANELBOARD OPTIONS:

PANELBOARD NOTES:

PANEL M2 SCHEDULE

225 AMP MLO 480Y/277 VOLTS 3PH, 4W, SN MIN. 14 KAIC SURFACE MOUNTED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	PFPB-1-02	1/2	12	20	6.1	1.7	A	5.5	19.9	60	4	1-1/4	PFPB-2-06	2
3	PFPB-1-03	1/2	12	20	6.1	1.7	B	6.6	23.8	60	4	1-1/4	PFPB-2-04	4
5	PFPB-1-04	1	6	45	20.9	5.8	C	5.9	21.3	60	4	1-1/4	PFPB-2-03	6
7	PFPB-1-05	1-1/4	4	60	33.9	9.4	A	1.2	4.3	20	12	1/2	PFPB-2-07	8
9	PFPB-1-06	1/2	12	20	6.9	1.9	B	11.5	41.5	60	4	1-1/4	SFPB-2-02	10
11	PFPB-1-07	1/2	12	20	6.5	1.8	C	6.8	24.5	60	4	1-1/4	SFPB-2-01	12
13	PFPB-1-08	1-1/4	4	60	20.6	5.7	A	7.9	28.5	60	4	1-1/4	SFPB-2-08	14
15	PFPB-1-10	1	6	50	15.9	4.4	B	4.8	17.3	25	10	1/2	CAV-2-09	16
17	SFPB-1-01	3/4	8	40	37.9	10.5	C	2.1	7.6	15	12	1/2	CAV-2-12	18
19	VAV-1-11	1/2	12	15	1.0	0.3	A	2.5	9.0	15	12	1/2	CAV-2-05	20
21	SPARE			20			B	1.9	6.9	15	12	1/2	VAV-2-13	22
23	SPARE			20			C	9.7	35.0	45	6	1	CAV-2-10	24
25	SPARE			20			A	14.4	51.9	60	4	1-1/4	CAV-2-11	26
27	SPARE			20			B			20			SPARE	28
29	SPARE			20			C			20			SPARE	30
31	SPARE			20			A			20			SPARE	32
33	SPARE			20			B			20			SPARE	34
35	SPARE			20			C			20			SPARE	36
37	SPARE			20			A			20			SPARE	38
39	SPARE			20			B	1.4	5.0	20	10	1	HEAT TRACE AT CHILLER - NOTE 1, 2, 3, 4	40
41	SPARE			20			C	1.4	5.0	20	12	1/2	HEAT TRACE AT BUILDING - NOTE 1, 2, 4	42

TOTAL AMPS (CONN. LOAD) A: 175.3 B: 123.4 C: 158.8
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 175.3 B: 123.4 C: 158.8

PANELBOARD OPTIONS:

PANELBOARD NOTES:
1. PROVIDE WITH 30MA GROUND FAULT EQUIPMENT PROTECTION.
2. COORDINATE BREAKER SIZE WITH LENGTH AND WATTAGE OF HEAT TRACE PROVIDED.
3. WIRE UPSIZED FOR VOLTAGE DROP.
4. PROVIDE LOCKABLE CIRCUIT BREAKER.

PANEL L1 SCHEDULE

100 AMP MLO 480Y/277 VOLTS 3PH, 4W, SN MIN. 14 KAIC SURFACE MOUNTED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	LTG: TRACK GIFT SHOP	1/2	12	20	2.5	0.7	A	1.1	4.0	20	12	1/2	LTG: ELEV PIT	2
3	LTG: TRACK GIFT SHOP	1/2	12	20	2.5	0.7	B	1.5	5.5	20	12	1/2	LTG: OPEN OFFICE, BREAK, COPY, TOILETS	4
5	LTG: MECH, CORR, STORAGE	1/2	12	20	3.3	0.9	C	0.3	0.9	20	12	1/2	LTG: EXTERIOR NORTH	6
7	LTG: NOTE 1	1/2	12	20	4.8	1.3	A	1.9	6.9	20	12	1/2	LTG: MULTI-PURPOSE	8
9	LTG: EXTERIOR WEST	1/2	12	20	0.8	0.2	B	0.2	0.9	20	12	1	LTG: EXTERIOR SOUTH	10
11	LTG: EXTERIOR EAST	1/2	12	20	0.9	0.3	C	0.6	2.0	20	12	1/2	LTG: EXTERIOR PATIO	12
13	LTG: ELEV HOIST WAY	1/2	12	20	0.1		A	1.4	5.0	20	6	1	LTG AND EF: SALLEYPORT - NOTE 3	14
15	LTG: NOTE 2	1/2	12	20	4.7	1.3	B	0.6	2.0	20	12	1/2	VISTOR CENTER ENTRANCE SIGNAGE	16
17	LTG: CHANGING EXHIBIT TRACK CKT 2	1/2	12	20	1.5	0.4	C			20			SPARE	18
19	LTG: SITE BOLLARDS - NOTE 3	1	10	20	2.0	0.6	A			20			SPARE	20
21	SPARE			20			B			20			SPARE	22
23	SPARE			20			C			20			SPARE	24
25	SPARE			20			A			20			SPARE	26
27	SPARE			20			B			20			SPARE	28
29	SPARE			20			C	4.2	15.2	30	10	1/2	LIGHTING INVERTER "INV"	30

TOTAL AMPS (CONN. LOAD) A: 25.2 B: 16.3 C: 23.8
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 25.2 B: 16.3 C: 23.8

PANELBOARD OPTIONS:

PANELBOARD NOTES:
1. STORAGE, SHOWER, WORKSHOP, TELECOM, ELEC, CONFERENCE, OFFICES.
2. CORRIDORS, RESTROOMS, STORAGE, KITCHEN, JANITOR, STAIR, CHANGING EXHIBIT.
3. WIRE UPSIZED FOR VOLTAGE DROP.

PANEL L2 SCHEDULE

100 AMP MLO 480Y/277 VOLTS 3PH, 4W, SN MIN. 14 KAIC SURFACE MOUNTED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	LTG: ORIENTATION, STOR, AV, STAIR	1/2	12	20	3.0	0.8	A			20			SPARE	2
3	LTG: EXHIBIT 240	1/2	12	20	0.9	0.3	B			20			SPARE	4
5	LTG: UPPER LOBBY 201	1/2	12	20	0.8	0.2	C			20			SPARE	6
7	LTG: UPPER LOBBY 201	1/2	12	20	0.4	0.1	A			20			SPARE	8
9	LTG: EXHIBIT 240	1/2	12	20	0.4	0.1	B			20			SPARE	10
11	LTG: EXHIBIT 240	1/2	12	20	0.7	0.2	C			20			SPARE	12
13	LTG: EXHIBIT 240	1/2	12	20	0.7	0.2	A			20			SPARE	14
15	SPARE			20			B			20			SPARE	16
17	SPARE			20			C			20			SPARE	18
19	SPARE			20			A			20			SPARE	20
21	SPARE			20			B			20			SPARE	22
23	SPARE			20			C			20			SPARE	24
25	SPARE			20			A			20			SPARE	26
27	SPARE			20			B			20			SPARE	28
29	LIGHTING CONTROL PANEL LCP2	1/2	12	20	3.0	0.8	C			20			SPARE	30

TOTAL AMPS (CONN. LOAD) A: 4.1 B: 1.3 C: 4.5
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 4.1 B: 1.3 C: 4.5

PANELBOARD OPTIONS:

PANELBOARD NOTES:

PANEL INV SCHEDULE

60 AMP MLO 480Y/277 VOLTS 3PH, 4W, SN MIN. 10 KAIC SURFACE MOUNTED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	EMERG LTG: MECH, STAIR, CORR, GIFT	1/2	12	20	2.5	0.7	A	0.4	1.4	20	12	1/2	EMERG LTG: NOTE 1	2
3	EMERG LTG: EXTERIOR WEST	1/2	12	20	0.2	0.1	B	0.5	1.9	20	12	1/2	EMERG LTG: NOTE 2	4
5	EMERG LTG: EXTERIOR EAST	1/2	12	20	0.3	0.1	C	0.6	2.2	20	12	1/2	EMERG LTG: LOBBY, EXHIBIT, ORIENTATION	6
7	EMERG LTG: SALLEYPORT - NOTE 3	1	6	20	3.6	1.0	A		0.1	20	12	1/2	EMERG LTG: ELEV CTRL	8
9	SPARE			20			B			20			SPARE	10
11	LIGHTING CONTROL PANEL LCP1	1/2	12	20	3.0	0.8	C			20			SPARE	12

TOTAL AMPS (CONN. LOAD) A: 7.6 B: 2.1 C: 5.5
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 7.6 B: 2.1 C: 5.5

PANELBOARD OPTIONS:

PANELBOARD NOTES:
1. ELEC, CORRIDOR, OPEN OFFICE, RESTROOMS
2. MULTI-PURPOSE, CORRIDORS, STAIRS, RESTROOMS.
3. WIRE UPSIZED FOR VOLTAGE DROP.

PANEL SDP SCHEDULE

400 AMP MCB 208Y/120 VOLTS 3PH, 4W, SN MIN. 10 KAIC SURFACE MOUNTED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	PANEL R1	1-1/2	1	100	67.7	8.1	A	7.0	58.2	100	1	1-1/2	PANEL R2	2
3					57.1	6.9	B	6.6	54.9					4
5					66.7	8.0	C	6.8	56.3					6
7	PANEL R3	1-1/2	1	100	73.4	8.8	A	11.2	93.4	125	1	1-1/2	HU-1	8
9					59.3	7.1	B	11.2	93.4				28.1 KW	10
11					66.3	8.0	C	11.2	93.4					12
13	PANEL R4	1-1/2	1	100	41.2	4.9	A	0.6	4.8	15	10	1	WELL PUMP	14
15					32.7	3.9	B	0.6	4.8				NOTE 1, 2, 3	16
17					24.8	3.0	C	0.6	4.8					18
19	PANEL R5	1-1/2	1	100	40.9	4.9	A			100			SPARE	20
21					32.5	3.9	B							22
23					34.7	4.2	C							24
25	PANEL EM	1-1/2	1	100	7.5	0.9	A						BUSSED SPACE	26
27					7.5	0.9	B							28
29					4.5	0.5	C							30
31	GRINDER PUMP	1	10	30	18.7	2.2	A						BUSSED SPACE	32
33	(2) 3 HP				18.7	2.2	B							34
35					18.7	2.2	C			15			SPARE	36
37	BUSSED SPACE						A							38
39							B	1.0	9.6	15	12	1/2	UH-1	40
41							C	1.0	9.6				2KW	42

TOTAL AMPS (CONN. LOAD) A: 405.7 B: 369.2 C: 378.6
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 405.7 B: 369.2 C: 378.6

PANELBOARD OPTIONS:
1. PROVIDE 100% RATED MCB.

PANELBOARD NOTES:
1. FIELD VERIFY EXISTING WELL PUMP HORSEPOWER AND PROVIDE BREAKER, WIRE, AND CONDUIT SIZED ACCORDINGLY.
2. WIRE UPSIZED FOR VOLTAGE DROP.
3. PROVIDE LOCKABLE BREAKER. LOCK IN "OFF" POSITION.

PANEL EM SCHEDULE

100 AMP MLO 208Y/120 VOLTS 3PH, 4W, SN MIN. 10 KAIC SURFACE MOUNTED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	RCPT: CHANGING EXHIBIT - NOTE 1	1/2	10	20	1.5	0.2	A	0.2	1.5	20	8	1/2	RCPT: EXHIBIT - NOTE 1	2
3	RCPT: CHANGING EXHIBIT - NOTE 1	1/2	10	20	1.5	0.2	B	0.2	1.5	20	8	1/2	RCPT: EXHIBIT - NOTE 1	4
5	RCPT: MULTI-PURPOSE - NOTE 1	1/2	10	20	1.5	0.2	C	0.2	1.5	20	8	1/2	RCPT: EXHIBIT - NOTE 1	6
7	RCPT: MULTI-PURPOSE - NOTE 1	1/2	10	20	1.5	0.2	A	0.2	1.5	20	8	1/2	RCPT: ORIENTATION - NOTE 1	8
9	RCPT: EXHIBIT - NOTE 1	1/2	10	20	1.5	0.2	B	0.2	1.5	20	8	1/2	RCPT: ORIENTATION - NOTE 1	10
11	RCPT: CONFERENCE	1/2	12	20	1.5	0.2	C			20			SPARE	12
13	RCPT: OPEN OFFICE	1/2	12	20	1.5	0.2	A			20			SPARE	14
15	RCPT: GIFT SHOP	1/2	12	20	1.5	0.2	B			20			SPARE	16
17	SPARE			20			C			20			SPARE	18
19	SPARE			20			A			20			SPARE	20
21	SPARE			20			B			20			SPARE	22
23	SPARE			20			C			20			SPARE	24
25	SPARE			20			A			20			SPARE	26
27	SPARE			20			B			20			SPARE	28
29	SPARE			20			C			20			SPARE	30

TOTAL AMPS (CONN. LOAD) A: 7.5 B: 7.5 C: 4.5
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 7.5 B: 7.5 C: 4.5

PANELBOARD OPTIONS:

PANELBOARD NOTES:
1. WIRE UPSIZED FOR VOLTAGE DROP.

PANEL R1 SCHEDULE

100 AMP MLO 208Y/120 VOLTS 3PH, 4W, SN MIN. 10 KAIC SURFACE MOUNTED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	RCPT: OFFICE 111, 112	1/2	12	20	9.0	1.1	A	0.9	7.5	20	12	1/2	RCPT: CONFERENCE / LIBRARY 117	2
3	RCPT: OFFICE 112, 113	1/2	12	20	9.0	1.1	B	0.7	6.0	20	12	1/2	RCPT: CONFERENCE / LIBRARY 117	4
5	RCPT: BREAK OUT CONF 114	1/2	12	20	10.5	1.3	C	0.9	7.5	20	12	1/2	RCPT: CONFERENCE / LIBRARY 117	6
7	RCPT: FRIDGE BREAKRM 116 - NOTE 1	1/2	12	20	8.3	1.0	A	1.1	9.0	20	12	1/2	RCPT: OPEN OFFICE 110	8
9	RCPT: WATER COOLER - NOTE 1	1/2	12	20	3.1	0.4	B	1.1	9.0	20	12	1/2	RCPT: CORRIDOR 102, 104	10
11	RCPT: COPY 115	1/2	12	20	6.0	0.7	C	1.1	9.0	20	12	1/2	RCPT: WORKSHOP 120, STORAGE 124A	12
13	RCPT: BREAKROOM 116	1/2	12	20	1.5	0.2	A	0.5	4.5	20	12	1/2	RCPT: RESTROOMS 103, 105, 124B	14
15	RCPT: BREAKRM 116, STORAGE 116A	1/2	12	20	6.0	0.7	B	0.5	4.5	20	12	1/2	RCPT: ELECT 118, EXTERIOR	16
17	RCPT: TELECOM 119	1/2	12	20	3.0	0.4	C	1.0	8.3	20	10	1/2	RCPT: WATER COOLER - NOTE 1, 2	18
19	RCPT: TELECOM 119	1/2	12	20	3.0	0.4	A	0.5	4.5	20	12	1/2	RCPT: VESTIBULE 124, EXTERIOR	20
21	RCPT: TELECOM 119	1/2	12	20	3.0	0.4	B	0.4	3.0	20	12	1/2	RCPT: ELEVATOR PIT	22
23	RCPT: TELECOM 119	1/2	12	20	3.0	0.4	C	0.4	3.0	20	12	1/2	RCPT: FLOOR BOX LOBBY 101	24
25	RCPT: MECHANICAL 127 - NOTE 2	1/2	10	20	6.0	0.7	A	0.7	6.0	20	10	1/2	RCPT: FLOOR BOX LOBBY 101 - NOTE 2	26
27	RCPT: MECHANICAL 127 - NOTE 2	1/2	10	20	6.0	0.7	B	0.7	6.0	20	12	1/2	DAS SYSTEM - NOTE 3	28
29	RCPT: VENDING 131 - NOTE 1, 2	1/2	10	20	8.3	1.0	C	1.0	8.0	20	12	1/2	RISER AIR COMPRESSOR	30
31	RCPT: VENDING 131 - NOTE 1, 2	1/2	10	20	8.3	1.0	A			20			SPARE	32
33	RCPT: BREAKROOM 116	1/2	12	20	1.5	0.2	B			20			SPARE	34
35	SPARE			20			C			20			SPARE	36
37	SPARE			20			A			20			SPARE	38
39	SPARE			20			B			20			SPARE	40
41	SPARE			20			C			20			SPARE	42

TOTAL AMPS (CONN. LOAD) A: 67.7 B: 57.1 C: 66.7
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 67.7 B: 57.1 C: 66.7

PANELBOARD OPTIONS:

PANELBOARD NOTES:
1. PROVIDE GFI CIRCUIT BREAKER.
2. WIRE UPSIZED FOR VOLTAGE DROP.
3. PROVIDE GFEP BREAKER. LOCK IN "OFF" POSITION.

PANEL R2 SCHEDULE

100 AMP MLO 208Y/120 VOLTS 3PH, 4W, SN MIN. 10 KAIC SURFACE MOUNTED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	RCPT: GIFT SHOP 130 - NOTE 2	1/2	10	20	6.0	0.7	A	1.1	9.0	20	12	1/2	RCPT: GIFT SHOP 130, STOR 130A - NOTE 2	2
3	RCPT: GIFT SHOP 130 - NOTE 2	1/2	10	20	7.5	0.9	B	0.2	1.5	20	12	1/2	RCPT: POS GIFT SHOP 130 - NOTE 2	4
5	SPARE			20			C	1.2	9.8	20	12	1/2	MOTORIZED DOOR - GIFT SHOP	6
7	ELEVATOR CAB LIGHTS / FAN - NOTE 2	1/2	12	20	5.0	0.6	A	0.4	3.0	20	12	1/2	RCPT: KITCHEN	8
9	ELEV SHUNT TRIP CONTROL POWER	1/2	12	20	1.0	0.1	B	1.2	10.0	20	12	1/2	RCPT: PRINTER COPY 115	10
11	FIRE ALARM CONTROL PANEL - NOTE 3,5	1/2	12	20	4.0	0.5	C	0.4	3.0	20	12	1/2	RCPT: POKE-THRU CHANGING EXHIBIT	12
13	RCPT: VENDING 131 - NOTE 1, 2	1/2	10	20	8.3	1.0	A	0.2	2.0	15	12	1/2	HWRP-1 (1/12 HP)	14
15	RCPT: EXTERIOR AT CHILLER - NOTE 2	1	8	20	1.5	0.2	B	0.2	1.5	20	12	1/2	RCPT: ELEV CTRL	16
17	DOOR OPERATORS	1/2	12	20	3.0	0.4	C	0.2	2.0	15	12	1/2	MOTORIZED DAMPER	18
19	DOOR OPERATORS	1/2	12	20	3.0	0.4	A	0.2	2.0	15	12	1/2	MOTORIZED DAMPER	20
21	SPARE			20			B	1.2	10.0	20	12	1/2	(2) DDC PANELS - NOTE 6	22
23	AHU-1 LIGHTS - NOTE 6	1/2	12	20	5.0	0.6	C	1.2	10.0	20	12	1/2	(2) DDC PANELS - NOTE 6	24
25	RCPT: ELEVATOR HOIST WAY	1/2	12	20	1.5	0.2	A	0.8	8.0	15	12	1/2	SUMP PUMP SP-1 (0.75 HP)	26
27	RCPT: RESTROOMS 205, 205, JAN 207	1/2	12	20	4.5	0.5	B	0.8	8.0				NOTE 4	28
29	RCPT: CORRIDOR 202, 204, 209	1/2	12	20	6.0	0.7	C			20			SPARE	30
31	RCPT: WATER COOLER - NOTE 1	1/2	12	20	3.1	0.4	A			20			SPARE	32
33	RCPT: KITCHEN 208	1/2	12	20	3.0	0.4	B			20			SPARE	34
35	RCPT: KITCHEN 208, STORAGE 203	1/2	12	20	6.0	0.7	C			20			SPARE	36
37	RCPT: FRIDGE KITCHEN 208 - NOTE 1	1/2	12	20	8.3	1.0	A			20			SPARE	38
39	RCPT: MULTI-PURPOSE 210	1/2	12	20	7.5	0.9	B			20			SPARE	40
41	RCPT: MULTI-PURPOSE 210 - NOTE 2	1/2	10	20	7.5	0.9	C			20			SPARE	42

TOTAL AMPS (CONN. LOAD) A: 58.2 B: 54.9 C: 56.3
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 58.2 B: 54.9 C: 56.3

PANELBOARD OPTIONS:

PANELBOARD NOTES:
1. PROVIDE GFI CIRCUIT BREAKER.
2. WIRE UPSIZED FOR VOLTAGE DROP.
3. PROVIDE LOCKABLE, RED BREAKER. LOCK IN "ON" POSITION.
4. COORDINATE ELECTRICAL REQUIREMENTS WITH ACTUAL PUMP TO BE INSTALLED PRIOR TO ROUGH-IN.
5. PROVIDE EXTERNAL SPD DIRECTLY ADJACENT TO PANELBOARD.
6. PROVIDE LOCKABLE CIRCUIT BREAKER.

PANEL R3 SCHEDULE

100 AMP MLO 208Y/120 VOLTS 3PH, 4W, SN MIN. 10 KAIC SURFACE MOUNTED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	MOTORIZED SCREEN (1/2 HP)	1/2	12	20	9.8	1.2	A	0.7	6.0	20	12	1/2	RCPT: CHANGING EXHIBIT	2
3	MOTORIZED SCREEN (1/2 HP)	1/2	12	20	9.8	1.2	B	0.9	7.5	20	12	1/2	RCPT: CHANGING EXHIBIT, INFO DESK	4
5	RCPT: PROJECTOR	1/2	12	20	8.0	1.0	C	1.0	8.0	20	12	1/2	RCPT: WARMING OVEN KITCHEN 208	6
7	RCPT: PROJECTOR	1/2	12	20	8.0	1.0	A	1.0	8.0	20	12	1/2	RCPT: WARMING OVEN KITCHEN 208	8
9	RCPT: MULTI-PURPOSE	1/2	12	20	4.5	0.5	B			20			SPARE	10
11	PWR: MOTORIZED DOOR - NOTE 2	1/2	12	20	9.8	1.2	C			20			SPARE	12
13	RCPT - BOMBPROOF - NOTE 1	1	4	20	4.1	0.5	A			20			SPARE	14
15	PWR: HAND DRYER - NOTE 2	1/2	12	20	10.0	1.2	B			20			SPARE	16
17	PWR: HAND DRYER - NOTE 2	1/2	12	20	10.0	1.2	C			20			SPARE	18
19	PWR: HAND DRYER - NOTE 2	1/2	12	20	10.0	1.2	A			20			SPARE	20
21	PWR: HAND DRYER - NOTE 2	1/2	12	20	10.0	1.2	B			20			SPARE	22
23	PWR: HAND DRYER - NOTE 2	1/2	12	20	10.0	1.2	C	0.2	1.5	20	6	1	ENTRY&EVENT PLAZA PEDESTAL - NOTE 1, 3	24
25	PWR: HAND DRYER - NOTE 2	1/2	12	20	10.0	1.2	A	0.2	1.5	20	6	1	ENTRY&EVENT PLAZA PEDESTAL - NOTE 1, 3	26
27	PWR: HAND DRYER - NOTE 2	1/2	12	20	10.0	1.2	B	0.2	1.5	20	6	1	ENTRY&EVENT PLAZA PEDESTAL - NOTE 1, 3	28
29	PWR: HAND DRYER - NOTE 2	1/2	12	20	10.0	1.2	C	0.2	1.5	20	6	1	ENTRY&EVENT PLAZA PEDESTAL - NOTE 1, 3	30
31	PWR: HAND DRYER - NOTE 2	1/2	12	20	10.0	1.2	A	0.2	1.5	20	6	1	ENTRY&EVENT PLAZA PEDESTAL - NOTE 1, 3	32
33	SPARE			20			B	0.2	1.5	20	6	1	ENTRY&EVENT PLAZA PEDESTAL - NOTE 1, 3	34
35	SPARE			20			C	0.2	1.5	20	3	1 1/4	RCPT: EARTHWORKS PEDESTAL - NOTE 1, 3	36
37	RCPT: BALCONY - NOTE 1	1/2	10	20	3.0	0.4	A	0.2	1.5	20	3	1 1/4	RCPT: EARTHWORKS PEDESTAL - NOTE 1, 3	38
39	RCPT: BALCONY - NOTE 1	1/2	10	20	3.0	0.4	B	0.2	1.5	20	3	1 1/4	RCPT: EARTHWORKS PEDESTAL - NOTE 1, 3	40
41	RCPTS: EARTHWORKS - NOTE 1	1	3	20	4.5	0.5	C	0.2	1.5	20	3	1 1/4	RCPT: EARTHWORKS PEDESTAL - NOTE 1, 3	42

2

TOTAL AMPS (CONN. LOAD) A: 73.4 B: 59.3 C: 66.3
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 73.4 B: 59.3 C: 66.3

PANELBOARD OPTIONS:

PANELBOARD NOTES:
1. WIRE UPSIZED FOR VOLTAGE DROP.
2. PROVIDE LOCKABLE BREAKER.
3. REFER TO EARTHWORKS PACKAGE.

PANEL R4 SCHEDULE

100 AMP MLO 208Y/120 VOLTS 3PH, 4W, SN MIN. 10 KAIC SURFACE MOUNTED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	FA AIR COMPRESSOR	1/2	12	20	9.8	1.2	A	1.2	10.0	20	12	1/2	PWR WHIP OPEN OFFICE 110	2
3	PWR: HOTBOX - NOTE 1	1	4	25	16.7	2.0	B	1.2	10.0	20	12	1/2	PWR WHIP OPEN OFFICE 110	4
5	PWR: HOTBOX - NOTE 1	1	8	20	8.3	1.0	C	1.2	10.0	20	12	1/2	PWR WHIP OPEN OFFICE 110	6
7	RCPT: HOTBOXES - NOTE 1	1	8	20	3.0	0.4	A	~~1.2~~	~~10.0~~	~~20~~	~~12~~	~~1/2~~	~~PWR WHIP OPEN OFFICE 110~~	8
9	MOTORIZED SHADES	1/2	12	20	3.0	0.4	B	0.2	1.5	20	10	1	GRINDER PUMP ALARM PANEL	10
11	GRINDER PUMP CONTROL PANEL	1	10	20	5.0	0.6	C			20			SPARE	12
13	PWR: HOTBOX - NOTE 1	1	10	20	8.3	1.0	A			20			SPARE	14
15	RCPT: HOTBOX - NOTE 1	1	10	20	1.5	0.2	B			20			SPARE	16
17	RCPT: ELEC 118	1/2	12	20	1.5	0.2	C			20			SPARE	18
19	SPARE			20			A			20			SPARE	20
21	SPARE			20			B			20			SPARE	22
23	SPARE			20			C			20			SPARE	24
25	SPARE			20			A			20			SPARE	26
27	SPARE			20			B			20			SPARE	28
29	SPARE			20			C			20			SPARE	30
31	SPARE			20			A			20			SPARE	32
33	SPARE			20			B			20			SPARE	34
35	SPARE			20			C			20			SPARE	36
37	SPARE			20			A			20			SPARE	38
39	SPARE			20			B			20			SPARE	40
41	SPARE			20			C			20			SPARE	42

2

TOTAL AMPS (CONN. LOAD) A: 41.2 B: 32.7 C: 24.8
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 41.2 B: 32.7 C: 24.8

PANELBOARD OPTIONS:

PANELBOARD NOTES:
1. WIRE UPSIZED FOR VOLTAGE DROP.

PANEL R5 SCHEDULE

100 AMP MLO 208Y/120 VOLTS 3PH, 4W, SN MIN. 10 KAIC SURFACE MOUNTED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	LTG: TRACK EXHIBIT	1/2	12	20	1.5	0.2	A	1.2	9.8	20	12	1/2	MOTORIZED SCREEN ORIENTATION 230	2
3	LTG: TRACK EXHIBIT	1/2	12	20	1.5	0.2	B	1.0	8.0	20	12	1/2	RCPT: PROJECTOR ORIENTATION 230	4
5	LTG: TRACK EXHIBIT	1/2	12	20	1.2	0.1	C	0.7	6.0	20	12	1/2	RCPT: ORIENTATION 230	6
7	LTG: TRACK EXHIBIT	1/2	12	20	1.2	0.1	A	0.7	6.0	20	12	1/2	RCPT: ORIENTATION 230, AV CLOSET 222	8
9	LTG: TRACK EXHIBIT	1/2	12	20	1.2	0.1	B	0.5	4.5	20	12	1/2	RCPT: EXHIBIT	10
11	LTG: TRACK EXHIBIT	1/2	12	20	1.2	0.1	C	0.5	4.5	20	12	1/2	RCPT: EXHIBIT	12
13	LTG: TRACK EXHIBIT	1/2	12	20	1.5	0.2	A	0.5	4.5	20	12	1/2	RCPT: EXHIBIT	14
15	LTG: TRACK EXHIBIT	1/2	12	20	1.5	0.2	B	0.7	6.0	20	12	1/2	RCPT: EXHIBIT	16
17	LTG: TRACK EXHIBIT	1/2	12	20	1.5	0.2	C	0.7	6.0	20	12	1/2	RCPT: EXHIBIT	18
19	LTG: TRACK EXHIBIT	1/2	12	20	1.5	0.2	A	0.7	6.0	20	12	1/2	RCPT: EXHIBIT	20
21	LTG: TRACK EXHIBIT	1/2	12	20	0.9	0.1	B	0.4	3.0	20	12	1/2	RCPT: POKE-THRU EXHIBIT 240	22
23	LTG: TRACK EXHIBIT	1/2	12	20	0.9	0.1	C	0.4	3.0	20	12	1/2	RCPT: POKE-THRU EXHIBIT 240	24
25	SPARE			20			A	0.4	3.0	20	12	1/2	RCPT: POKE-THRU EXHIBIT 240	26
27	SPARE			20			B	0.4	3.0	20	12	1/2	RCPT: POKE-THRU EXHIBIT 240	28
29	SPARE			20			C	0.4	3.0	20	12	1/2	RCPT: POKE-THRU EXHIBIT 240	30
31	SPARE			20			A	0.4	3.0	20	12	1/2	RCPT: EXHIBIT	32
33	SPARE			20			B	0.4	3.0	20	12	1/2	RCPT: AV CLOSET	34
35	SPARE			20			C	0.9	7.5	20	12	1/2	RCPT: UPPER LOBBY	36
37	SPARE			20			A	0.4	3.0	20	12	1/2	RCPT: EXHIBIT	38
39	SPARE			20			B			20			SPARE	40
41	SPARE			20			C			20			SPARE	42

TOTAL AMPS (CONN. LOAD) A: 40.9 B: 32.5 C: 34.7
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 40.9 B: 32.5 C: 34.7

PANELBOARD OPTIONS:

PANELBOARD NOTES:

PANEL DIRECTORY		
MDP	L2	R2
M1	INV	R3
M2	SDP	R4
L1	EM	R5
-	R1	-

DEPARTMENT OF NATURAL AND CULTURAL RESOURCES

VISITOR CENTER AND UNDERWATER ARCHAEOLOGY BUILDING AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S
KURE BEACH, NC 28449

SCO#: 16-16311-02A
CODE: 41614
ITEM: 4C01

DESIGNER

CLARKNEXSEN

333 FAYETTEVILLE STREET, SUITE 1000
RALEIGH, NORTH CAROLINA 27601
919·828·1876

CLARK NEXSEN LICENSE NUMBER: C-1028

PROFESSIONAL SEAL

SUBMITTAL

APRIL 29, 2022

BID SET

REVISIONS

1	06/10/22	ADDENDUM 1
2	06/17/22	ADDENDUM 2

SHEET

PANELBOARD SCHEDULES - VISITOR CENTER

EP601

DESIGN: FA
DRAWN: FA
REVIEW: PJR

CN 7173-B

PANEL U-DP SCHEDULE

450 AMP MCB 208Y/120 VOLTS 3PH, 4W, SN MIN. 22 KAIC SURFACE MOUNTED SE RATED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	PANEL U-P1	2	1/0	150	110.5	13.3	A	8.2	68.4	100	1	1-1/2	PANEL U-P3	2
3					107.2	12.9	B	8.1	67.7					4
5					111.8	13.4	C	9.1	75.9					6
7	WH-2	3/4	8	35	25.0	3.0	A	2.7	22.4	50	6	1	AHU-2-U	8
9	9 KW				25.0	3.0	B	2.7	22.4				SUPPLY FAN	10
11					25.0	3.0	C	2.7	22.4				7.5 HP	12
13	PANEL U-P2	1-1/2	1	125	95.0	11.4	A	6.3	52.8	90	2	1-1/4	CU-2-U	14
15					84.8	10.2	B	6.3	52.8					16
17					76.8	9.2	C	6.3	52.8					18
19	GRINDER PUMP	1	10	25	18.0	2.2	A	3.3	27.8	40	8	3/4	AHU-2-U	20
21	(2) 2 HP				18.0	2.2	B	3.3	27.8				ELECTRIC HEAT	22
23					18.0	2.2	C	3.3	27.8				10 KW	24
25	SPARE			15			A						BUSSED SPACE	26
27							B							28
29							C							30
31	SPARE			15			A						BUSSED SPACE	32
33							B							34
35							C							36
37	SURGE PROTECTIVE DEVICE (SDP)	3/4	10	30			A						BUSSED SPACE	38
39							B							40
41							C							42

TOTAL AMPS (CONN. LOAD) A: 419.9 B: 405.7 C: 410.4
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 419.9 B: 405.7 C: 410.4

PANELBOARD OPTIONS:
1. PROVIDE WITH DIGITAL MULTIMETER.
2. PROVIDE 100% RATED MCB.
3. PROVIDE EXTERNALLY MOUNTED SPD.

PANELBOARD NOTES:

LOAD DESCRIPTION	PANEL CONN LOAD		SUBFEED CONN LOAD		FEEDTHRU CONN LOAD		TOTAL LOAD		D.F. MULT.	TOTAL KVA DEMAND	
LIGHTING		KVA	3.5	KVA		KVA	3.5	KVA	1.00	3.5	KVA
RECEPTACLES		KVA	25.9	KVA		KVA	25.9	KVA	NEC	17.9	KVA
MECH EQUIP	27.1	KVA	14.7	KVA		KVA	41.8	KVA	1.00	41.8	KVA
ELECTRIC HEAT	19.0	KVA	26.6	KVA		KVA	45.6	KVA	1.00	45.6	KVA
PUMPS	6.5	KVA	0.8	KVA		KVA	7.3	KVA	1.00	7.3	KVA
MISCELLANEOUS		KVA	24.0	KVA		KVA	24.0	KVA	1.00	24.0	KVA
ELEVATOR		KVA		KVA		KVA		KVA	0.80		KVA
EXTERIOR LIGHTING		KVA	0.4	KVA		KVA	0.4	KVA	1.00	0.4	KVA
EARTHWORKS LTG		KVA		KVA		KVA		KVA	1.00		KVA
		KVA		KVA		KVA		KVA			KVA
		KVA		KVA		KVA		KVA			KVA
		KVA		KVA		KVA		KVA			KVA
TOTALS (CONN. KVA)	52.6	KVA	95.8	KVA		KVA	148.3	KVA		140.4	KVA
TOTALS (CONN. KVA + 20%)	63.1	KVA	114.9	KVA		KVA	178.0	KVA		168.5	KVA
TOTALS (CONN. AMPS)	145.9	AMPS	265.8	AMPS		AMPS	411.7	AMPS		389.7	AMPS
TOTALS (CONN. AMPS + 20%)	175.1	AMPS	319.0	AMPS		AMPS	494.0	AMPS		467.6	AMPS

PANEL U-P1 SCHEDULE

150 AMP MLO 208Y/120 VOLTS 3PH, 4W, SN MIN. 10 KAIC SURFACE MOUNTED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	PPPB-3-01-U	1/2	12	15	7.2	0.8	A	2.2	20.7	30	10	1/2	VAV-3-01-U	2
3	1.5 KW				7.2	0.8	B	2.2	20.7				4 KW	4
5	PPPB-3-02-U	1/2	12	15	7.7	0.8	C	2.2	20.7	30	10	1/2	CAV-3-01-U	6
7	1.6 KW				7.7	0.8	A	2.2	20.7				6.1 KW	8
9	PPPB-3-04-U	3/4	8	35	20.7	2.2	B	1.4	13.5	25	10	1/2	PPPB-3-05-U	10
11	4.3 KW				20.7	2.2	C	1.4	13.5				2.8 KW	12
13	PPPB-3-03-U	1/2	12	15	4.8	0.5	A			20			SPARE	14
15	1.0 KW				4.8	0.5	B							16
17	RH-1-U	1/2	12	15	7.7	0.8	C			20			SPARE	18
19					7.7	0.8	A							20
21	RH-2-U	1/2	12	15	7.7	0.8	B			20			SPARE	22
23					7.7	0.8	C							24
25	RH-3-U	1/2	12	15	7.7	0.8	A			15			SPARE	26
27					7.7	0.8	B							28
29	RH-4-U	1/2	12	15	9.6	1.0	C							30
31					9.6	1.0	A			15			SPARE	32
33	SPARE			15			B							34
35							C							36
37	AIR COMPRESSOR	1-1/4	4	60	29.0	3.5	A	0.8	6.9	15	12	1/2	RLF-1-U	38
39	10 HP				29.0	3.5	B	0.8	6.9				1.5 HP	40
41					29.0	3.5	C	0.8	6.9					42

TOTAL AMPS (CONN. LOAD) A: 110.5 B: 107.2 C: 111.8
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 110.5 B: 107.2 C: 111.8

PANELBOARD OPTIONS:

PANELBOARD NOTES:

PANEL U-P2 SCHEDULE

125 AMP MLO 208Y/120 VOLTS 3PH, 4W, SN MIN. 22 KAIC SURFACE MOUNTED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	OU-1-U / SS-1-U	1/2	12	20	9.6	1.0	A	0.9	7.2	15	12	1/2	WF-1-U (1/3 HP)	2
3					9.6	1.0	B	0.9	7.2	15	12	1/2	WF-2-U (1/3 HP)	4
5	OU-2-U / SS-2-U	1/2	12	20	9.6	1.0	C	0.9	7.2	15	12	1/2	WF-3-U (1/3 HP)	6
7					9.6	1.0	A						SPARE	8
9	OU-3-U / SS-3-U	1/2	12	20	9.6	1.0	B	0.6	5.0	20	12	1	GRINDER PUMP CONTROL PANEL	10
11					9.6	1.0	C	0.2	1.5	20	12	1	GRINDER PUMP ALARM PANEL	12
13	LEF-01 (1/3 HP)	1/2	12	15	7.2	0.9	A			20			SPARE	14
15	RCPT: ROOF	1/2	12	20	1.5	0.2	B	0.4	3.0	15	12	1/2	MOTORIZED DAMPERS	16
17	FIRE ALARM NAC PANEL - NOTE 2, 3	1/2	12	20	4.0	0.5	C	1.2	9.8	20	12	1/2	ROLL-UP DOOR, STORAGE U120	18
19	HAND DRYER - NOTE 1	1/2	12	20	10.0	1.2	A	1.2	9.8	20	12	1/2	ROLL-UP DOOR, STORAGE U120	20
21	HAND DRYER - NOTE 1	1/2	12	20	10.0	1.2	B	1.2	9.8	20	12	1/2	ROLL-UP DOOR, STORAGE U120	22
23	HWRP-1	1/2	12	15	4.4	0.5	C	1.2	9.8	20	12	1/2	ROLL-UP DOOR, WORKSHOP U118	24
25	EF-2-U (1/3 HP)	1/2	12	15	7.2	0.9	A	1.2	10.0	20	12	1/2	FUME HOOD, CONSERV LAB U114 - NOTE 1	26
27	HOTBOX - NOTE 4	1	4	25	16.7	2.0	B	0.7	6.0	20	12	1/2	RCPT: OPEN OFFICE	28
29	HOTBOX - NOTE 4	1	6	20	8.3	1.0	C	0.7	6.0	20	12	1/2	RCPT: OPEN OFFICE, CONF	30
31	RCPT: HOTBOXES - NOTE 4	1	6	20	3.0	0.4	A	0.9	7.5	20	12	1/2	RCPT: CONFERENCE RM	32
33	RCPT: CONDENSATE PUMP - U118	1/2	12	20	1.0	0.1	B	0.4	3.0	20	12	1/2	RCPT: CORRIDORS	34
35	RCPT: CONDENSATE PUMP - U109&U125	1/2	12	20	2.0	0.2	C	0.6	5.0	20	12	1/2	RCPT: OPEN OFFICE POWER POLE	36
37	RCPT: ELEC 125	1/2	12	20	1.5	0.2	A	0.6	5.0	20	12	1/2	RCPT: OPEN OFFICE POWER POLE	38
39	SPARE			20			B	0.6	5.0	20	12	1/2	RCPT: OPEN OFFICE POWER POLE	40
41	SPARE			20			C	0.2	2.0	15	12	1/2	HWRP-2 (1/12 HP)	42

TOTAL AMPS (CONN. LOAD) A: 95.0 B: 84.8 C: 76.8
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 95.0 B: 84.8 C: 76.8

PANELBOARD OPTIONS:

PANELBOARD NOTES:
1. PROVIDE LOCKABLE BREAKER.
2. PROVIDE LOCKABLE, RED BREAKER. LOCK IN "ON" POSITION.
3. PROVIDE EXTERNAL SPD DIRECTLY ADJACENT TO PANELBOARD.
4. WIRE UPSIZED FOR VOLTAGE DROP.

2

PANEL U-P3 SCHEDULE

100 AMP MLO 208Y/120 VOLTS 3PH, 4W, SN MIN. 22 KAIC SURFACE MOUNTED

CKT. NO.	LOAD DESCRIPTION	COND SIZE	WIRE SIZE	BKR TRIP	AMPS	KVA	PH	KVA	AMPS	BKR TRIP	WIRE SIZE	COND SIZE	LOAD DESCRIPTION	CKT. NO.
1	LTG: OFFICES, OPEN OFFICE, STOR	1/2	12	20	8.3	1.0	A	0.4	3.0	20	12	1/2	RCPT: TELECOM U109	2
3	LTG: CONF, CORR, LAB, WORKSHOP	1/2	12	20	8.0	1.0	B	0.4	3.0	20	12	1/2	RCPT: TELECOM U109	4
5	LTG: ELEC, MECH, TEL, RESTRM, DIVE	1/2	12	20	6.2	0.7	C	0.4	3.0	20	12	1/2	RCPT: TELECOM U109	6
7	LTG: GARAGE, EQUIP WASH, WET STOR	1/2	12	20	6.3	0.8	A	0.4	3.0	20	12	1/2	RCPT: TELECOM U109	8
9	LTG: EXTERIOR	1/2	12	20	1.0	0.1	B	0.4	3.0	20	12	1/2	RCPT: TELECOM U109	10
11	LTG CONTROL PANEL	1/2	12	20	2.0	0.2	C	0.9	7.5	20	12	1/2	RCPT: OFFICE U102	12
13	LTG: BOLLARDS - NOTE 1	1/2	10	20	2.0	0.2	A	0.9	7.5	20	12	1/2	RCPT: OFFICE U103	14
15	DAS SYSTEM - NOTE 3	1/2	12	20	6.0	0.7	B	0.9	7.5	20	12	1/2	RCPT: OFFICE U104	16
17	SPARE			20			C	1.1	9.0	20	12	1/2	RCPT: OFFICE U105	18
19	SPARE			20			A	1.3	10.5	20	12	1/2	RCPT: DRY ARCHIVAL STORAGE U107	20
21	SPARE			20			B	0.7	6.0	20	12	1/2	RCPT: ELEC U125, MECH U127	22
23	SPARE			20			C	0.5	4.5	20	12	1/2	RCPT: MECH U127	24
25	SPARE			20			A	0.5	4.5	20	12	1/2	RCPT: JAN U111, WOMEN U113, MEN U115	26
27	SPARE			20			B	1.0	8.3	20	12	1/2	RCPT: BREAKROOM U112	28
29	RCPT: MICROWAVE	1/2	12	20	8.3	1.0	C	1.0	8.3	20	12	1/2	RCPT: BREAKROOM U112	30
31	RCPT: EXTERIOR	1/2	12	20	1.5	0.2	A	1.0	8.3	20	12	1/2	RCPT: BREAKROOM U112	32
33	RCPT: WORKSHOP U118	1/2	12	20	6.0	0.7	B	1.0	8.3	20	12	1/2	RCPT: FRIDGE BREAKROOM U112 - NOTE 2	34
35	RCPT: EQUIP WASH, ARCHIVAL STOR	1/2	12	20	6.0	0.7	C	0.9	7.5	20	12	1/2	RCPT: CONSERVATION LAB U114	36
37	RCPT: BOAT STORAGE	1/2	12	20	7.5	0.9	A	0.7	6.0	20	12	1/2	RCPT: CONSERVATION LAB U114	38
39	RCPT: DIVE LOCKERS	1/2	12	20	4.5	0.5	B	0.7	6.0	20	12	1/2	RCPT: CONSERVATION LAB U114	40
41	RCPT: DIVE LOCKERS	1/2	12	20	7.5	0.9	C	0.7	6.0	20	12	1/2	RCPT: WORKSHOP U118	42

TOTAL AMPS (CONN. LOAD) A: 68.4 B: 67.7 C: 75.9
TOTAL AMPS (FEEDTHRU) A: B: C:
TOTAL AMPS (CONN. LOAD + FEED-THRU) A: 68.4 B: 67.7 C: 75.9

PANELBOARD OPTIONS:

PANELBOARD NOTES:
1. WIRE UPSIZED FOR VOLTAGE DROP.
2. PROVIDE GFI BREAKER.
3. PROVIDE GFEP BREAKER. LOCK IN "OFF" POSITION.

PANEL DIRECTORY		
U-DP	U-P1	U-P3
-	U-P2	-
-	-	-
-	-	-

DEPARTMENT OF NATURAL AND CULTURAL RESOURCES

CLARK NEXSEN

333 FAYETTEVILLE STREET, SUITE 1000
RALEIGH, NORTH CAROLINA 27601
919·828·1876

VISITOR CENTER AND UNDERWATER ARCHAEOLOGY BUILDING AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S
KURE BEACH, NC 28449

SCO#: 16-16311-02A
CODE: 41614
ITEM: 4C01

DESIGNER

CLARK NEXSEN LICENSE NUMBER: C-1028
PROFESSIONAL SEAL

SUBMITTAL
APRIL 29, 2022
BID SET

REVISIONS

1	06/10/22	ADDENDUM 1
2	06/17/22	ADDENDUM 2

SHEET
PANELBOARD SCHEDULES - UAB

EP601U

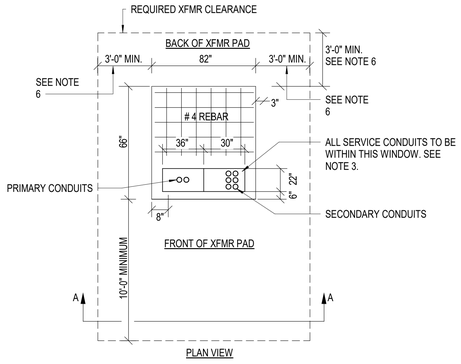
DESIGN: FA
DRAWN: FA
REVIEW: PJR

CN 7173-B

6/15/2022 5:11:09 PM
C:\Revit Projects\7173_Fort Fisher Visitor's Center E20_tgilleland.rvt

UNDERGROUND CONDUIT AND CABLE SCHEDULE

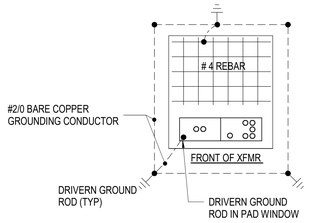
ID	CONDUIT SIZE	CONDUCTOR SIZE / QUANTITY	DESCRIPTION
1	4"	N/A	SPARE WITH PULLSTRING.
2	4"	REFER TO RISER DIAGRAM	SECONDARY FROM TRANSFORMER (UAB BUILDING).
3	4"	REFER TO RISER DIAGRAM	SECONDARY FROM TRANSFORMER (VISITOR'S CENTER).
4	3"	REFER TO PANEL SCHEDULES	CIRCUIT FOR AIR-COOLED CHILLER.
5	1"	N/A	SPARE WITH PULLSTRING.
6	1"	REFER TO PANEL SCHEDULES	CONVENIENCE RECEPTACLE AT CHILLER.
7	1"	REFER TO PANEL SCHEDULES	HEAT TRACE AT CHILLER.
8	1"	REFER TO PANEL SCHEDULES	EXTERIOR SITE PEDESTALS.
9	1-1/4"	N/A	CONDUIT FROM BUILDING TO POST-INDICATOR VALVE (PIV) LOCATION.
10	1"	REFER TO PANEL SCHEDULES	POWER TO HOTBOXES AND RECEPTACLES.



NOTES:

1. TRANSFORMER PAD SHALL BE INSTALLED IN A LOCATION TO REMAIN READILY ACCESSIBLE FOR LINE TRUCKS.
2. PROVIDE GROUNDING SYSTEM AS PER UTILITY COMPANY REQUIREMENTS AND SPECIFICATIONS.
3. SERVICE CONDUIT SHALL BE LOCATED IN THE EXTREME RIGHT SIDE OF THE SECONDARY COMPARTMENT.
4. OTHER UTILITIES ARE NOT TO BE INSTALLED UNDER TRANSFORMER PAD.
5. CONCRETE PAD SHALL BE CONSTRUCTED AS PER UTILITY COMPANY SPECIFICATIONS.
6. WHERE A METER IS MOUNTED TO A TRANSFORMER, A CLEAR SPACE AROUND THE METER OF AT LEAST 3 FEET WIDE, 4 FEET DEEP, AND 8 FEET HIGH MUST BE PROVIDED AND ALWAYS AVAILABLE FOR READING, TESTING AND MAINTENANCE OPERATIONS.

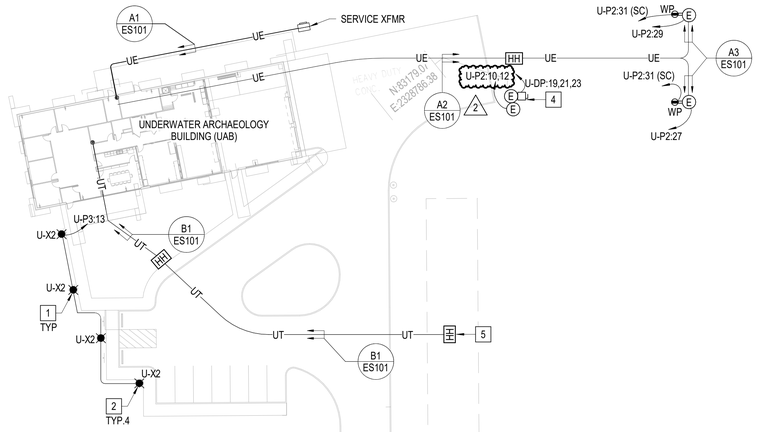
C1 TRANSFORMER PAD DETAIL - UAB
NO SCALE

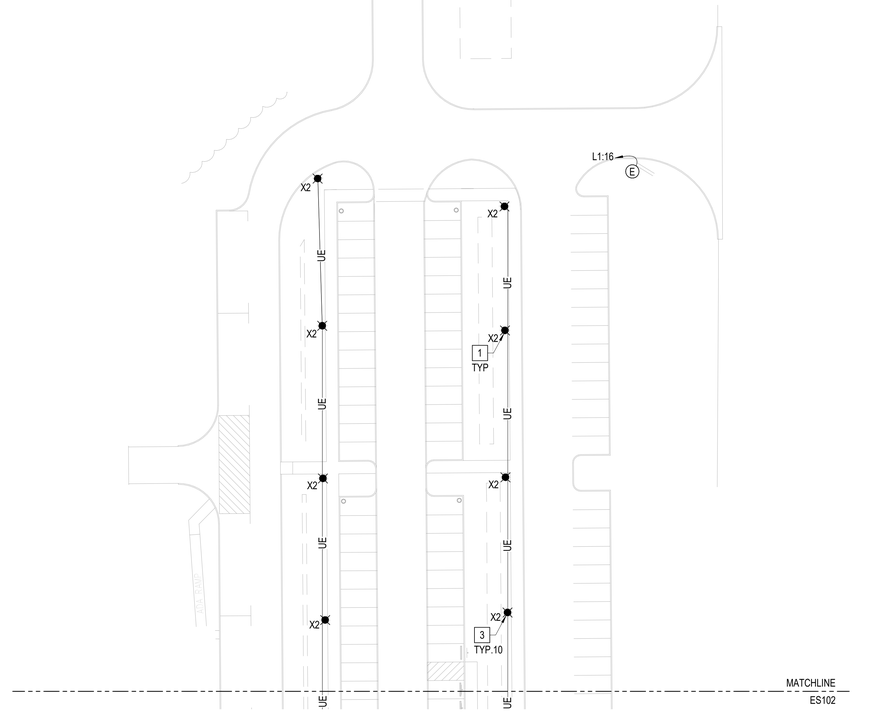


NOTES:

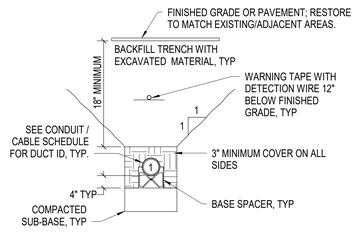
1. GROUND ROD TO BE 5/8 IN DIA. X 8 FT. LONG COPPER CLAD STEEL.
2. GROUND ROD IN PRIMARY WINDOW TO BE 4 INCHES FROM EACH SIDE OF THE CORNER.
3. GROUNDING CONDUCTOR TO BE # 2/0 BARE COPPER MINIMUM.
4. GROUNDING CONDUCTOR DEPTH TO BE 30 INCHES MINIMUM.
5. MECHANICAL/ELECTRICAL CONNECTIONS IN THE GROUND SHALL BE EXOTHERMIC WELDS (EX. CADWELD).
6. GROUNDING CONDUCTOR TO BE 2 FT. FROM THE EDGE OF BOX PAD.

C2 TRANSFORMER GROUNDING
NO SCALE

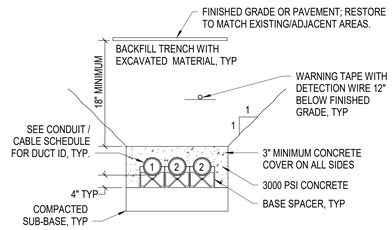




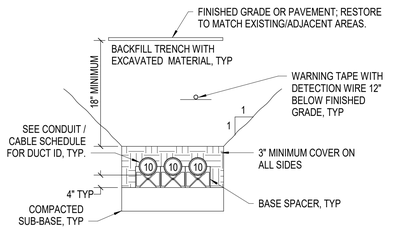
B3 ELECTRICAL SITE PLAN
1" = 30'-0"



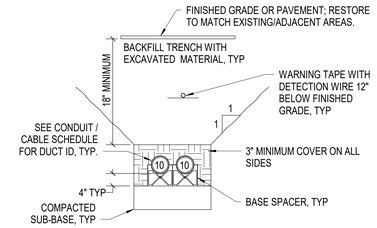
B1 DUCTBANK - UAB TELECOM
NO SCALE



A1 DUCTBANK - UAB SERVICE
NO SCALE



A2 DUCTBANK - UAB HOTBOXES
NO SCALE



A3 DUCTBANK - UAB HOTBOX
NO SCALE

GENERAL NOTES

A. WHERE DUCT BANKS ENTER MANHOLES OR BUILDINGS, THEY SHALL BE CONSTRUCTED AS INTEGRAL TO THE WALL. DUCT BANK SHALL EXTEND TO THE INSIDE SURFACES OF THE WALLS. AND THE DUCT BANK REINFORCING SHALL BE INTEGRATED WITH THE WALL REINFORCING.

B. BELL ENDS SHALL BE PROVIDED ON DUCTS WHERE THE DUCTS ENTER MANHOLES OR BUILDINGS.

KEY NOTES

1 PROVIDE SLEEVING FOR BOLLARD TO ALLOW INSTALLATION OF FIXTURE AFTER HARDSCAPE INSTALLATION IS COMPLETE.

2 ALTERNATE NO. 4: PROVIDE FOUR LIGHT BOLLARDS AS INDICATED.

3 ALTERNATE NO. 5: PROVIDE TEN LIGHT BOLLARDS AS INDICATED ON SHEETS ES101 AND ES102.

4 PROVIDE CONNECTION TO GRINDER PUMP CONTROL PANEL. REFER TO CU101 FOR EXACT LOCATION. PROVIDE HEAVY DUTY NEMA-4X, 250V RATED FUSED DISCONNECT SWITCH, 15A FUSES, 30A FRAME. PROVIDE NEMA-4X MANUAL TRANSFER SWITCH WITH GENERATOR CONNECTION RECEPTACLE. REFER TO CU501 FOR GRINDER PUMP AND PANEL MOUNTING DETAILS AS WELL AS OTHER ELECTRICAL REQUIREMENTS.

5 FOR OWNER'S SERVICE PROVIDER'S USE.

GRAPHIC SCALE(S)

1" = 30'

0 30' 60' 120'

DEPARTMENT OF NATURAL AND CULTURAL RESOURCES

VISITOR CENTER AND UNDERWATER ARCHAEOLOGY BUILDING AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S
KURE BEACH, NC 28449

SCO#: 16-16311-02A
CODE: 41614
ITEM: 4C01

DESIGNER

CLARKNEXSEN

333 FAYETTEVILLE STREET, SUITE 1000
RALEIGH, NORTH CAROLINA 27601
919·828·1876

CLARK NEXSEN LICENSE NUMBER: C-1028
PROFESSIONAL SEAL

SUBMITTAL

APRIL 29, 2022

BID SET

REVISIONS

2	06/17/22	ADDENDUM 2

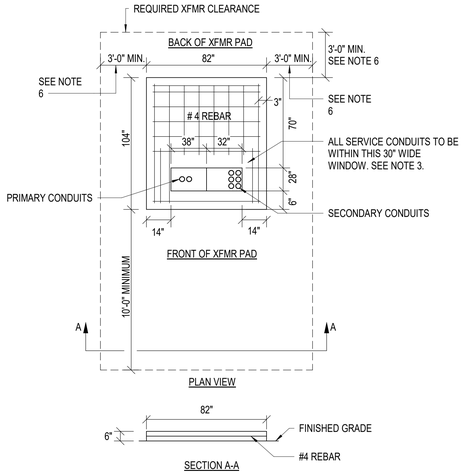
SHEET

ELECTRICAL SITE PLAN

ES101

DESIGN: PML
DRAWN: PML
REVIEW: MDP

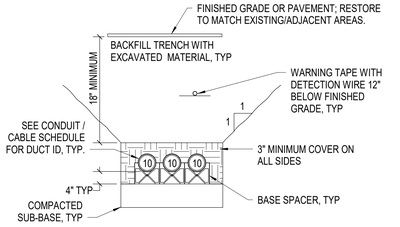
CN 7173-B



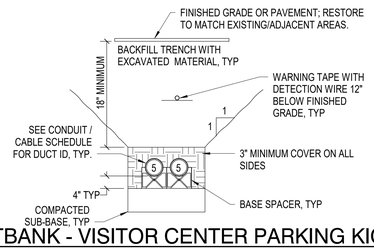
NOTES:

1. TRANSFORMER PAD SHALL BE INSTALLED IN A LOCATION TO REMAIN READILY ACCESSIBLE FOR LINE TRUCKS.
2. PROVIDE GROUNDING SYSTEM AS PER UTILITY COMPANY REQUIREMENTS AND SPECIFICATIONS.
3. SERVICE CONDUIT SHALL BE LOCATED IN THE EXTREME RIGHT SIDE OF THE SECONDARY COMPARTMENT.
4. OTHER UTILITIES ARE NOT TO BE INSTALLED UNDER TRANSFORMER PAD.
5. CONCRETE PAD SHALL BE CONSTRUCTED AS PER UTILITY COMPANY SPECIFICATIONS.
6. WHERE A METER IS MOUNTED TO A TRANSFORMER, A CLEAR SPACE AROUND THE METER OF AT LEAST 3 FEET WIDE, 4 FEET DEEP, AND 8 FEET HIGH MUST BE PROVIDED AND ALWAYS AVAILABLE FOR READING, TESTING AND MAINTENANCE OPERATIONS.

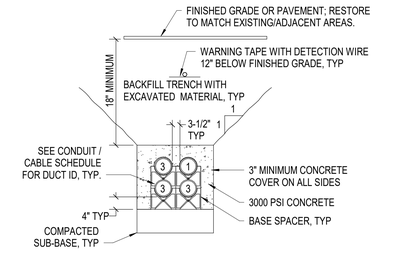
D1 TRANSFORMER PAD DETAIL - VISITOR CENTER
NO SCALE



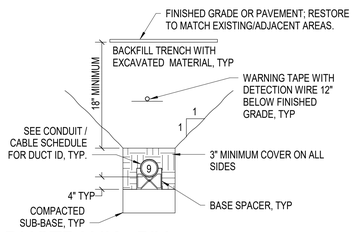
C1 DUCTBANK - HOTBOXES
NO SCALE



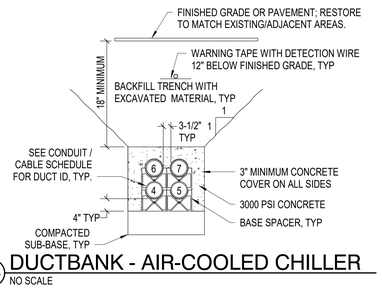
B1 DUCTBANK - VISITOR CENTER PARKING KIOSK
NO SCALE



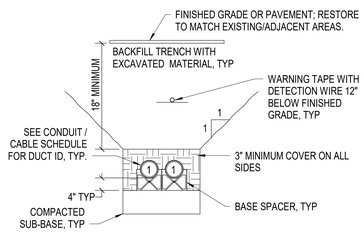
A1 DUCTBANK - VISITOR CENTER SERVICE
NO SCALE



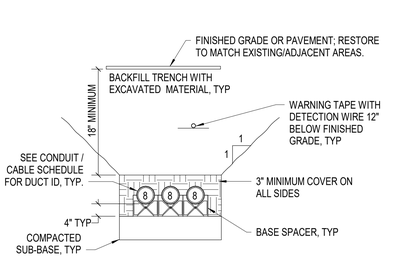
B5 DUCTBANK - PIV
NO SCALE



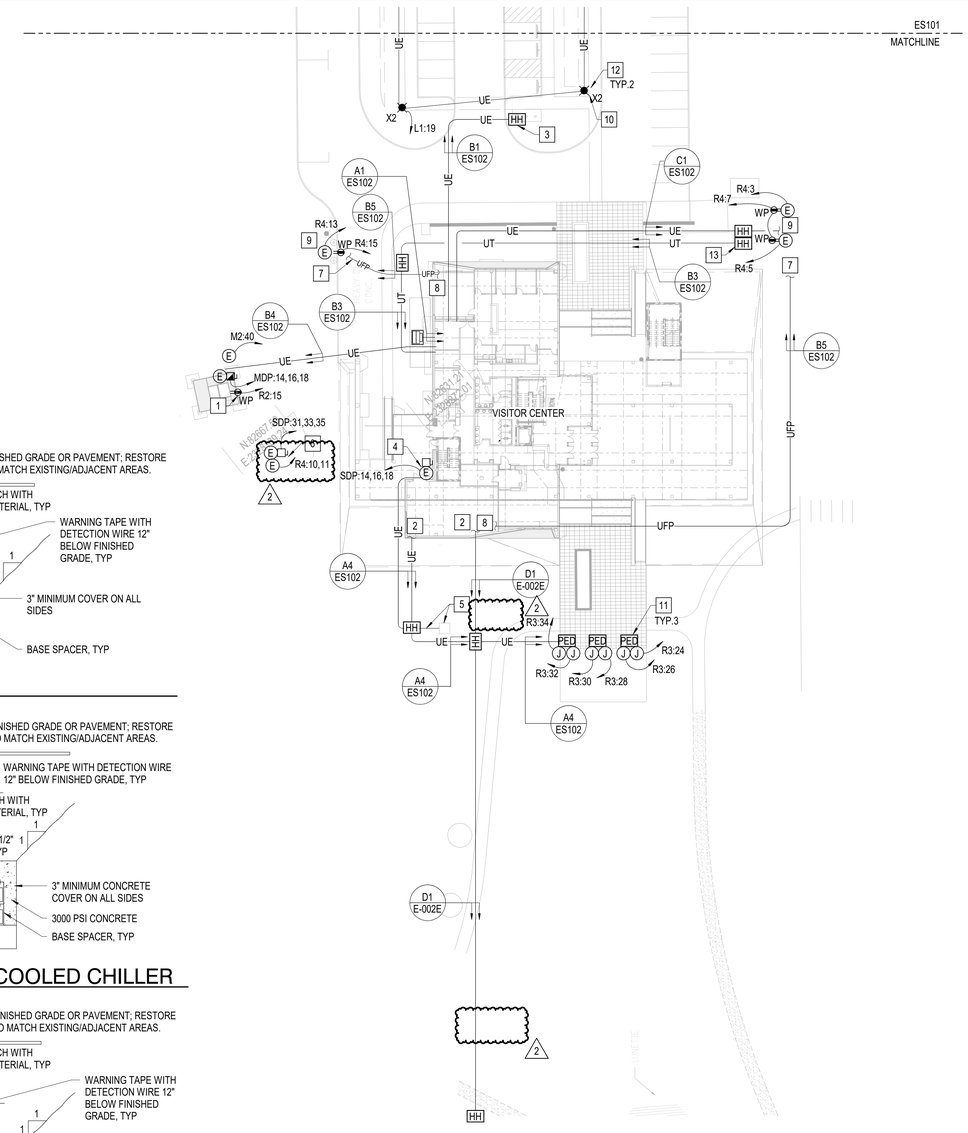
B4 DUCTBANK - AIR-COOLED CHILLER
NO SCALE



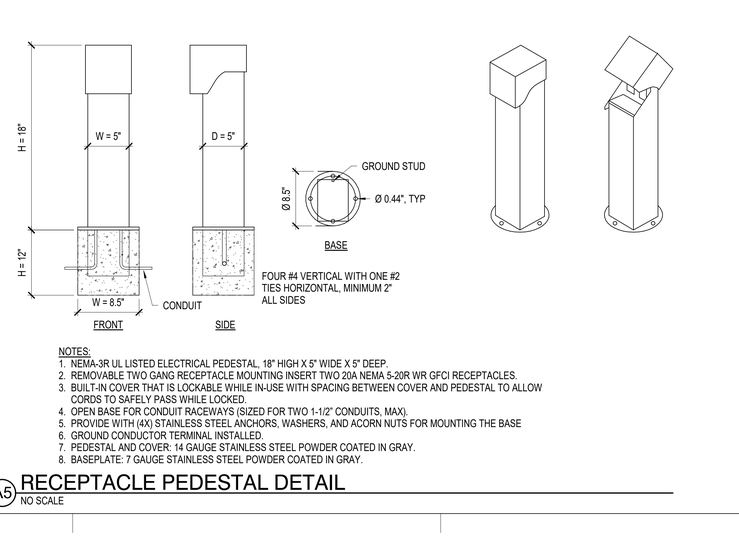
B3 DUCTBANK - TELECOM
NO SCALE



A4 DUCTBANK - SITE PEDESTALS
NO SCALE



C2 ELECTRICAL SITE PLAN
1" = 30'-0"



NOTES:

1. NEMA-3R UL LISTED ELECTRICAL PEDESTAL, 18" HIGH X 5" WIDE X 5" DEEP.
2. REMOVABLE TWO GANG RECEPTACLE MOUNTING INSERT TWO 20A NEMA 5-20R WR GFCI RECEPTACLES.
3. BUILT-IN COVER THAT IS LOCKABLE WHILE IN-USE WITH SPACING BETWEEN COVER AND PEDESTAL TO ALLOW CORDS TO SAFELY PASS WHILE LOCKED.
4. OPEN BASE FOR CONDUIT RACEWAYS (SIZED FOR TWO 1-1/2" CONDUITS, MAX).
5. PROVIDE WITH (4X) STAINLESS STEEL ANCHORS, WASHERS, AND ACORN NUTS FOR MOUNTING THE BASE
6. GROUND CONDUCTOR TERMINAL INSTALLED.
7. PEDESTAL AND COVER: 14 GAUGE STAINLESS STEEL POWDER COATED IN GRAY.
8. BASEPLATE: 7 GAUGE STAINLESS STEEL POWDER COATED IN GRAY.

A5 RECEPTACLE PEDESTAL DETAIL
NO SCALE

GENERAL NOTES

A. WHERE DUCT BANKS ENTER MANHOLES OR BUILDINGS, THEY SHALL BE CONSTRUCTED AS INTEGRAL TO THE WALL. DUCT BANK SHALL EXTEND TO THE INSIDE SURFACES OF THE WALLS. AND THE DUCT BANK REINFORCING SHALL BE INTEGRATED WITH THE WALL REINFORCING.

B. BELL ENDS SHALL BE PROVIDED ON DUCTS WHERE THE DUCTS ENTER MANHOLES OR BUILDINGS.

KEY NOTES

1 PROVIDE RECEPTACLE AT CHILLER LOCATION. MOUNT ON UNISTRUT AT A MINIMUM OF 36" AFF.

2 ROUTE CONDUITS UNDER SLAB TO MAIN ELECTRICAL ROOM.

3 LOCATE HANDHOLE NEAR FUTURE PAY STATION LOCATION. STUB-UP CONDUIT IN ELECTRICAL ROOM FOR FUTURE USE.

4 PROVIDE CONNECTION TO WELL PUMP CONTROL PANEL LOCATED ON EXTERIOR WALL. PROVIDE NEMA-4X FUSED DISCONNECT SWITCH, 250V RATED, HEAVY DUTY, 30A FRAME. COORDINATE REQUIRED FUSE SIZES WITH HORSEPOWER OF EXISTING PUMP.

5 ROUTE 1" CONDUIT FROM WELL PUMP CONTROL PANEL TO WELL LOCATION. COORDINATE WITH CIVIL PLANS FOR EXACT LOCATION OF PUMP. ROUTE APPROPRIATE WIRING FROM CONTROL PANEL TO PUMP.

6 PROVIDE CONNECTION TO GRINDER PUMP CONTROL PANEL. REFER TO CU101 FOR EXACT LOCATION. PROVIDE HEAVY DUTY NEMA-4X, 250V RATED FUSED DISCONNECT SWITCH, 20A FUSES, 30A FRAME. PROVIDE NEMA-4X MANUAL TRANSFER SWITCH WITH GENERATOR CONNECTION RECEPTACLE. REFER TO CU501 FOR GRINDER PUMP AND PANEL MOUNTING DETAILS AS WELL AS OTHER ELECTRICAL REQUIREMENTS.

7 ROUTE CONDUIT TO PIV LOCATION. REFER TO CU101 FOR EXACT LOCATION.

8 CONDUIT FOR FIRE PROTECTION CONNECTION TO POST INDICATOR VALVE. REFER TO FA101 FOR EXACT LOCATION.

9 TO HOT BOXES. REFER TO CU101 FOR EXACT LOCATIONS. PROVIDE CONNECTION TO HOT BOX HEATERS AND INSTALL RECEPTACLE INSIDE OF EACH HOT BOX.

10 PROVIDE SLEEVING FOR BOLLARD TO ALLOW INSTALLATION OF FIXTURE AFTER HARDSCAPE INSTALLATION IS COMPLETE.

11 ALTERNATE NO. 3: PROVIDE THREE POWER PEDESTALS AS INDICATED.

12 ALTERNATE NO. 5: PROVIDE TEN LIGHT BOLLARDS AS INDICATED ON SHEETS ES101 AND ES102.

13 FOR OWNER'S SERVICE PROVIDER'S USE.

GRAPHIC SCALE(S)

1" = 30'

0 30' 60' 120'

DESIGN: FA
DRAWN: FA
REVIEW: PJR

CN 7173-B

DEPARTMENT OF NATURAL AND CULTURAL RESOURCES

VISITOR CENTER AND UNDERWATER ARCHAEOLOGY BUILDING AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S
KURE BEACH, NC 28449

SCO#: 16-16311-02A
CODE: 41614
ITEM: 4C01

DESIGNER

CLARKNEXSEN
333 FAYETTEVILLE STREET, SUITE 1000
RALEIGH, NORTH CAROLINA 27601
919-828-1876

CLARK NEXSEN LICENSE NUMBER: C-1028
PROFESSIONAL SEAL

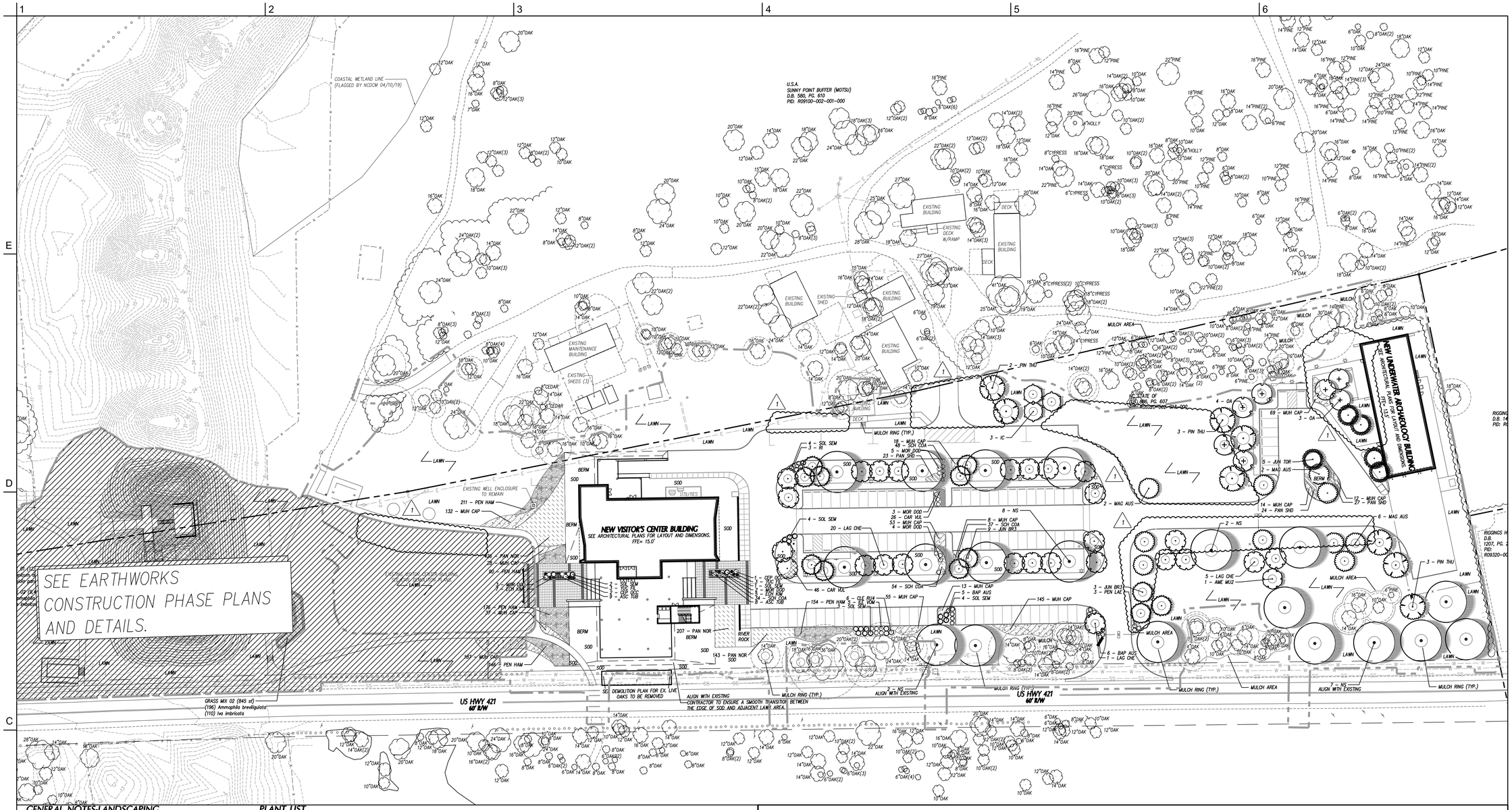
SUBMITTAL
APRIL 29, 2022
BID SET

REVISIONS

1	06/10/22	ADDENDUM 1
2	06/17/22	ADDENDUM 2

SHEET
ELECTRICAL SITE PLAN

ES102



GENERAL NOTES-LANDSCAPING

1. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH ALL NCSCO STANDARDS AND SPECIFICATIONS.
2. LOCATE ALL EXISTING UTILITIES PRIOR TO INSTALLATION OF PLANT MATERIAL. NOTIFY OWNER OF ANY DISCREPANCIES BETWEEN FIELD CONDITIONS AND THOSE SHOWN ON THE PLAN.
3. VERIFICATION OF TOTAL QUANTITIES AS SHOWN ON THE PLANT LIST SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR AND THE TOTAL QUANTITIES SHALL BE AS SHOWN ON THE PLAN.
4. ALL PLANT MATERIAL SHALL CONFORM WITH THE STANDARDS SET FORTH BY THE AMERICAN ASSOCIATION OF NURSERYMEN AND THE WRITTEN SPECIFICATIONS.
5. ALL PLANT MATERIAL (SHRUBS/TREES) SHALL BE A MINIMUM DISTANCE OF 4 1/2 FEET FROM BACK OF CURB, EXCEPT ALONG ANY NEW WALLS ADJACENT TO PARKING WHERE CURB STOPS WILL BE USED. ALL PLANTING BEDS TO BE MULCHED WITH A MINIMUM OF 3" OF MULCH.
6. ALL PLANT GROUPINGS SHALL BE MULCHED AS ONE BED. 3" OF DYED BROWN DOUBLE SHREDDED HARDWOOD MULCH SHALL BE USED AROUND ALL PLANTINGS.
7. APPLY PRE-EMERGENT HERBICIDE TO ALL NEW PLANTING BEDS AT MANUFACTURER'S RECOMMENDED RATE PRIOR TO INSTALLATION OF MULCH.
8. ESTABLISH POSITIVE DRAINAGE IN ALL PLANTING BEDS AND AWAY FROM BUILDINGS.
9. DO NOT INSTALL PLANT MATERIAL IN IMPERVIOUS SOILS, (i.e. HOLES WHICH, WHEN FILLED WITH WATER, DO NOT COMPLETELY DRAIN WITHIN TWO HOURS.) SEE SPECIFICATIONS FOR TOPSOIL REQUIREMENTS.
10. LAWN AREAS SHALL BE SEEDED WITH RIVIERA BERMUDA GRASS (SEE COVERAGE (BASED ON A PER SQUARE YARD SAMPLE) SHALL BE ATTAINED PRIOR TO FINAL INSPECTION. SEE DETAIL SHEET FOR RATES AND SPECIFICATIONS FOR ADDITIONAL INFORMATION.
11. SOD AREAS SHALL RECEIVE TIFWAY 419 BERMUDA SOD.
12. CONTACT THE LANDSCAPE ARCHITECT FOR INSPECTION 48 HOURS IN ADVANCE OF THE SCHEDULED SITE VISIT AND AT THE FOLLOWING INTERVALS:
    - 12.1. REVIEW OF GRADING PRIOR TO PLANT AND LAWN INSTALLATION
    - 12.2. REVIEW OF PLANT MATERIAL PRIOR TO INSTALLATION.
    - 12.3. ONE SUBSTANTIAL COMPLETION MEETING FOR PLANT INSTALLATION.
    - 12.4. ONE FINAL INSPECTION FOR ALL SEEDING/PLANTING OPERATIONS.
13. THE TREE PROTECTION FENCE SHALL BE MAINTAINED ON THE SITE UNTIL ALL SITE WORK IS COMPLETED AND THE FINAL SITE INSPECTION PRIOR TO THE CERTIFICATE OF OCCUPANCY (CO) IS SCHEDULED. THE FENCING SHALL BE REMOVED PRIOR TO FINAL SITE INSPECTION FOR THE CO.
14. LANDSCAPE SUB-CONTRACTOR (UNDER GC CONTRACT) SHALL BE RESPONSIBLE FOR WATERING ALL PLANTS AND LAWN AREAS. CONTRACTOR CAN PROVIDE THEIR OWN WATER SOURCE OR UTILIZE THE EXISTING WELL WITH THREE HOSE BIBS AS THE WATER SOURCE. PLANT MATERIALS OR AREAS OF GRASS WHICH PERISH SHALL BE RE-ESTABLISHED BY THE CONTRACTOR AT NO EXPENSE TO THE OWNER.
15. GENERAL CONTRACTOR SHALL BE RESPONSIBLE FOR KEEPING ALL EQUIPMENT & SUBCONTRACTORS AWAY FROM SEEDED AREAS. IF DAMAGE OCCURS, THROUGH NO FAULT OF THE OWNER, AREAS SHALL BE REGRADED AND RESEEDED IMMEDIATELY AT NO ADDITIONAL COST TO THE OWNER. CONTRACTOR SHALL WATER AND MAINTAIN THOSE AREAS UNTIL THEY ARE AT 95% COVERAGE AT FINAL COMPLETION.
16. SUBSTITUTIONS OF PLANT MATERIAL SHALL ONLY BE ACCEPTED 60 DAYS PRIOR TO COMMENCEMENT OF PLANTING OPERATIONS. SUBSTITUTION REQUESTS MUST BE IN WRITING AND WILL ONLY BE ACCEPTED FOR LACK OF AVAILABILITY REASONS WHICH CAN BE SUBSTANTIATED OR FOR SUPERIOR STOCK SUBSTITUTIONS.
17. LANDSCAPE CONTRACTOR SHALL NOTIFY LANDSCAPE ARCHITECT TO REVIEW GRADING ONE WEEK PRIOR TO SEEDING, IF THE LANDSCAPE CONTRACTOR AND LANDSCAPE ARCHITECT FIND GRADING UNACCEPTABLE FOR FINAL SEEDING, LANDSCAPE CONTRACTOR SHALL BRING IT TO THE ATTENTION OF THE GENERAL CONTRACTOR. LANDSCAPE CONTRACTOR SHALL NOT PROCEED WITHOUT APPROVAL BY LANDSCAPE ARCHITECT.
18. IF CONFLICTS OCCUR BETWEEN WRITTEN SPECIFICATIONS AND THE DRAWINGS, THE WRITTEN SPECIFICATIONS SHALL PREVAIL.
19. ALL FOUNDATION SHRUBS AND TREES TO BE PLANTED A MINIMUM OF 5–FT FROM BUILDING WALL. NOTIFY LANDSCAPE ARCHITECT FOR ANY DISCREPANCIES.
20. INSTALL PERMANENT SEEDING ALONG ALL ROADSIDE DITCHES AND CHANNELS WITHIN CONSTRUCTION LIMITS OF PROJECT. SEE EROSION CONTROL PLANS FOR ADDITIONAL INFORMATION.
21. CONTRACTOR SHALL WASH THE FOLIAGE OF NEWLY INSTALLED PLANTS AT LEAST ONCE PER WEEK UNTIL THE WARRANTY PERIOD IS OVER.
22. THE SOIL INSIDE OF THE PLANTERS NEEDS TO BE NATIVE SOIL OR NATIVE TOPSOIL.

- SEE CIVIL SHEET CE101 FOR TREE PROTECTION FENCING.
- SEE DETAIL SHEET L301 FOR PLANTING DETAILS AND ADDITIONAL INFORMATION.
- GRAPHIC SYMBOLS SUPERSEDE WRITTEN QUANTITIES WHERE DISCREPANCIES OCCUR.
- IRRIGATION NOTE: THE OWNER HAS DECIDED NOT TO INSTALL PERMANENT IRRIGATION. A WATER SOURCE WILL BE AVAILABLE TO THE CONTRACTOR DURING THE INSTALLATION AND ONE–YEAR WARRANTY PERIOD.

PLANT LIST

PLANT SCHEDULE

CANOPY TREES	QTY	BOTANICAL / COMMON NAME	CONT	CAL	SIZE
NS	19	Nyssa sylvatica Black Gym	B&B	2.0"	8–10' HT
OA	17	Oxydendrum arboreum Sourwood Tree	B&B		5'–6' HT.

EVERGREEN TREES	QTY	BOTANICAL / COMMON NAME	CONT	CAL	SIZE
IC	3	Ilex cassine Dahoon Holly – Tree Form	B&B	1" MIN.	4–5' HT
JUN TOR	5	Juniperus chinensis 'Torulosa' Hollywood Juniper	CONT.		4–5' HT
JUN BR3	12	Juniperus silicicola 'Brodie' Brodie Southern Red Cedar	CONT.		5'–6' HT.
MAG AUS	10	Magnolia virginiana australis Sweet Bay – Multitrunk	B&B	1" MIN.	6–7' HT
PIN THU	8	Pinus thunbergii Japanese Black Pine	B&B		4–5' HT

SMALL VARIETY TREES	QTY	BOTANICAL / COMMON NAME	CONT	CAL	SIZE
AME MU2	11	Amelanchier canadensis Shadblow Serviceberry Multitrunk	B&B	MULTI–TRUNK	6–7' HT
LAG CHE	26	Lagerstroemia indica 'Cherokee' Cherokee Crape Myrtle	B&B	MULTI–TRUNK	6–7' HT

SHRUBS	QTY	BOTANICAL / COMMON NAME	CONT	–	SIZE
CEP OCC	3	Cephalanthus occidentalis Buttonbush	CONT.		15–18" HT.
ILE VOM	5	Ilex vomitoria Youpon Holly	CONT.	1 GAL.	FULL
MOR DOD	17	Morella cerifera 'Don's Dwarf' Don's Dwarf Wax Myrtle	CONT.		18–24" HT.
RI	3	Rhaphiolepis indica Indian Hawthorn	CONT.		18–24" HT.
YUC FIL	6	Yucca filamentosa Adam's Needle	CONT.	1 GAL.	FULL

PERENNIAL	QTY	BOTANICAL / COMMON NAME	CONT	–	SIZE
ASC TUB	17	Asclepias tuberosa Butterfly Milkweed	CONT.	1 GAL.	FULL
BAP AUS	11	Baptisia australis Blue Wild Indigo	CONT.	1 GAL.	FULL
CLE RU4	6	Clethra alnifolia 'Ruby Spice' Ruby Spice Clethra	CONT.		18–24" HT.
ECH KIM	12	Echinacea purpurea 'Kim's Knee High' Purple Coneflower	CONT.	1 GAL.	FULL
PEN LAE	3	Penstemon laevigatus Eastern Smooth Beardtongue	CONT.	1 GAL.	FULL
SOL SEM	18	Solidago sempervirens Seaside Goldenrod	CONT.	1 GAL.	FULL

PLANT SCHEDULE

GRASSES	CODE	QTY	BOTANICAL / COMMON NAME	CONT.	–	SIZE	SPACING
	CAR VUL	72	Carex vulpinoidea Brown Fox Sedge	CONT.	1 GAL.		24" o.c.
	MUH CAP	771	Muhlenbergia capillaris Pink Muhly Grass	CONT.	1 GAL.		24" o.c.
	PAN NOR	776	Panicum virgatum 'North Wind' Northwind Switch Grass	CONT.	1 GAL.		24" o.c.
	PAN SHD	74	Panicum virgatum 'Shenandoah' Shenandoah Switch Grass	CONT.	1 GAL.		24" o.c.
	PEN HAM	777	Pennisetum alopecuroides 'Hamelin' Hamelin Fountain Grass	CONT.	1 GAL.		24" o.c.
	SCH COA	173	Schizachyrium littorale Coastal Little Bluestem	CONT.	1 GAL.	Full	12" o.c.

LAWN

LAWN AREAS:
Cynodon dactylon 'Riviera'/ Riviera Bermuda Grass: SEED

GRAPHIC SCALE

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

DEPARTMENT OF NATURAL AND CULTURAL RESOURCES

VISITOR CENTER AND UNDERWATER ARCHAEOLOGY BUILDING AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S
KURE BEACH, NC 28449

SCO #: 16-16311-02A
CODE: 41614
ITEM: 4C01

DESIGNER

CLARKNEXSEN
333 FAYETTEVILLE STREET, SUITE 1000
RALEIGH, NORTH CAROLINA 27601
919-828-1876

CLH DESIGN, P.A.
Regency Park
400 Regency Forest Drive
Suite 120
Cary, North Carolina 27518
Phone: (919) 319–0716
Fax: (919) 319–7516
LA: C–106, PE: C–1595

CLARK NEXSEN LICENSE NUMBER: C-1028
PROFESSIONAL SEAL

SUBMITTAL
APRIL 29, 2022
BID SET

REVISIONS

1	JUNE 17, 2022	ADDENDUM 2

SHEET
SITE LANDSCAPING PLAN

L201

DESIGN: ZRP, ST
DRAWN: ST
REVIEW: ZRP

CN 7173-B
CLH 18-147

VOLUME 4a: PHASE 2 TABLE OF CONTENTS

DIVISION 21 - FIRE SUPPRESSION

DIVISION 22 - PLUMBING

VOLUME 4c: PHASE 2 TABLE OF CONTENTS

DIVISION 31 - EARTHWORK

DIVISION 32 - EXTERIOR IMPROVEMENTS

DIVISION 33 - UTILITIES

DOCUMENT 003132 - GEOTECHNICAL DATA

1.1 GEOTECHNICAL DATA

A. This Document and its referenced attachments are for information and are not part of the Contract Documents.

B. A geotechnical investigation report, prepared by Terracon, dated Dec 20, 2019, is included in this submittal.

C. A soil investigation report, prepared by Fred D. Smith Soil Scientist, dated July 1, 2019 is included in this submittal *as Appendix D in the above geotechnical report*.

D. A wetland delineation report, prepared by Terracon, dated September 9, 2019 is included in this submittal.

END OF DOCUMENT 003132

SECTION 012300 - ALTERNATES

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 alternates.

1.3 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Execute accepted alternates under the same conditions as other work of the Contract.

C. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No. 1: Earthworks and Fortifications.

1. Base Bid: The base bid will consist of the work indicated as for the Phase 2 - Visitor Center and Underwater Archaeology Buildings as indicated in Drawings Volume 2 and as specified in Volumes 3 and 4 of the Project Manual. Allowance No. 20 is not to be included as part of the base bid.
2. Alternate: In addition to Phase 2 work as indicated above, the work shall include Phase 1 – Fortifications and Earthworks as indicated in Drawings Volume and as specified in Volume 2 of the Project Manual. Include Allowance No. 20 in Alternate No. 1.

B. Alternate No. 2: Fencing and Gate at the UAB Utility Yard

1. Base Bid: Provide work at the Underwater Archaeology Building as indicated without the fencing indicated as Alternate No. 2 on Sheets L101 ~~L201~~, CG102 and CU101.
2. Alternate: Provide the work of Phase 2 – Visitor Center and Underwater Archaeology Building including the fencing at the Underwater Archaeology Building Utility Yard as indicated on Sheets L101 ~~L201~~, CG102 and CU101 and as specified in Section 323113 “Chain Link Fence and Gates” located in Volume 4 of the Project Manual.

C. Alternate No. 3: Power Pedestals

1. Base Bid: Provide work at the Visitor Center Exterior South Plaza as indicated without the (3) Power Pedestals indicated as Alternate No. 3 on Sheet ES102 “Electrical Site Plan.”
2. Alternate: Provide the work of Phase 2 – Visitor Center and Underwater Archaeology Building including the (3) Pedestals at the Visitor Center South Plaza as indicated on Sheet ES102 “Electrical Site Plan” and as specified in Section 260533 “Raceways and Boxes for Electrical Systems” and 260543 “Underground Ducts and Raceways for Electrical Systems” located in Volume 4 of the Project Manual.

D. Alternate No. 4: Light Bollards at the UAB Parking Lot

1. Base Bid: Provide work at the Underwater Archaeology Building Parkin Lot as indicated without the (4) Light Bollards indicated as Alternate No. 4 on Sheet ES101.
2. Alternate: Provide the work of Phase 2 – Visitor Center and Underwater Archaeology Building including the (4) Light Bollards at the Underwater Archaeology Building Parking Lot as indicated on Sheet ES101 “Electrical Site Plan” and as specified in Section 265619 “Exterior Lighting” located in Volume 4 of the Project Manual.

E. Alternate No. 5: Light Bollards at the Visitor Center Parking Lot

1. Base Bid: Provide work at the Parking Lot as indicated without the (10) Light Bollards indicated as Alternate No. 5 on Sheet ES101.
2. Alternate: Provide the work of Phase 2 – Visitor Center and Underwater Archaeology Building including the (10) Light Bollards at the Visitor Center Parking Lot as indicated on Sheets ES101 and ES102 and as specified in Section 265619 "Exterior Lighting" located in Volume 4 of the Project Manual.

F. Alternate No. 6: NOT USED

G. Alternate No. 7: NOT USED

H. Alternate No. 8: NOT USED

I. Alternate No. 9: Polished Concrete Topping

1. Base Bid: Provide polished concrete floor finish in locations indicated in the schedule and as specified in Section 033000 "Polished Concrete Finishing."
2. Alternate: In lieu of base bid finish scheduled for polished concrete on Sheet AF601, add a cementitious topping to the slab as specified in Section 033553 "Polished Concrete Topping." Coordinate recessed slab locations and depth with manufacturer's minimum product thickness requirements and structural engineering requirements for structural slab thickness and rebar coverage.

END OF SECTION 012300

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Form-facing material for cast-in-place concrete.
2. Shoring, bracing, and anchoring.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each of the following:

1. Exposed surface form-facing material.
2. Concealed surface form-facing material.
3. Form ties.
4. Waterstops.
5. Form-release agent.

B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.

    a. Location of construction joints is subject to approval of the Architect.

3. Indicate location of waterstops.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Minutes of preinstallation conference.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:

a. Plywood, metal, or other approved panel materials.
b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

1) APA Plyform Class I, B-B or better; mill oiled and edge sealed.

B. Formliners for board formed concrete:

1. Basis-of-Design Product: Subject to compliance with requirements, provide: SpecFormliners 1224 Historic Wood Grain 5.5" Board Width or comparable product by one of the following:

a. Symons (Dayton Superior)
b. Fitzgerald Formliners.
c. Greenstreak.

2. Formliners shall be obtained in the largest size available from manufacturer.

3. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments of concrete

4. See locations indicated.

C. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

1. Provide lumber dressed on at least two edges and one side for tight fit.

2.3 WATERSTOPS

A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

2.4 RELATED MATERIALS

A. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
2. Form release agent for form liners shall be acceptable to form liner manufacturer.

F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.

C. Limit concrete surface irregularities as follows:

1. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.

D. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
3. Install keyways, reglets, recesses, and other accessories, for easy removal.

F. Do not use rust-stained, steel, form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

1. Provide and secure units to support screed strips.
2. Use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2. Locate temporary openings in forms at inconspicuous locations.

I. Chamfer exterior corners and edges of permanently exposed concrete.

J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.
2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

L. Construction and Movement Joints:

1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
3. Place joints perpendicular to main reinforcement.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.

a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls as indicated on Drawings.

a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
5. Clean embedded items immediately prior to concrete placement.

3.3 INSTALLATION OF WATERSTOPS

A. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, according to manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.

1. Install in longest lengths practicable.
2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
3. Protect exposed waterstops during progress of the Work.

3.4 SHORING AND RESHORING INSTALLATION

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Inspections:

1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 031000

SECTION 064023 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior standing and running trim for transparent finish.
2. Interior standing and running trim for opaque finish.
3. Closet and utility shelving.
4. Interior wood stair treads and risers.
5. Miscellaneous materials.
6. Shop finishing.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing interior architectural woodwork that are concealed within other construction before interior architectural woodwork installation.
2. Section 062023 "Interior Finish Carpentry" for interior carpentry exposed to view that is not specified in this Section.

1.2 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections, to ensure that interior architectural woodwork can be supported and installed as indicated.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Anchors.
2. Adhesives.
3. Shop finishing materials.

B. Shop Drawings:

1. Include the following:

a. Dimensioned plans, elevations, and sections.
b. Attachment details.

2. Show large-scale details.
3. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.

C. Samples: For each exposed product and for each shop-applied color and finish specified.

1. Size:

a. Lumber Products: Not less than 5 inches wide by 12 inches long, for each species and cut, finished on one side and one edge.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Architectural Woodwork Standards, Section 2.

B. Do not deliver interior architectural woodwork until painting and similar finish operations that might damage woodwork have been completed in installation areas.

C. Store woodwork in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.7 FIELD CONDITIONS

A. Environmental Limitations without Humidity Control: Do not deliver or install interior architectural woodwork until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of the construction period.

B. Field Measurements: Where interior architectural woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 WOODWORK, GENERAL

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

2.2 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

A. Architectural Woodwork Standards Grade: Premium.

B. Hardwood Lumber:

1. Species: White oak.
2. Cut: Plain sliced/plain sawn.
3. Wood Moisture Content: 8 to 13 percent.

2.3 INTERIOR WOOD STAIRS

A. Architectural Woodwork Standards Grade: Premium.

B. Wood for Transparent Finish:

1. Species and Cut:

a. Risers: White oak, rift cut
b. Treads: White oak, rift cut

2. Wood Moisture Content: 8 to 13 percent.

2.4 SLAT WALL SHEET MATERIALS

A. Composite Wood Products: Provide materials that comply with requirements of the Architectural Woodwork Standards for each type of interior architectural woodwork and quality grade specified unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide Marlite MDF Slat Wall Display system as identified on Sheet AF601 or an equivalent product by one of the following:

a. SpaceWall
b. StoreWall.

2. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130
3. Particleboard: ANSI A208.1, Grade M-**2**.

4. Softwood Plywood: DOC PS 1**,** medium-density overlay.

2.5 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Nailers: Softwood or hardwood lumber kiln-dried to less than 15 percent moisture content.

B. Provide self-drilling screws for metal-framing supports, as recommended by metal-framing manufacturer.

C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage.

1. Provide metal expansion sleeves or expansion bolts for post-installed anchors.
2. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

D. Installation Adhesive: Product recommended by fabricator for each substrate for secure anchorage.

2.6 FABRICATION

A. Fabricate interior architectural woodwork to dimensions, profiles, and details indicated.

1. Ease edges to radius indicated for the following:

a. Edges of Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.

B. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site.

1. Disassemble components only as necessary for shipment and installation.
2. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.
3. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled.

a. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting.
b. Verify that parts fit as intended, and check measurements of assemblies against field measurements indicated on approved Shop Drawings before disassembling for shipment.

C. Stairs:

1. Fabricate stairs with treads and risers no more than 1/16 inch from indicated position and no more than 1/16 inch out of relative position for adjacent treads and risers.

2.7 SHOP FINISHING

A. Finish interior architectural woodwork with transparent finish at fabrication shop. Defer only final touchup, cleaning, and polishing until after installation.

B. Preparation for Finishing: Comply with Architectural Woodwork Standards, Section 5 for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.

1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of interior architectural woodwork. Apply two coats to end-grain surfaces.

C. Transparent Finish:

1. Architectural Woodwork Standards Grade: Premium.
2. Finish System:

a. 12: Polyurethane, Water Based.

3. Staining: Match Architect's sample.
4. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter in accordance with ASTM D523.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition interior architectural woodwork to humidity conditions in installation areas for not less than 72 hours prior to beginning of installation.

B. Before installing interior architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming of concealed surfaces.

3.2 INSTALLATION

A. Grade: Install interior architectural woodwork to comply with same grade as item to be installed.

B. Assemble interior architectural woodwork and complete fabrication at Project site to the extent that it was not completed during shop fabrication.

C. Install interior architectural woodwork level, plumb, true in line, and without distortion.

1. Shim as required with concealed shims.
2. Install level and plumb to a tolerance of 1/8 inch in 96 inches.

D. Scribe and cut interior architectural woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Anchor interior architectural woodwork to anchors or blocking built in or directly attached to substrates.

1. Secure with countersunk, concealed fasteners and blind nailing.
2. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with interior architectural woodwork.
3. For shop-finished items, use filler matching finish of items being installed.

F. Standing and Running Trim:

1. Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible.
2. Do not use pieces less than **36 inches** long, except where shorter single-length pieces are necessary.
3. Scarf running joints and stagger in adjacent and related members.
4. Fill gaps, if any, between top of base and wall with latex sealant, painted to match wall.
5. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.

G. Stairs:.

1. Install stairs with treads and risers no more than 1/16 inch from indicated position.
2. Secure with countersunk, concealed fasteners and blind nailing.

3.3 REPAIR

A. Repair damaged and defective interior architectural woodwork, where possible, to eliminate functional and visual defects and to result in interior architectural woodwork being in compliance with requirements of Architectural Woodwork Standards for the specified grade.

B. Where not possible to repair, replace defective woodwork.

C. Shop Finish: Touch up finishing work specified in this Section after installation of interior architectural woodwork.

1. Fill nail holes with matching filler where exposed.
2. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are shop applied.

3.4 CLEANING

A. Clean interior architectural woodwork on exposed and semiexposed surfaces.

END OF SECTION 064023

SECTION 071326 - SELF-ADHERING SHEET WATERPROOFING

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 elevator pit waterproofing as follows:

1. Modified bituminous sheet waterproofing.
2. Blindside sheet waterproofing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, expansion joints, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

C. Samples: For each exposed product and for each color and texture specified, including the following products:

1. 8-by-8-inch square of waterproofing and flashing sheet.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

C. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.

1. Do not apply waterproofing in snow, rain, fog, or mist.

B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.

1. Warranty Period: Five years from date of Final Acceptance.

B. Installer's Special Warranty: Specified form, on warranty form at end of this Section, signed by Installer, covering Work of this Section, for warranty period of two years.

1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pavers on plaza decks.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Waterproofing System: Obtain waterproofing materials, protection course, from single source from single manufacturer.

2.2 MODIFIED BITUMINOUS SHEET WATERPROOFING

A. Modified Bituminous Sheet: Minimum 60-mil nominal thickness, self-adhering sheet consisting of 56 mils of rubberized asphalt laminated on one side to a 4-mil- thick, polyethylene-film reinforcement, and with release liner on adhesive side; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Carlisle Coatings & Waterproofing Inc.
    b. Polyguard Products, Inc.
    c. W. R. Meadows, Inc.

2. Physical Properties:

    a. Tensile Strength, Membrane: 250 psi minimum; ASTM D 412, Die C, modified.
    b. Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
    c. Low-Temperature Flexibility: Pass at minus 20 deg F; ASTM D 1970/D 1970M.
    d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch movement; ASTM C 836/C 836M.
    e. Puncture Resistance: 40 lbf minimum; ASTM E 154/E 154M.
    f. Water Absorption: 0.2 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D 570.
    g. Water Vapor Permeance: 0.05 perm maximum; ASTM E 96/E 96M, Water Method.
    h. Hydrostatic-Head Resistance: 200 feet minimum; ASTM D 5385.

2.3 BLINDSIDE SHEET WATERPROOFING

A. Blindside Sheet Waterproofing for Horizontal Applications: Uniform, flexible, multilayered-composite sheet membrane that forms a permanent bond with fresh concrete placed against it; complete with accessories and preformed shapes for an unbroken waterproofing assembly; with the following physical properties:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Carlisle Coatings & Waterproofing Inc.
    b. Polyguard Products, Inc.
    c. W. R. Meadows, Inc.

2. Physical Properties:

    a. Low-Temperature Flexibility: Pass at minus 20 deg F; ASTM D 1970/D 1970M.
    b. Peel Adhesion to Concrete: 5 lbf/in. minimum; ASTM D 903, modified.
    c. Lap Adhesion: 5 lbf/in. minimum; ASTM D 1876, modified.
    d. Hydrostatic-Head Resistance: 230 feet; ASTM D 5385, modified.
    e. Puncture Resistance: 200 lbf minimum; ASTM E 154/E 154M.

f. Water Vapor Permeance: 0.1 perm maximum; ASTM E 96/E 96M, Water Method.
g. Ultimate Elongation: 335 percent minimum; ASTM D 412, modified.

B. Mastic, Adhesives, and Detail Tape: Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.

2.4 AUXILIARY MATERIALS

A. Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.

1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.

B. Primer: Liquid waterborne primer recommended for substrate by sheet-waterproofing material manufacturer.

C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by sheet-waterproofing material manufacturer.

D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.

E. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.

F. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8 inch, predrilled at 9-inch centers.

G. Protection Course: Extruded-polystyrene board insulation, unfaced, ASTM C 578, Type X, 1/2 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of waterproofing.

1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
3. Verify that compacted subgrade is dry, smooth, sound, and ready to receive waterproofing sheet.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.

E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Install sheet strips of width according to manufacturer's written instructions and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch.

F. Bridge and cover isolation joints, expansion joints, and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips of widths according to manufacturer's written instructions.

1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.

G. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.

1. Install membrane strips centered over vertical inside corners. Install 3/4-inch fillets of liquid membrane on horizontal inside corners and as follows:

a. At footing-to-wall intersections, extend liquid membrane in each direction from corner or install membrane strip centered over corner.
b. At plaza-deck-to-wall intersections, extend liquid membrane or sheet strips onto deck waterproofing and to finished height of sheet flashing.

H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to ASTM D 6135.

3.3 MODIFIED BITUMINOUS SHEET-WATERPROOFING APPLICATION

A. Install modified bituminous sheets according to waterproofing manufacturer's written instructions and per recommendations in ASTM D 6135.

B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.

C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure watertight installation.

1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F.

D. Two-Ply Application: Install sheets to form a membrane with lap widths not less than 50 percent of sheet widths, to provide a minimum of two thicknesses of sheet membrane over areas to receive waterproofing.

E. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.

F. Seal edges of sheet-waterproofing terminations with mastic.

G. Install sheet-waterproofing and auxiliary materials to tie into adjacent waterproofing.

H. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches beyond repaired areas in all directions.

I. Immediately install protection course with butted joints over waterproofing membrane.

1. may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer and installed immediately.

3.4 BLINDSIDE SHEET-WATERPROOFING APPLICATION

A. Install blindside sheet waterproofing according to manufacturer's written instructions.

B. Place and secure molded-sheet drainage panels over substrate. Lap edges and ends of geotextile to maintain continuity.

C. Horizontal Applications: Install sheet with face against substrate. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required by membrane manufacturer. Overlap and seal seams, and stagger and tape end laps to ensure watertight installation.

D. Corners: Seal lapped terminations and cut edges of sheet waterproofing at inside and outside corners with detail tape.

E. Seal penetrations through sheet waterproofing to provide watertight seal with detail tape patches or wraps and a liquid-membrane troweling.

F. Install sheet-waterproofing and auxiliary materials to produce a continuous watertight tie into adjacent waterproofing.

G. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Tape perimeter of damaged or nonconforming area extending 6 inches beyond repaired areas in all directions. Apply a patch of sheet waterproofing and firmly secure with detail tape.

3.5 FIELD QUALITY CONTROL

A. ~~Manufacturer's Field Service: Engage a site representative~~ *Provide daily reports prepared by an individual* qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components~~; and to furnish daily reports to Architect~~. *Provide a final inspection report provided by the Manufacturer's Field Service Representative*.

B. Waterproofing will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 PROTECTION, REPAIR, AND CLEANING

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 071326

SECTION 072100 - THERMAL INSULATION

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. Extruded polystyrene foam-plastic board.
2. Glass-fiber blanket.
3. Mineral-wool blanket.

B. Related Requirements:

1. ~~Section 042000 "Unit Masonry" for insulation installed in masonry cells.~~
2. Section 072119 "Foamed-in-Place Insulation" for spray-applied polyurethane foam insulation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.

3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD

A. Extruded polystyrene boards in this article are also called "XPS boards." Roman numeral designators in ASTM C 578 are assigned in a fixed random sequence, and their numeric order does not reflect increasing strength or other characteristics.

B. Extruded Polystyrene Board, Type IV : ASTM C 578, Type IV, 25-psi minimum compressive strength; unfaced; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. DiversiFoam Products.
b. Dow Chemical Company (The).
c. Owens Corning.

2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

2.2 GLASS-FIBER BLANKET

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Glass-Fiber Blanket, Unfaced Insert drawing designation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed Corporation.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Owens Corning.

C. Usage: Provide in wall cavities.

2.3 MINERAL-WOOL BLANKETS

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Mineral-Wool Blanket, Unfaced: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Industrial Insulation Group, LLC (IIG-LLC).
b. Roxul Inc.
c. Thermafiber, Inc.; an Owens Corning company.

C. Usage: typical in locations requiring backing materials and fire safing.

2.4 ACCESSORIES

A. Insulation for Miscellaneous Voids:

1. Spray Polyurethane Foam Insulation: ASTM C 1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

1. Adhesives shall have a VOC content of 70 g/L or less.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 LOCATIONS

A. Provide Glass Fiber Blanket insulation as indicated on the drawings within interior framing.

B. Provide Mineral Wool Blanket insulation at acoustically sensitive areas including conference room and large meeting room partitions and in toilet room walls.

3.3 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 081743 – FIBERGLASS REINFORCED POLYESTER DOORS AND FRAMES

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 fiberglass reinforced polyester doors and frames.

B. Related Requirements:

1. ~~Section 042000 "Unit Masonry Assemblies."~~
2. Section 084113 “Aluminum Curtain Wall and Entrance Framing”
3. Section 087111 “Door Hardware”
4. Section 088000 "Glazing" for glass view panels in flush wood doors.
5. Section 089000 “Louvers and Vents”

1.3 PRE-INSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1. FRP Doors and Frames are part of the building envelope. Installer for the FRP doors and frames shall attend pre-installation meetings associated with the construction of the building envelope.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of door. Include description of materials, components, fabrication, finishes and installation.

B. Shop Drawings: Submit manufacturer’s shop drawings, including elevations, sections and details indicating dimensions, tolerances, materials, fabrication, doors, panels, framing, hardware schedule and finish.

1. Indicate dimensions and locations of mortises and holes for hardware
2. Indicate dimensions and locations of cutouts
3. Indicate door finishes
4. Indicate fire protection ratings for fire rated doors
5. Indicate frame details for each frame type, including profiles and metal thicknesses
6. Details of each different wall opening condition

7. Details of anchorages, joints, field splices and connections
8. Details of accessories

C. Samples for Initial Selection:

1. Submit manufacturer's full range of colors for doors and frames (including full range of premium selections).
2. Submit manufacturer's sample of door showing face sheets, core, framing and finish.

D. Samples for Verification:

1. Corner sections of doors, approximately 8 by 10 inches (200 by 250 mm), with door faces and edges representing actual materials to be used.

E. Schedule: Provide a schedule of FRP door frames and doors prepared by or under the supervision of supplier, using same reference numbers for details and for openings as those on the drawings. Coordinate with final door hardware schedule.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Submit certified test reports from qualified independent testing agency indicating doors comply with specified performance requirements.

B. Manufacturer's Project References: Submit list of successfully completed projects including project name and location, name of architect, and type and quantity of doors manufactured.

C. Maintenance Manual: Submit manufacturer's maintenance and cleaning instructions for doors, including maintenance and operating instructions for hardware.

D. Warranty: Submit manufacturer's standard warranty

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain FRP doors from single manufacturer.

B. Performance: A minimum ten year record of production of manufacturing of frames, doors and panels and completion of similar types and size projects is required.

C. Instruction: The manufacturer or his representative will be available for consultation to all parties engaged in the project including instruction during the installation period.

D. Field Measurement: The supplier shall field verify all information prior to fabrication and furnishing of materials. Omitted details due to lack of verification shall be furnished at no additional cost to the Owner.

E. Regulation and Codes: Comply with the current edition in force at the project location of all local, state, and federal codes and regulations, including the American with Disabilities Act of 1992.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the job site in their original, unopened packages with labels intact. Each door and frame will be tagged with a mark or number, which correlates with designation system used for shop drawings. Inspect materials for damage and advise manufacturer immediately or any unsatisfactory materials.

B. Package door assemblies in individual corrugated cartons so no portion of the door has contact with the outer shell of the container. Package and ship frames pre-assembled to the greatest extent possible.

C. Store material in a secure, weatherproof space.

D. Handle doors and frames with care. Do not walk or place other materials on top of stacked doors. Contractor shall use all means necessary to protect doors from damage prior to, during, and after installation. All damaged doors shall be repaired or replaced by the contractor at not cost to the Owner.

1.8 PROJECT WARRANTY

A. Provide a written warranty signed by manufacturer agreeing to replace at no cost to the Owner, any doors, frames, hardware, or factory hardware which fail in materials and in workmanship, within the warranty period. Failure of materials or workmanship includes excessive deflection, faulty operation of entrances, deterioration of finish or construction, in excess of normal weathering, and defects in hardware installation. The warranty period begins at Final Acceptance.

1. FRP doors will carry a 25-year limited warranty on doors of structural integrity, mainframe, and lamination between the face sheets and the core.
2. System manufacturer will guarantee the entire system for a period of 10-years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Corrim Company
2. Special-Lite, Inc.
3. Edgewater FRP Doors
4. ChemPruf Doors, Ltd.

2.2 PERFORMANCE REQUIREMENTS

A. General: Provide door assemblies that have been designed and fabricated to comply with specified performance requirements, as demonstrated by testing manufacturers corresponding standard systems.

B. Air Infiltration: For a single door 3'-0" x 7'-0", test specimen shall be tested in accordance with ASTM E 283 at pressure differential of 6.27 psf: Door shall not exceed 0.58 cfm/ft².

C. Water Resistance: For a single door 3'-0" x 7'-0", test specimen shall be tested in accordance with ASTM E 331 at pressure differential of 7.50 psf: Door shall not have water leakage.

D. Hurricane Test Standards, Single Door:

1. Uniform Static Load, ASTM E 330: Plus or minus 195 pounds per square foot
2. Forced Entry Test, 300 pound load applied, SFBC 3603.2: Passed
3. Cyclic Load Test, SFBC PA 203: Plus or minus or 53 pounds per square foot
4. Large Missile Impact Test, SFBC PA 201: Passed

E. Hurricane Test Standards, Pair of Doors with single point latching:

1. Uniform Static Load, ASTM E 330: Plus or minus 112.5 pounds per square foot
2. Forced Entry Test, 300 pound load applied, AAMA 1304: Passed
3. Cyclic Load Test, ASTM E 1886: Plus or minus 75 pounds per square foot
4. Large Missile Impact Test, ASTM E 1886: Passed

F. Blast Test, Doors and Frames, ASTM F 1642-04, 6 psi/41 pmi-msec: Minimal Hazard

G. Swinging Door Cycle Test: Doors and Frames, ANSI A250.4: Minimum of 25,000 cycles

H. Cycle Slam Test Method, NWWDA T.M. 7-90: Minimum 5,000,000 cycles

I. Swinging Security Door Assembly, Doors and Frames, ASTM F 476: Grade 40

J. Salt Spray: Exterior Doors and Frames, ASTM B 117: Minimum of 500 hours

K. Sound Transmission, Exterior Doors, STC, ASTM E 90: Minimum of 25

L. Thermal Transmission, Exterior Doors, U-Value, AAMA 1503-98; Maximum of 0.29 BTU/Hr x sf x degrees F: Minimum of 55 CRF

M. Surface Burning Characteristics, FRP Doors and Panels, ASTM E 84:

1. Flame Spread: Maximum of 200, Class
2. Smoke Developed: Maximum of 450, Class C

N. Surface Burning Characteristics: Class A Option of Interior Faces of FRP Exterior Panels and Both Faces of FRP Interior Panels, ASTM E 84:

1. Flame Spread: Maximum of 25

2. Smoke Developed: Maximum of 450

O. Impact Strength, FRP Doors and Panels, Nominal Value, ASTM D 256: 14 foot-pounds per inch of notch

P. Tensile Strength, FRP Doors and Panels, Nominal Value, ASTM D 638: 14,000 psi

Q. Flexural Strength, FRP Doors and Panels, Nominal Value, ASTM D 790: 21,000 psi

R. Water Absorption, FRP Doors and Panels, Nominal Value, ASTM D 570: 0.20 percent after 24 hours

S. Indentation Hardness: FRP Doors and Panels, Nominal Value ASTM D 2583: 55

T. Gardner Impact Strength, FRP Doors and Panels, Nominal Value ASTM D 5420: 120 lb-in.

U. Abrasion Resistance, Face Sheet, Taber Abrasion Test, 25 cycles at 1,000 Gram Weight with CS-17 Wheel: Maximum of 0.029 average weight loss percentage

V. Stain Resistance: ASTD D 1308: Face Sheet unaffected after exposure to red cabbage, tea and tomato acid. Stain removed easily with mild abrasive or FRP cleaner when exposed to crayon and crankcase oil.

W. Chemical Resistance, ASTM D 543: Excellent Rating

1. Acetic Acid, Concentrated
2. Ammonium Hydroxide, Concentrated
3. Citric Acid, 10%
4. Formaldehyde
5. Hydrochloric Acid, 10%
6. Sodium hypochlorite, 4- to 6-percent solution

X. Compressive Strength, Foam Core, Nominal Value, ASTM D 1621: 79.9 psi

Y. Compressive Modulus, Foam Core, Nominal Value, ASTM D 1621: 370 psi

Z. Tensile Adhesive: Foam Core, Nominal Value, ASTM D 1623: 45.3

AA. Thermal and Humid Aging, Foam Core, Nominal Value, 158-degrees F and 100 percent humidity for 14-days, ASTM D 2126: Minus 5.14 percent volume change.

2.3 MATERIALS AND ACCESSORIES

A. Fasteners: Provide aluminum, non-magnetic stainless steel or other non-corrosive metal fasteners, guaranteed by the manufactured to be compatible with the doors, frames and stops, panels, hardware, anchors, and other items being fastened. For exposed fasteners, if any, provide Oval Phillips Head Screws with finish matching the item to be fastened. The use of sec bolts or through bolts will not be accepted.

B. Glazing Gaskets: For glazing factory installed glass, and for gaskets, which are factory installed in "captive" assembly of glazing stops, manufacturer's standard stripping of molded neoprene, complying with ASTM D 200 or molded PVC complying with ASTM C 509 Grade 4.

2.4 FIBERGLASS REINFORCED POLYESTER FRP FLUSH DOORS

A. Construction

1. Door Thickness: 1 ¾-inches
2. Stiles and Rails: Seamless, solid FRP of thickness to meet structural requirements
3. Corners: Monolithic
4. Rail caps or other face sheet capture methods are not acceptable
5. Meeting Stiles: Pile brush weather-seals. Extrude meeting stile to include integral pocket to accept pile brush weather seals.
6. Bottom of door: Install bottom weather bar with nylon brush weather-stripping into extruded interlocking edge of bottom rail.
7. Glue: Use of glue to bond sheet to core of extrusions is not acceptable.

B. Face Sheet

1. FRP, 0.120-inch thickness, finish color throughout
2. Finish: Integrally colored gel coat finish.
3. Texture: Smooth
4. Protective Coating: Abuse resistance engineered surface. Provide FRP with protective coating
5. Color shall be provided as selected from manufacturer's full range of colors.
6. Adhesion: The use of glue bond to face sheet to foam core is prohibitive

C. Core

1. Material: Poured in place polyurethane foam
2. Density: Minimum of 5-pounds per cubic foot
3. R-value: Minimum of 9

D. Cutouts: Factory install vision lites, louvers and panels

E. Hardware: Pre-machine doors in accordance with templates from specified hardware manufacturers and hardware schedule.

2.5 FRP FRAMES

A. Perimeter Frame Members.

1. 3/16" thick pultruded fiberglass open throat with return.
2. Factory fabricated.
3. Finish: Match door.
4. 2" face available for frame headers (unless otherwise indicated)
5. Integral door stops as indicated

B. Assembly: Monolithic construction or chemically welded.

1. Corners mitered with 2" x 2" x 1/4" pultruded FRP angle reinforcement with interlocking pultruded FRP brackets.
2. All member to member connections chemically welded at factory.
3. Provide monolithic joint appearance without visible joints.

C. Reinforcement: FRP reinforcement bonded to frame at hinge, strike and closer locations.

D. Hardware: Pre-machine and reinforce frame for hardware in accordance with manufacturer's standards and door hardware schedule.

E. Anchors:

1. Masonry or Concrete:

a. Existing concrete or block punch and dimple.
b. Sill anchor.
c. Concealed existing masonry anchor.
d. Fiberglass masonry t anchor.

2. Drywall.

a. Standard jamb anchor tuck.
b. Optional punch and dimple tuck with either metal studs.

2.6 FABRICATION

A. Sizes and Profiles: Required sizes for doors and frame units, and profile requirements shall be as indicated on the drawings.

B. Coordination of Fabrication: Field Measure before fabrication and show recorded measurements on the shop drawings.

C. Fit:

1. Maintain continuity of line and accurate relation of planes and angles
2. Secure attachments and support at mechanical joints with hairline fit at contacting members.

2.7 GLAZING

A. Provide factory glazed 1-inch insulating glass.

B. Lites in Exterior Doors: Allow for thermal expansion

C. Provide in sizes and locations as indicated on the drawings. Install with scree applied aluminum anodized to match perimeter door rails.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive doors. Notify architect of conditions that would adversely affect installation or subsequent use. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Comply with manufacturer's recommendations and specifications for the installation of the doors and frames. Factory install glass and louvers in doors.

B. Set units plumb, level and true to line, without harp or rack of doors and frames. Anchor securely in place. Separate aluminum and other metal surfaces with bituminous coatings of other means as approved by the architect.

C. Set thresholds in beds of mastic and back-seal.

D. Clean surfaces promptly after installation of doors and frames, exercising care to avoid damage to the protective coating.

E. Ensure that the doors and frames will be without damage or deterioration (other than normal weathering) at the time of acceptance.

3.3 ADJUSTING

A. Adjust doors, hinges, and locksets for smooth operation with binding.

B. Provide owner with adjustment tools and instruction sheets. Arrange an in-service session to Owner at Owner's convenience. Provide a minimum of one year written warranty on all labor related to this section. Any workmanship which is defective or deficient shall be corrected to the Owner's satisfaction and at no additional cost to the Owner.

3.4 CLEANING

A. Clean doors promptly after installation in accordance with manufacturer's instructions.

B. Do not use harsh cleaning materials or methods that would damage finish.

3.5 PROTECTION

A. Protect installed doors to ensure that, except for normal weathering, doors will be without damage or deterioration at time of substantial completion.

END OF SECTION 081743

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

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. Aluminum-framed storefront systems.
2. Aluminum-framed entrance door systems.

B. Related Requirements:

1. Section 087100 "Door Hardware" for door hardware schedule for aluminum-framed entrance systems.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:

a. Joinery, including concealed welds.
b. Anchorage.
c. Expansion provisions.
d. Glazing.

e. Flashing and drainage.

3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
4. Include point-to-point wiring diagrams showing the following:

a. Power requirements for each electrically operated door hardware.
b. Location and types of switches, signal device, conduit sizes, and number and size of wires.

C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

D. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds.
2. Anchorage.
3. Expansion provisions.
4. Glazing.
5. Flashing and drainage.

E. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

F. Delegated-Design Submittal: For aluminum-framed entrances and storefronts including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Installer.
2. For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the State of North Carolina.

B. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.

1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.

C. Source quality-control reports.

D. Field quality-control reports.

E. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.

B. Maintenance Data for Structural Sealant: For structural-sealant-glazed storefront to include in maintenance manuals. Include ASTM C1401 recommendations for post-installation-phase quality-control program.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project ~~who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors~~.

B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

C. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of storefront systems that include structural glazing.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including, but not limited to, excessive deflection.
b. Noise or vibration created by wind and thermal and structural movements.
c. Deterioration of metals and other materials beyond normal weathering.
d. Water penetration through fixed glazing and framing areas.
e. Failure of operating components.

2. Warranty Period: Five years from date of Final Acceptance.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 20 years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.

B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

a. Thermal stresses transferring to building structure.
b. Glass breakage.
c. Noise or vibration created by wind and thermal and structural movements.
d. Loosening or weakening of fasteners, attachments, and other components.
e. Failure of operating units.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.

D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:

1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches.
2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.

E. Structural: Test according to ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Water Penetration under Static Pressure: Test according to ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft..

G. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft..
2. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

H. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor):

   a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.41 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
   b. Entrance Doors: U-factor of not more than 1.10 Btu/sq. ft. x h x deg F as determined according to NFRC 100.

2. Solar Heat-Gain Coefficient (SHGC):

   a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.26 as determined according to NFRC 200.
   b. Entrance Doors: SHGC of not more than 0.25 as determined according to NFRC 200.

3. Air Leakage:

    a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft. when tested according to ASTM E283.
    b. Entrance Doors: Air leakage of not more than 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..

4. Condensation Resistance Factor (CRF):

    a. Fixed Glazing and Framing Areas: CRF for the system of not less than 55 as determined according to AAMA 1503.
    b. Entrance Doors: CRF of not less than 57 as determined according to AAMA 1503.

I. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 3 for basic protection.

1. Large-Missile Test: For glazing located within 30 feet of grade.
2. Small-Missile Test: For glazing located between 30 feet and 60 feet above grade.

J. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

    a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
    b. Low Exterior Ambient-Air Temperature: 0 deg F.
    c. Interior Ambient-Air Temperature: 75 deg F.

K. Structural-Sealant Joints:

1. Designed to carry gravity loads of glazing.

L. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed, aluminum-framed entrances and storefronts without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.3 STOREFRONT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Kawneer North America, an Arconic company.
2. Oldcastle BuildingEnvelope.
3. YKK AP America Inc.

B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Exterior Framing Construction: Thermally broken.
2. Interior Vestibule Framing Construction: Nonthermal.
3. Glazing System: As indicated.
4. Glazing Plane: Front.
5. Finish: Superior-performance organic finish.
6. Fabrication Method: Field-fabricated stick system.
7. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
8. Steel Reinforcement: As required by manufacturer.

C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.4 ENTRANCE DOOR SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Kawneer North America, an Arconic company.
2. Oldcastle BuildingEnvelope.
3. YKK AP America Inc.

B. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.

1. Door Construction: 2-inch overall thickness, with minimum 0.188-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.

    a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.

2. Door Design: Medium stile; 3-1/2-inch nominal width.

3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.

    a. Provide nonremovable glazing stops on outside of door.

4. Finish: Match adjacent storefront framing finish.

2.5 ENTRANCE DOOR HARDWARE

A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 087100 "Door Hardware."

B. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule for each entrance door, to comply with requirements in this Section.

1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products complying with BHMA standard referenced.
2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
3. Opening-Force Requirements:

    a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion and not more than 15 lbf to open the door to its minimum required width.
    b. Accessible Interior Doors: Not more than 5 lbf to fully open door.

2.6 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: As recommended by manufacturer.

D. Structural Glazing Sealants: ASTM C1184 chemically curing silicone formulation that is compatible with system components with which it comes in contact; specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in storefront system indicated.

1. Color: As selected by Architect from manufacturer's full range of colors.

E. Weatherseal Sealants: ASTM C920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed storefront manufacturers for this use.

1. Color: Match structural sealant.

2.7 MATERIALS

A. Sheet and Plate: ASTM B209.

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.

C. Structural Profiles: ASTM B308/B308M.

D. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.

2.8 ACCESSORIES

A. Automatic Door Operators: Section 084229.33 "Swinging Automatic Entrances."

B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system , fabricated from 300 series stainless steel.

C. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.

D. Concealed Flashing: Dead-soft, 0.018-inch- thick stainless steel, complying with ASTM A240/A240M, of type recommended by manufacturer.

E. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.

F. Rigid PVC Filler.

2.9 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from exterior.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.

F. Storefront Framing: Fabricate components for assembly using shear-block system.

G. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

1. At interior and exterior doors, provide compression weather stripping at fixed stops.

H. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
2. At exterior doors, provide weather sweeps applied to door bottoms.

I. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

J. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.10 ALUMINUM FINISHES

A. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
2. Color and Gloss: As selected by Architect from manufacturer's full range.

2.11 SOURCE QUALITY CONTROL

A. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Seal perimeter and other joints watertight unless otherwise indicated.

G. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.

I. Install joint filler behind sealant as recommended by sealant manufacturer.

J. Install components plumb and true in alignment with established lines and grades.

3.3 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 088000 "Glazing."

3.4 INSTALLATION OF STRUCTURAL GLAZING

A. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

B. Set glazing into framing according to sealant manufacturer and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.

C. Set glazing with proper orientation so that coatings face exterior or interior as specified.

D. Hold glazing in place using temporary retainers of type and spacing recommended by manufacturer, until structural sealant joint has cured.

E. Apply structural sealant to completely fill cavity, according to sealant manufacturer and framing manufacturer's written instructions and in compliance with local codes.

F. Apply structural sealant at temperatures indicated by sealant manufacturer for type of sealant.

G. Allow structural sealant to cure according to manufacturer's written instructions.

H. Clean and protect glass as indicated in Section 088000 "Glazing."

3.5 INSTALLATION OF WEATHERSEAL SEALANT

A. After structural sealant has completely cured, remove temporary retainers and insert backer rod between lites of glass as recommended by sealant manufacturer.

B. Install weatherseal sealant to completely fill cavity, according to sealant manufacturer's written instructions, to produce weatherproof joints.

3.6 INSTALLATION OF ALUMINUM-FRAMED ENTRANCE DOORS

A. Install entrance doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.7 ERECTION TOLERANCES

A. Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
3. Alignment:

a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.

4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed entrances and storefronts.

1. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..

a. Perform a minimum of three tests in areas as directed by Architect.

2. Water Penetration: ASTM E1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.

C. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.

1. Test a minimum of two areas on each building facade.
2. Repair installation areas damaged by testing.

D. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 084113

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

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 acoustical panels and exposed suspension systems for interior ceilings.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

1. Acoustical Panels: Set of 6-inch- square Samples of each type, color, pattern, and texture.
2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- long Samples of each type, finish, and color.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension-system members.
2. Method of attaching hangers to building structure.
3. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
4. Size and location of initial access modules for acoustical panels.
5. Items penetrating finished ceiling and ceiling-mounted items including the following:

    a. Lighting fixtures.
    b. Diffusers.

c. Grilles.
d. Speakers.
e. Sprinklers.
f. Access panels.
g. Perimeter moldings.

6. Minimum Drawing Scale: 1/8 inch = 1 foot.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Class A according to ASTM E1264.
2. Smoke-Developed Index: 450 or less.

2.3 ACOUSTICAL PANELS ACT1

A. Manufacturers: Subject to compliance with requirements, provide products Armstrong Ceiling & Wall Solutions Ultima, or an equivalent product by the following:

1. CertainTeed Corporation.
2. USG Corporation.

B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.

C. Classification: Provide panels as follows:

1. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 2, water felted.
2. Pattern: E (lightly textured).

D. Color: White.

E. Light Reflectance (LR): Not less than 0.85.

F. Noise Reduction Coefficient (NRC): Not less than 0.80.

G. Edge/Joint Detail: Square Tegular sized to fit flange of exposed suspension-system members.

H. Thickness: 7/8 inch.

I. Modular Size: 24 by 24 inches.

2.4 ACOUSTICAL PANELS ACT2

A. Manufacturers: Subject to compliance with requirements, provide products Armstrong Ceiling & Wall Solutions Ultima, or an equivalent product by the following:

1. CertainTeed Corporation.
2. USG Corporation.

B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.

C. Classification: Provide panels as follows:

1. Type and Form: Type IV, mineral-fiber base with membrane-faced overlay; Form 2, cloth. Binder shall not contain urea formaldehyde.
2. Pattern: E (lightly textured).

D. Color: White.

E. Light Reflectance (LR): Not less than 0.90.

F. Noise Reduction Coefficient (NRC): Not less than 0.95.

G. Edge/Joint Detail: Square Tegular sized to fit flange of exposed suspension-system members.

H. Thickness: 7/8 inch.

I. Modular Size: 24 by 48 inches.

J. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D3273, ASTM D3274, or ASTM G21 and evaluated according to ASTM D3274 or ASTM G21.

2.5 ACOUSTICAL PANELS ACT3

A. Manufacturers: Subject to compliance with requirements, provide products Armstrong Ceiling & Wall Solutions Lyra, or an equivalent product by the following:

1. CertainTeed Corporation.
2. USG Corporation.

B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.

C. Classification: Provide panels as follows:

1. Type and Form: Type XII, fiberglass with membrane-faced overlay; Form 2, water felted; with vinyl overlay on face.
2. Pattern: E (lightly textured).

D. Color: Peppercorn.

E. Light Reflectance (LR): Not less than 0.80.

F. Ceiling Attenuation Class (CAC): Not less than 40.

G. Edge/Joint Detail: Square Tegular sized to fit flange of exposed suspension-system members.

H. Thickness: 7/8 inch.

I. Modular Size: 24 by 24 inches.

J. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D3273, ASTM D3274, or ASTM G21 and evaluated according to ASTM D3274 or ASTM G21.

2.6 ACOUSTICAL PANELS ACT4

A. Manufacturers: Subject to compliance with requirements, provide products Armstrong Ceiling & Wall Solutions Feltworks Blades Rectangular Panels, or an equivalent product by the following:

1. Filzfelt.
2. HunterDouglas Heartfelt Baffle Ceiling System.

B. Color: As indicated on the Drawings: see Finish Schedule.

C. Edge Detail: Square.

D. Thickness: Manufacturer’s standard.

E. Panel Size: As indicated on Drawings.

2.7 METAL SUSPENSION SYSTEM (ACT1, ACT2, ACT3)

A. Manufacturers: Subject to compliance with requirements, provide Armstrong Ceiling & Wall Solutions, Suprafine or a comparable product by one of the following:

1. CertainTeed Corporation.

2. USG Corporation.

B. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C635/C635M and designated by type, structural classification, and finish indicated.

1. High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" according to ASTM C635/C635M.

C. Narrow-Faced, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 9/16-inch- wide metal caps on flanges.

1. Structural Classification: Intermediate-duty system.
2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
3. Face Design: Flat, flush.
4. Cap Material: Cold-rolled steel.
5. Cap Finish: Match ceiling tile colors.

2.8 METAL SUSPENSION SYSTEM (ACT-4)

A. Manufacturers: Subject to compliance with requirements, provide ceiling suspension system provided by the manufacturer designed to support ACT-4 including concrete anchors and hangers required to complete the suspended ceiling system.

2.9 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E488/E488M or ASTM E1512 as applicable, conducted by a qualified testing and inspecting agency.

a. Type: Postinstalled expansion or Postinstalled bonded anchors.
b. Corrosion Protection: Carbon-steel components zinc plated according to ASTM B633, Class SC 1 (mild) service condition.

B. Wire Hangers, Braces, and Ties: Provide wires as follows:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.

2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.106-inch- diameter wire.

C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

2.10 METAL EDGE MOLDINGS AND TRIM

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.

B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.

1. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils. Comply with ASTM C635/C635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.11 ACOUSTICAL SEALANT

A. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated and comply with layout shown on reflected ceiling plans.

B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

A. Install acoustical panel ceilings according to ASTM C636/C636M and manufacturer's written instructions.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.
2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

D. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

E. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.

1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
2. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
3. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
4. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 ERECTION TOLERANCES

A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.

B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.

B. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems on each floor has reached 20 percent completion, but no panels have been installed. Do not proceed with installations of acoustical panel ceiling hangers for the next area

until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.

1. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf of tension.
2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

C. Acoustical panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 221113 - FACILITY WATER DISTRIBUTION PIPING

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. This Section includes water-distribution piping and related components outside the building for water service and fire-service.

B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.3 DEFINITIONS

A. EPDM: Ethylene propylene diene terpolymer rubber.

B. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

1. Wiring Diagrams: Power, signal, and control wiring for alarms.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water valves, pumps, control panels and specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.

2. *Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.*
3. *Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.*

B. *Piping materials shall bear label, stamp, or other markings of specified testing agency.*

C. *Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.*

D. *Comply with ASTM F645 for selection, design, and installation of thermoplastic water piping.*

E. *Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service products.*

F. *NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.*

1. *Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372.Include marking "NSF-pw" on piping.*

1.7 DELIVERY, STORAGE, AND HANDLING

A. *Preparation for Transport: Prepare valves, including fire hydrants, according to the following:*

1. *Ensure that valves are dry and internally protected against rust and corrosion.*
2. *Protect valves against damage to threaded ends and flange faces.*
3. *Set valves in best position for handling. Set valves closed to prevent rattling.*

B. *During Storage: Use precautions for valves, including fire hydrants, according to the following:*

1. *Do not remove end protectors unless necessary for inspection; then reinstall for storage.*
2. *Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.*

C. *Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.*

D. *Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.*

E. *Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.*

F. *Protect flanges, fittings, and specialties from moisture and dirt.*

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify Owner no fewer than 7 days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Owner's written permission.

1.9 COORDINATION

A. Coordinate connection to water main with utility authority.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Application" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372.

C. Hard Copper Tube: ASTM B88, Type K, water tube, drawn temper.

1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.

E. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

2.2 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and stainless steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

C. Flanges: ASME 16.1, Class 125, cast iron.

2.3 PVC PIPE AND FITTINGS

A. PVC, Schedule 40 Pipe: ASTM D1785.

1. PVC, Schedule 40 Socket Fittings: ASTM D2466.

2.4 JOINING MATERIALS

A. Refer to Section 330500 "Common Work Results for Utilities" for commonly used joining materials.

2.5 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:

1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.

a. Standard: AWWA C219.
b. Center-Sleeve Material: Ductile iron.
c. Gasket Material: Natural or synthetic rubber.
d. Pressure Rating: 150 psig minimum.
e. Metal Component Finish: Corrosion-resistant coating or material.

C. Split-Sleeve Pipe Couplings:

1. Description: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.

a. Standard: AWWA C219.
b. Sleeve Material: Stainless steel.
c. Sleeve Dimensions: Of thickness and width required to provide pressure rating.
d. Gasket Material: O-rings made of EPDM rubber, unless otherwise indicated.
e. Pressure Rating: 150 psig minimum.
f. Metal Component Finish: Corrosion-resistant coating or material.

D. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2.6 CORROSION-PROTECTION PIPING ENCASEMENT

A. Encasement for Underground Metal Piping:

1. Standards: ASTM A674 or AWWA C105.
2. Form: Tube.
3. Material: LLDPE film of 0.008-inch minimum thickness.
4. Color: Black.

2.7 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:

1. Nonrising-Stem, Resilient-Seated Gate Valves:

a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.

1) Standard: AWWA C509.
2) Minimum Pressure Rating: 200 psig.
3) End Connections: Mechanical joint.
4) Interior Coating: Complying with AWWA C550.

2. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:

a. Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.

1) Standard: AWWA C509.
2) Minimum Pressure Rating: 200 psig.

3) End Connections: Flanged.

B. Bronze Gate Valves:

1. OS&Y, Rising-Stem Gate Valves:

a. Description: Bronze body and bonnet and bronze stem.

1) Standards: UL 262 and FMG approved.
2) Minimum Pressure Rating: 175 psig.
3) End Connections: Threaded.

2. Nonrising-Stem Gate Valves:

a. Description: Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable-iron handwheel.

1) Standard: MSS SP-80.

2.8 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Description: Sleeve and valve compatible with drilling machine.

a. Standard: MSS SP-60.
b. Tapping Sleeve: Ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.9 CHECK VALVES

A. AWWA Check Valves:

1. *Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.*

    a. *Standard: AWWA C508.*
    b. *Pressure Rating: 175 psig.*

2.10 DETECTOR CHECK VALVES

A. *Detector Check Valves:*

1. *Description: Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.*

    a. *Standards: UL 312 and FMG approved.*
    b. *Pressure Rating: 175 psig.*
    c. *Water Meter: AWWA C700, disc type.. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.*

2.11 CORPORATION VALVES AND CURB VALVES

A. *Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.*

1. *Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.*
2. *Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.*

B. *Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.*

C. *Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches in diameter.*

1. *Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.*

2.12 WATER METERS

A. *Water meters will be furnished by utility authority.*

2.13 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Standard: AWWA C511.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
4. Size: As indicated
5. Design Flow Rate: 48 gpm UAB Building, 63 gpm Visitor Center .
6. Selected Unit Flow Range Limits: 75 gpm 2 1/2" and 115 gpm 3".
7. Pressure Loss at Design Flow Rate: 12 psig for 2 1/2" and smaller; and 12 psig for 3" and larger.
8. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
9. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
10. Configuration: Designed for horizontal, straight through flow.
11. Accessories:

a. Valves: OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

B. Double-Check, Detector-Assembly Backflow Preventers:

1. Standards: ASSE 1048 and UL listed or FMG approved.
2. Operation: Continuous-pressure applications.
*3. Pressure Loss: **7** psig maximum, through middle 1/3 of flow range.*
4. Size: 8 NPS.
5. Design Flow Rate: 388 gpm Visitor Center, 1500 gpm UAB Buildiing.
6. Selected Unit Flow Range Limits: 2400 gpm - 8", 1600 – 6".
7. Pressure Loss at Design Flow Rate: 7psig.
8. Body: Ductile iron with interior lining complying with AWWA C550 or that is FDA approved.
9. End Connections: Flanged.
10. Configuration: Designed for horizontal, straight through flow.
11. Accessories:

a. Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

C. Backflow Preventer Test Kits:

1. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.14 WATER METER BOXES

A. Description: Cast-iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.

2.15 PROTECTIVE ENCLOSURES

A. Freeze-Protection Enclosures:

1. Description: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of 40 deg F when external temperatures reach as low as minus 34 deg F.

a. Standard: ASSE 1060.
b. Class I-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.

1) Housing: Reinforced-aluminum or -fiberglass construction.

a) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
b) Drain opening for units with drain connection.
c) Access doors with locking devices.
d) Insulation inside housing.
e) Anchoring devices for attaching housing to concrete base.

2) Electric heating cable or heater with self-limiting temperature control.

2.16 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:

1. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.

a. Standard: AWWA C502.
b. Pressure Rating: 150 psig minimum.
c. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
d. Operating and Cap Nuts: Pentagon, 1-1/2 inches point to flat.
e. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
f. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

B. Fire Department Connections:

1. Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- high brass sleeve; and round escutcheon plate.

a. Standard: UL 405.
b. Connections: Two NPS 2-1/2 inlets.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, , and special fittings shall be used, on aboveground piping and piping in vaults.

E. Underground water-service piping NPS 3/4 to NPS 3 shall be the following:

1. Soft copper tube, ASTM B88, Type K wrought-copper, solder-joint fittings; and brazed joints.
2. PVC, Schedule 40 pipe; PVC, Schedule 40 and socket fittings; and solvent-cemented joints.

F. Water Meter Box Water-Service Piping NPS 3/4 to NPS 2 1/2 shall be same as underground water-service piping.

G. Aboveground Water-Service Piping NPS 3/4 to NPS 3 shall be the following:

H. Hard copper tube, ASTM B88, Type K (ASTM B88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.

I. Underground Fire-Service-Main Piping NPS 4 to NPS 12 shall be the following:

1. *Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed and mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.*

J. *Aboveground and Vault Fire-Service-Main Piping NPS 4 to NPS 12 shall be ductile-iron flangepipe; ductile-iron-pipe appurtenances; and flange joints.*

3.3 VALVE APPLICATIONS

A. *General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.*

B. *Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:*

1. *Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated gate valves with valve box.*
2. *Underground Valves, NPS 4 and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.*
3. *Use the following for valves aboveground:*

    a. *Gate Valves, NPS 2 1/2 and Smaller: Bronze, rising stem.*
    b. *Gate Valves, NPS 3 and Larger: AWWA, cast iron, OS&Y rising stem, resilient seated .*
    c. *Check Valves: AWWA C508, swing type.*

4. *Relief Valves: Use for water-service piping in vaults and aboveground.*

    a. *Air-Release Valves: To release accumulated air.*

5. *Detector Check Valves: Use for water-service piping in vaults and aboveground to detect unauthorized use of water.*

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. *See Section 330500 "Common Work Results for Utilities" for piping-system common requirements.*

3.5 PIPING INSTALLATION

A. *Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.*

B. *Make connections larger than NPS 2 with tapping machine according to the following:*

1. *Install tapping sleeve and tapping valve according to MSS SP-60.*

2. *Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.*
3. *Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.*
4. *Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.*

C. *Make connections NPS 2 and smaller with drilling machine according to the following:*

1. *Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.*
2. *Install corporation valves into service-saddle assemblies.*
3. *Install curb valve in water-service piping with head pointing up and with service box.*
4. *Install PE corrosion-protection encasement according to ASTM A674 or AWWA C105.*
5. *Install copper tube and fittings according to CDA's "Copper Tube Handbook."*

D. *Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.*

1. *Install PE corrosion-protection encasement according to ASTM A674 or AWWA C105.*

E. *Bury piping with depth of cover over top at least 36 inches, and according to the following:*

1. *Under Driveways: With at least 36 inches cover over top.*

F. *Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.*

1. *Terminate water-service piping 5 feet from the face of the building wall. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.*

G. *Sleeves are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."*

H. *Mechanical sleeve seals are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."*

I. *Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping..*

J. *JOINT CONSTRUCTION*

K. *See Section 330500 "Common Work Results for Utilities" for basic piping joint construction.*

L. *Make pipe joints according to the following:*

1. *Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.*
2. *Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.*

3.6 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Locking mechanical joints.
2. Set-screw mechanical retainer glands.
3. Bolted flanged joints.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
2. Fire-Service-Main Piping: According to NFPA 24.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

C. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

D. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.

E. MSS Valves: Install as component of connected piping system.

F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

G. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

3.8 DETECTOR-CHECK VALVE INSTALLATION

A. Install aboveground.

B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.

C. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers.

3.9 WATER METER INSTALLATION

A. Install water meters, piping, and specialties according to utility company's written instructions.

B. Water Meters: Shall be supplied by the utility authority.

3.10 ROUGHING-IN FOR WATER METERS

A. Rough-in piping and specialties for water meter installation according to utility company's written instructions.

3.11 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.12 WATER METER BOX INSTALLATION

A. Install water meter boxes in paved areas flush with surface.

B. Install water meter boxes in grass or earth areas with top 2 inches above surface.

3.13 CONCRETE VAULT INSTALLATION

A. Install precast concrete vaults according to ASTM C891.

3.14 PROTECTIVE ENCLOSURE INSTALLATION

A. Install concrete base level and with top a minimum of 2 inches above grade or as indicated on drawings.

B. Install protective enclosure over valves and equipment.

C. Anchor protective enclosure to concrete base.

3.15 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. AWWA Fire Hydrants: Comply with AWWA M17.

C. UL/FMG Fire Hydrants: Comply with NFPA 24.

3.16 ALARM DEVICE INSTALLATION

A. Supervisory Switches: Supervise valves in open position.

1. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.

B. Locking and Sealing: Secure unsupervised valves as follows:

1. Post Indicators: Install padlock on wrench on indicator post.

C. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.

3.17 CONNECTIONS

A. See Section 330500 "Common Work Results for Utilities" for piping connections to valves and equipment.

B. Connect water-distribution piping to utility water main. Use tapping sleeve and tapping valve or service clamp and corporation valve as indicated.

C. Connect water-distribution piping to interior domestic water and fire-suppression piping.

3.18 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.19 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Section 330500 "Common Work Results for Utilities" for identifying devices.

3.20 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 221113

SECTION 221343 - FACILITY PACKAGED SEWAGE PUMPING STATIONS

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. This Section includes wet-well, packaged pumping stations with submersible grinder sewage pumps.

1.3 PERFORMANCE REQUIREMENTS

A. Pressure Rating of Sewage Pumps and Discharge Piping Components: At least equal to sewage pump discharge pressure, but not less than 125 psig.

B. Pressure Rating of Other Piping Components: At least equal to system operating pressure.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Show fabrication and installation details for each packaged sewage pumping station. Detail equipment assemblies and indicate dimensions; shipping, installed, and operating weights; loads; required clearances; method of field assembly; components; electrical characteristics; and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of sewage pump, signed by product manufacturer.

B. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

1. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Qualification Data: For Installer.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Warranty: Special warranty specified in this Section.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with HI 1.1-1.2, "Centrifugal Pumps for Nomenclature and Definitions"; HI 1.3, "Centrifugal Pumps for Design and Application"; and HI 1.4, "Centrifugal Pumps for Installation, Operation and Maintenance," for sewage pumps.

D. Comply with UL 778, "Motor-Operated Water Pumps," for sewage pumps.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewer Service: Do not interrupt sanitary sewer service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sanitary sewer service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary sewer service.
2. Do not proceed with interruption of sanitary sewer service without Owner's written permission.

1.9 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged sewage pumping stations that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including shell.
b. Faulty operation of sewage pumps, controls, or accessories.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period for Shells: 1 year from date of Substantial Completion.
3. Warranty Period for Sewage Pumps and Controls: 1 year from date of Substantial Completion.
4. Warranty Period for Accessories: 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 WET-WELL, PACKAGED SEWAGE PUMPING STATIONS

A. Wet-Well, Packaged Sewage Pumping Stations with Submersible Grinder Sewage Pumps:

1. Description: Factory fabricated, assembled, and tested with wet well for sewage pumps and collection of sanitary sewage and with dry equipment chamber for controls and accessories.

a. Orientation: Shell underground with dry equipment chamber underground with top flush above grade .
b. Shell: Factory fabricated from fiberglass.
c. Sewage Pumps: Two submersible grinder-type sewage pumps, with guide rail, quick-disconnect system, controls, and piping. Include stainless-steel grinder impeller and hermetically sealed motor with moisture-sensing probe, mechanical seals, and waterproof power cable.

2. Capacities and Characteristics:

a. Diameter or Dimensions of Shell: as indicated.
b. Height of Shell Base Section: as indicated.
c. Pumping Station, Inlet Pipe Size: as indicated.
d. Pumping Station, Discharge Pipe Size: as indicated.
e. Sewage Pumps: Two required.
f. Each Sewage Pump: as indicated on plans.

1) Electrical Characteristics: as indicated.

2.2 CONTROLS

A. Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.

B. Float-Switch or Pressure-Switch System: Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on 6-inch minimum differential of liquid level.

C. Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.

D. 120-V accessory controls with 15-A, single-phase circuit breakers or fuses for each item.

E. Control Panel: Enclosure complying with UL 508A and with UL 508A, Supplement SB separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20-A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel. Contractor Shall coordinate with wireless telemetry system and provide a complete, functional system.

1. Mounting: Outside, on pedestal, as indicated..
2. Enclosure: NEMA 250, Type 4X.

F. Install labels on panel face to identify switches and controls.

G. Wiring: Tin-copper wiring.

H. Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Section 263600 "Transfer Switches" and receptacles are specified in Section 262726 "Wiring Devices."

2.3 ACCESSORIES

A. High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.

B. Remote Alarm Circuit: Include contacts for connection to remote alarm panel.

2.4 MOTORS

A. General requirements for motors are specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

2.5 MISCELLANEOUS MATERIALS

A. Grout: ASTM C1107, Grade B, nonshrink cement grout.

1. Design Mix: 3000-psi, 28-day compressive strength.

B. Concrete: Concrete is specified in Section 033000 "Cast-in-Place Concrete."

2.6 PACKAGED SEWAGE PUMPING STATION FABRICATION

A. Fabricate shell from fiberglass with structural-steel reinforcement.

1. Attach structural-steel reinforcement to top and bottom heads.
2. Fabricate shell with continuous joints to make watertight and gastight construction.

B. Entrance Cover: Waterproof and corrosion resistant, with lock.

C. Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.

D. Factory fabricate piping between unit components.

1. Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
2. Use fittings for changes in direction and branch connections.
3. Flanged and union joints may be used instead of joints specified.
4. Use dielectric fittings for connections between ferrous- and copper-alloy piping.

E. Piping Connections: Unless otherwise indicated, make the following piping connections:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment having NPS 2 or smaller threaded pipe connection.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

F. Valves: Ferrous alloy.

1. Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.

G. Wiring: Tin-coated copper.

2.7 SOURCE QUALITY CONTROL

A. Test and inspect sewage pumps according to HI 1.6, "Centrifugal Pump Tests." Include test recordings that substantiate correct performance of pumps at design head, capacity, suction lift, speed, and horsepower.

B. Test accessories and controls through complete cycle. Include test recordings that substantiate correct performance.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of sewerage piping systems to verify actual locations of piping connections before packaged sewage pumping station installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 INSTALLATION

A. Install packaged sewage pumping station components where indicated, according to specific equipment and piping arrangement indicated.

B. Grout under and around shell. Ensure that there are no voids between foundation slab and under slab of pumping station.

C. Fill voids between shell sidewalls, sleeves, and piping and make watertight seal with grout.

3.4 CONNECTIONS

A. Sanitary sewer piping installation requirements are specified in Section 221313 "Facility Sanitary Sewers." Drawings indicate general arrangement of piping.

B. Install piping adjacent to machine to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 IDENTIFICATION

A. Install identifying labels permanently attached to equipment.

B. Install operating instruction signs permanently attached to equipment or on pumping station wall near equipment.

C. Arrange for installing green warning tape or detectable warning tape over outside edges of underground packaged sewage pumping stations. Tape materials and their installation are specified in Section 312000 "Earth Moving."

3.6 PAINTING

A. Prepare and paint ferrous piping in wet wells, structural-steel supports, and anchor devices with coal-tar epoxy-polyamide paint according to SSPC-Paint 16.

B. Paint field-welded areas to match factory coating.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform field tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. After installing packaged sewage pumping stations and after electrical circuitry has been energized, test for compliance with requirements. Furnish water required for pump tests.
2. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Remove and replace packaged sewage pumping stations that do not pass tests and inspections and retest as specified above.

3.8 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup check according to manufacturer's written instructions.
2. Adjust pump, accessory, and control settings, and safety and alarm devices.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged sewage pumping stations. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 221343

SECTION 270001 - DATA COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Managed, cellular-based communication system for alarm monitoring and remotely controlling water and wastewater collection systems equipment with data collection and reporting services.

B. System Components:

1. Remote terminal units to collect and transmit data from Project site to central server location.
2. Cellular communications via specified carriers between remote terminal units and central server location.
3. Central server location to receive, record, and analyze telemetry reported by remote terminal units.
4. Alarm notification system to alert operating personnel about system alarms and malfunction conditions.
5. Secure web-based user interface to access recorded data, generate system reports, and control local equipment through remote terminal unit.

1.2 DEFINITIONS

A. Remote Terminal Unit (RTU): Microprocessor-controlled electronic device that interfaces between equipment and SCADA system by transmitting telemetry and object status data to central server center, and by using messages from central server center to remotely control connected objects.

B. Supervisory Control and Data Acquisition (SCADA): Managed system operating with coded signals over cellular communication channels to acquire information about remote equipment status for display, recording, and alarm signaling functions and to provide control of remote equipment.

1.3 SUBMITTALS

A. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.
2. Include list of owners, locations, and duration of service, where products are in use upon request.

B. Manufacturer's installation instructions.

C. Warranty: See Warranty .

D. Operation and Maintenance Manual: For remote terminal units, data communication system, and support service.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firm engaged in manufacture of cellular-based remote terminal units (RTUs) and operation of managed SCADA service for a minimum of 10 years.

B. Supplier Qualifications: Manufacturer, or firm that is manufacturer's authorized and trained agent, or combination of both, that provides, maintains, and warrants on-site monitoring equipment and web-based data reporting system.

1. Provide required monitoring-related services with field equipment. Maintain ongoing cellular service agreements through relationships with cellular carrier provider(s).
2. Provide specified server center and server infrastructure.
3. Provide continuous technical support, at all times.
4. Demonstrate similar services are currently provided to minimum 100 United States public agencies.
5. Demonstrate products and services are in conformance with American Recovery and Reinvestment Act requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the Project site, unless otherwise indicated.

B. Label products with manufacturer’s name, product, or product brand name. Assign unique, original identifier (serial number) to each RTU.

1.6 WARRANTY

1. 1 year from date of Substantial Completion.

PART 2 - PRODUCTS AND SERVICES

2.1 MANUFACTUERS

A. Basis-of-Design: Subject to compliance with requirements, provide products and systems by basis of design manufacturer or comparable products and systems by one of the following:

1. Mission Communications; as basis of design.

a. The Engineer has worked with the following representative/distributor/vendor in the development of the Specifications for this equipment. This person is identified solely as a potential convenience with no intended or implied restriction, recommendation, endorsement, etc.: Vinnie Bryant with Clearwater Inc. vinnie.bryant@clearwaterinc.net.

B. Acceptable Manufacturer:

1. Mission Communications; Model MyDro M850.

2.2 Substitutions: Must be approved by Owner REMOTE TERMINAL UNITS (RTU) - GENERAL

A. RTU: Factory assembled and programmed data collection and reporting device, contained within electrical enclosure designed for 25 year life expectancy.

B. Data Cellular Radio: Communicate with central server location via cellular radio transmitting data through Transmission Control Protocol (TCP) socket connection.

1. Provide encrypted and end-to-end acknowledged transmissions. Short Message Service (SMS), User Datagram Protocol (UDP), and satellite-based data transmission methods are not permitted.
2. Accommodate radios from various cellular carriers; field-interchangeable within 10 minutes.
3. Support LTE, 3GPP and 3GPP/2 technology for CDMA and HSPA+ networks.

a. LTE: Quad Band LTE: 700/850/AWS (1700/2100)/1900 MHz; FDD-Band (17,5,4,2); Tri Band UMTS (WCDMA): 850/AWS (1700/2100)/1900 MHz; FDD-Band (5,4,2) Quad Band GSM/GPRS/EDGE: 850/900/1800/1900 MHz
b. GSM: Quad-band (850/900/1800/1900 MHz) GSM/GPRS/EDGE, 3GPP release 99/4 improved SAIC.
c. CDMA: Triple-band CDMA2000, Bands: BC0/BC1 & BC10 subclass 2+3 (800/1900 MHz), 3GPP2: 1xAdvanced, EV-DO Rev. A.

C. Basis-of-Design Product: Subject to compliance with requirements, provide basis of design product or comparable product by the following:

1. Mission Communications, Model M850; as basis-of-design.

D. Remote Terminal Unit (RTU) Enclosure:

1. NEMA 250, Type 4X Enclosure: Outdoor, watertight enclosure with front sun shield to reduce internal temperature and with accommodation for housing 12 V, 5Ahr back-up battery.

a. Size (W x H x D): 13.75 x 13.75 , 5.5 inches.

E. Power Requirements: UL Recognized, 120 VAC to 12 VAC transformer. Includes back-up battery capable of powering RTU for 20 to 48 hours.

F. Digital Inputs:

1. Eight (8) inputs shall detect normal, off-normal and wire fault (supervised) state changes.

    a. Model M850: Eight over-the-air configurable inputs to report real-time pump run status and run times User-selectable normally open (NO) or normally closed (NC) logic. Selectable input type (with wire fault supervision, without wire fault supervision, or with strap on current sensor where greater than 5A indicates pump run.) LCD Touch screen for indication of open, closed, and wire fault conditions.

2. Input Option Board: Includes eight (8) additional digital inputs.

G. Analog Inputs:

1. Two inputs measuring 4-20 mA or 0-5 VDC at 10 bit resolution.

    a. Model M850: Transmit value every two minutes or more rapidly when value deviates from previous transmission by 5% or more of full scale.

2. Alarm Threshold: Four, user configurable alarm points for each input.
3. Input Option Board: Includes four (4) additional analog inputs and two (2) pulse inputs.

H. Pulse Inputs:

1. Input Option Board: Includes two (2) pulse counting inputs.

    a. Model M850: Transmit data every two minutes when change in pulse data occurs.

2. Input Type: Open collector circuits or dry switch state changes of up 60 Hz and duration as low as 18 milliseconds.
3. Input Scaling: Based on unit of measurement.

I. Digital Outputs:

1. Number: Three, form C, dry contact relay outputs

    a. M850 rated at 5 ampere at 12 or 24VDC.

2. Type: Single pole double throw (SPDT) for NO or NC.
3. Circuit Logic: Fail-safe.

J. Analog Outputs:

1. Output Option Board: Two capable of transmitting a 4-20 mA output signal.
2. Output Scaling: Accessible from web portal.
3. Output Value Changes: Performed by manual page from remote interface, or automatically via intertie to analog value from another RTU.

K. On-Board Telemetry Data: Report AC voltage, battery voltage, signal strength and printed circuit board temperature, hourly. Dispatch alarms for AC failure, low battery voltage, elevated and low temperature, and loss of communications.

L. Electronic Key: Provide electronic key reader, accessible without opening RTU enclosure to record personnel site visits to RTU. Sound audible tone confirming key reading.

1. Key Functions: Place RTU in service state for one hour; acknowledge alarms; and/or document site personnel's presence.
2. Service Status Light: Activates optional local light indicating RTU service state when connected to an unused digital relay output configured for that purpose.
3. Key Identity: Code keys uniquely identifiable to Owner assigned personnel.

M. Wet Well Module:

1. Detect pump run status without a direct connection to high voltages or interposing relays.
2. Support minimum of three strap-on pump run Hall-effect current sensors.
3. Provide continuous detection and reporting of high wet well state when no AC power is available to station via back-up battery of the RTU.

2.3 COMMUNICATIONS

A. RTU Communication: Transmit data through cellular radios that communicate through third and fourth generation GSM and, or CDMA cellular networks.

1. Provide cellular radios with private IP addresses.
2. Communication Link Structure: TCP socket connection from RTU through cellular system to the Supplier’s servers. Short Message Service (SMS), User Datagram Protocol (UDP), and satellite-based data transmission methods are not permitted.

    a. Provide private gateways through respective cellular networks.

3. Data Encryption: Transmit data after application layer encryption and with carrier level encryption.
4. End-to-End Data Acknowledgment: Confirm every data packet from RTU to central server with central server acknowledgement back to RTU in real-time.
5. Communication Failure Alarms: Dispatch communication failure alarm.

    a. Monitor and report secure socket connections for end-to-end uptime.
    b. Report interruption durations 15 seconds and greater, and every disconnect/reconnect event.

B. Cellular Service:

1. Provide relationships with cellular providers.
2. Included in annual managed service fee.
3. Maintain cellular data contract with cellular carrier and interface with carrier when technical support is required.

4. Obtain approval from cellular provider, accepting cellular radios for use on respective cellular network in accordance with FCC requirements.

C. Data Transmission Rates

1. Off-normal conditions: Transmit data on occurrence to initiate alarm notifications. Ability to delay alarm notifications via the web portal user interface.
2. The data transmission rates shall be configurable over-the-air by Manufacturer.
3. Model M850: Pump state transmitted in real-time. Transmit analog value every two minutes or more rapidly when value deviates from previous transmission by 5% or more of full scale. Pulse count transmitted every 2 minutes.

    a. System monitored telemetry data transmitted every hour (signal strength, board temperature, AC and battery voltages).

2.4 SERVER CENTER AND SERVER INFRASTRUCTURE

A. Provide and maintain central server center that will house redundant and linked servers, interconnects, databases, power supplies, inbound cellular connections, and outbound internet hubs and providers.

B. Server Center Performance Requirements

1. Survivability: Server center structure sufficient to maintain continuous operations following direct hit by F-3 tornado.

C. Portable Generator power will provided.

D. Data:

1. Ownership: Data is Owner's property and will not be disclosed, unless authorized by Owner in writing.

    a. Provide historical RTU data storage forever.
    b. Manufacturer shall backup and archive databases daily.

2. Data Export and Data Links: Provide the following capabilities.

    a. Interfacing to an Object Linking and Embedding for Process Control (OPC) compliant Human Machine Interface (HMI) for client/server SCADA systems.
    b. Connection will be based OPC-UA 1.03 (October 2015) or greater
    c. Security:

        1) User must be authenticated before a connection can be established
        2) Authentication must support X.509 certificates before connection is allowed
        3) All messages encrypted with 128 bit or better encryption
        4) All messages must be signed to ensure that they are received exactly as they are sent
        5) Owner’s firewalls will not be required to accept incoming socket connections.

6) Allow for multiple concurrent OPC connections to provide redundant HMI database operation at Owner's locations.
7) Auditing and logging must be available for all user activities

E. Security: Provide access to web portals via TLS crypotographic security protocol. SSL methods must be disabled. Web portal must receive an A rating from Shttps://www.ssllabs.com/ssltest/

2.5 ALARM AND ALERT NOTIFICATION SYSTEM

A. Alarms

1. Provide alarm notifications for off-normal conditions and upon return-to-normal conditions.

    a. Provide capability to transmit return to normal alarms to different notification group.

2. Alarm Notification: Via telephone (voice call), fax, pager (numeric or alphanumeric - short alpha or long alpha format), text message, email, or any combination, simultaneously.
3. Provide capability to allow alarm notification cycles with configurable delay between each cycle and with each cycle containing multiple notification destinations.
4. Provide capability to acknowledge alarms at time of initial alarm delivery or by a toll free return phone call, text message, two-way pager, email or via Owner's web portal.
5. Provide system capability to cease alarm notification when user acknowledges alarm event, with capability to re-initiate alarm notification when alarm input remains off-normal after user settable time.
6. Provide capability for specific users to be notified of individual alarm events.
7. Provide capability for alarm notifications to be configured based on time of alarm. Permit alarm notification groups to switch between groups at different hours of the day and different days of week.

    a. Provide alarm notification groups that accommodate multiple teams within each group to easily facilitate rotation of teams of on-call personnel.

B. Alarm Message Formats

1. Alarm Notifications: Describe alarm condition, time, location at time of off normal condition. Also provide the following:

    a. M850 RTUs: pump status

2. Provide capability for alarms to be delivered individually or grouped into one message so multiple, simultaneous alarms (like AC Fail at multiple sites) can be delivered and acknowledged in one phone call.
3. Deliver alarm with added introductory message asking for specific person, when calling a phone where the person answering is not known.

C. Voice Alarm Delivery Capacity:

1. Provide capacity to deliver minimum 20 outbound simultaneous voice phone lines.

D. Alarm Dispatch Logs: Document each alarm event with the following:

1. Event information:

a. Date.
b. Time.
c. Station name.
d. Alarm condition.

2. Notification information:

a. Date.
b. Time.
c. Name of person notified.
d. Notification method (phone, text message, email, fax etc.).
e. Status of Notification: "Success", "Failure", or "Event Acknowledged".

1) For notification failure, log failure reason (i.e., line busy, call dropped, etc.).

3. Provide recording of each voice notification attempt, to document notification.

E. Alert Notification System:

1. Provide email and/or fax alerts for less critical items, such as low battery voltage and communication failure reminder.
2. Provide analyses for daily pump runtimes over 30 days, with an alert triggered if pump runtime falls outside 30-day high or low average runtime pattern.
3. Provide analyses of hourly pump runtimes and automatically compare runtimes to two user-set thresholds. Dispatch an alert next day when alert threshold is exceeded. Dispatch alarm immediately when alarm threshold is exceeded.
4. Provide analysis of hourly pump starts and automatically compare starts to two user-set thresholds. Dispatch an alert next day when alert threshold is exceeded. Dispatch alarm immediately when alarm threshold is exceeded.

2.6 REMOTE DATA ACCESS

A. Remote Data Access Format

1. Provide remote access to system collected data via web browser, through internet-enabled smart phone, tablet, laptop, or desktop computer.

a. UI must be optimized for viewing both on small screens and large monitors.

2. Provide secure access through specified phone that does not require web access (Voice SCADA). This will require user login credentials, with minimum of numeric five-digit login and associated phone number for that site to maintain site security.

3. Provide access to web portals via TLS crypotographic security protocol. SSL methods must be disabled. Web portal must receive an A rating from Shttps://www.ssllabs.com/ssltest/
4. Provide web portal display of graphs, reports, alarms, and RTU setup.

    a. Optimize data to minimize page loading times.
    b. Windows (reports, graphs) must update automatically when new data is available.
    c. Utilize Responsive Design patterns where the Graphical User Interface (GUI) automatically adapts to the screen size.

5. System Access: Require user name and password credentials for access to web portal.

    a. Provide three levels of access:

        1) Read only: Can view pages but cannot make changes.
        2) Administrator: Can view pages, can make system changes, and alter control functions.
        3) Super Admin: Can view pages, make system changes, alter control functions and add, modify or remove user credentials.

B. Data Presentation

1. Model M850:

    a. Map to display location of each unit and color coded status indication.
    b. Battery voltage, AC voltage, temperature, and radio status condition.
    c. Report end-to-end uptime history and daily connection percentage of each RTU.
    d. RTU electronic key reads with user names, time of read, and site name.
    e. Pump runtimes by hour and day with historical graphs and tables and individual pump flow estimates.
    f. Automatic daily analysis of pump runtimes for abnormalities with automatic notification of abnormalities.
    g. Pump starts with hourly analysis of excess pump starts with automatic notifications of excess pump starts.
    h. Present analog data available in table, graph, polar chart and spreadsheet format. Label and scale analog data based on unit of measurement.
    i. Present digital data available in table and spreadsheet format.
    j. Data Exports: Support XLS, CSV, PDF, and JPEG file formats.
    k. Produce and automatically deliver report summarizing alarms and responses; pump runtimes and flow estimates; weekly end-to-end uptime percentages of each RTU, and electronic key uses at the RTU sites.
    l. Perform and display volumetric inflow/outflow calculations from RTU-supplied data for each pump cycle using real-time pump start/stop data with simultaneously gathered level transducer or float data to perform inflow/outflow and pump GPM calculations.
    m. Pump flow capacity estimations for station capacity analysis based on station design capacity and RTU-supplied data for each pump cycle.
    n. Show pump run status from map view
    o. Data Exports: Support XLS,.CSV, PDF, and JPEG file formats.

C. Security Data:

1. Passwords and Access

    a. Log accesses to User web portal. Include date, time, and duration of access; User Name and Password to access site, and IP address of accessing computer.

        1) Provide accessibility to log through User web portal.
        2) Store passwords in encrypted/blind format. There are no default passwords.

2. Tank and Well Control package requires password for system changes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install remote terminal units in accordance with Manufacturer and Supplier's recommendations.

1. Delineate timing of RTU installation and commissioning.
2. Conform to National Electric Code and local codes.
3. Label inputs as to their purpose on enclosure lid schematic.
4. Terminations inside RTU enclosure: Low voltage.
5. Provide Manufacturer's Representative inspection of sites prior to completion.
6. Test inputs for successful transmission prior to municipality acceptance.
7. Adjust antenna placement or elevation to obtain consistent, stable system operation.

3.2 DEMONSTRATION AND TRAINING

A. Startup Training: Vinnie Bryant Clearwater Inc. vinnie.bryant@clearwaterinc.net.

B. Demonstrate proper methods for operating and maintaining equipment, and explain contents of operation and maintenance manual to Owner's personnel.

C. Ongoing Training: Provide ongoing training at no charge throughout initial year of service, in form of weekly webinars, online videos, white papers, and other documents.

1. A training library shall be available on the Supplier's website.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Representative approval that installed equipment operates satisfactorily and in compliance with the requirements of this Section.

3.4 SERVICE AGREEMENT

A. Beginning at Substantial Completion, provide continuous, renewable annual service agreement including:

1. Data Services: Cellular data connections, servers and infrastructure that acts on and stores Owner's data, and administration of same. No separate overage charges or early termination fees shall apply.
2. Notifications: Provide real-time alarm notifications and alarm notification recording.
3. Provide record of success or failure of each event including audio recording of voice alarm callouts.
4. Web Portal: Web portals optimized for personal computers and mobile devices.
5. Technical support: Provide live telephone technical support from 8 AM to 6 PM eastern time. Provide emergency technical support at all times at no additional charge.

3.5 MONITORING POINT SCHEDULE

A. RTU-1 Inputs and Outputs:

1. Digital inputs:

a. DI-1: Pump 1 Status
b. DI-2: Pump 2 Status
c. DI-3: Not used
d. DI-4: High Wet Well
e. DI-5: Pump 1 Fail
f. DI-6: Pump 2 Fail
g. DI-7: Phase Fail
h. DI-8: Not used

2. Additional digital inputs via optional expansion board:

a. DI-9: Not required
b. DI-10: Not required
c. DI-11: Not required
d. DI-12: Not required
e. DI-13: Not required
f. DI-14: Not required
g. DI-15: Not required
h. DI-16: Not required

3. Analog inputs (with four (4) high/low threshold alarms):

a. AI-1: Not used
b. AI-2: Not used

4. Additional analog inputs via optional expansion board:

a. AI-3: Not required

b. AI-4: Not required
c. AI-5: Not required
d. AI-6: Not required

5. Pulse inputs via optional expansion board:

a. P-1: Not required
b. P-2: Not required

6. Analog outputs (optional):

a. AO-1: Not required
b. AO-2: Not required

7. Relay outputs:

a. R-1: Not used
b. R-2: Not used
c. R-3: Not used

END OF SECTION 270001

Geotechnical Engineering Report

Fort Fisher Visitors' Center & Underwater Archeology Buildings
Kure Beach, North Carolina
December 20, 2019
Terracon Project No. 70195145

Prepared for:
North Carolina Department of Natural & Cultural Resources
Raleigh, North Carolina

Prepared by:
Terracon Consultants, Inc.
Raleigh, North Carolina

December 20, 2019

North Carolina Department of Natural and Cultural Resources (NCDNCR)
109 East Jones Street
Raleigh, North Carolina 27601

Attn: Mr. Tony Romaine, P.E.
Telephone: 919-814-6614
E-mail: tony.romaine@ncdcr.gov

Re: Geotechnical Engineering Investigation, R1
New Visitor Center Building & Underwater Archeological Buildings
Fort Fisher State Historic Site
1610 Fort Fisher Boulevard
Kure Beach, North Carolina
Terracon Project No. 70195145

Dear Mr. Romaine:

We have completed geotechnical engineering services for the above referenced project. This study was performed in general accordance with revisions Terracon Proposal No. P70195014 dated May 21, 2019. This revised report (Revision 1) presents the findings of the subsurface exploration, including cone penetration test soundings, and provides geotechnical recommendations for proposed design and construction.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, please contact us.

Sincerely,
Terracon Consultants, Inc.

NORTH CAROLINA PROFESSIONAL SEAL 031022 ENGINEER ANDREW A. NASH 12/20/19

Mark Weritz, P.E.
Senior Engineer

Andrew A. Nash, P.E.
Geotechnical Department Manager
Registered, NC 031022

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Terracon has completed the geotechnical engineering investigation for the proposed Fort Fisher Visitors' Center project in Kure Beach, North Carolina. Twenty (20) soil test borings and three (3) SCPT soundings were advanced across the project property. The following geotechnical considerations were identified:

- Subsurface conditions consist of very loose to medium dense, fine- to medium-grained sands to an approximate depth of 35 feet below the existing ground surface. Below a depth of 35 feet, loose to dense sands and cemented sands were encountered to a depth of 50 feet. An approximate 5-foot thick layer of very soft to soft clay is present at a depth of approximately 37 feet within the southeastern half of the Visitors' Center building. Groundwater was measured at depths between 7 and 9 feet below existing grade.

- Very loose to loose, clean (less than 10 percent fines), saturated sands comprise a large part of the site subgrade. These sands are susceptible to effects of liquefaction, which can induce significant ground settlement and/or temporary reduction of shear strength during a large earthquake event. Cone Penetration Test (CPT) results confirm liquefiable subgrade within the depth interval of 14 to 28 feet. Based on CPT data, estimated settlement due to liquefaction is approximately 2 to 3 inches. Subgrade modification is generally recommended for sites with estimated liquefaction settlement greater than 4 inches.

- The new Visitors' Center Building will consist of a two-level structure with maximum column loads on the order of 620 kips. For coastal plain sites, deep foundations such as driven pre-stressed concrete piles or concrete auger cast piles are generally required to support column loads more than 300 kips. Vertical load capacity of piles typically ranges between 15 and 75 tons; however, loss of shear strength due to liquefaction can reduce allowable load capacity. A table summarizing allowable load capacities of 12-inch and 14-inch pre-stressed concrete piles is included in this report.

- The new Underwater Archeological Building will consist of a single-story structure with a maximum column load of 26 kips. Lightly loaded, single-story structures can typically be designed with conventional spread or column foundations. For the Underwater Archeological Building, conventional shallow foundations can be designed with an allowable bearing pressure of 2,500 pounds per square foot.

- Subgrade improvement techniques such as vibrocompaction or rammed aggregate piers designed, performed, and/or installed by a specialty ground improvement contractor can create a densified subsurface zone within a building footprint, which can act as a relatively deep, stiffened, subgrade that can adequately support light to relatively heavy building loads. Properly designed subgrade modification techniques may significantly reduce anticipated settlements induced by normal structural loads or seismic events and can provide a viable alternative to extended foundations.

- The geotechnical engineer should be retained during construction of the project to observe earthwork and to perform necessary tests and observations such as proof-rolling; placement and compaction of controlled compacted fills; observation of subgrade preparation, and backfilling of excavations into the completed subgrade.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

Geotechnical Engineering Report

New Visitors' Center & Underwater Archeological Buildings
1610 Fort Fisher Boulevard
Kure Beach, North Carolina

Terracon Project No. 70195145
December 20, 2019

1.0 INTRODUCTION

This revised report (Revision 1) presents the results of our subsurface exploration and geotechnical engineering services performed for the new Visitors' Center and Underwater Archeological Building at the Fort Fisher State Historical Site in Kure Beach, North Carolina. The purpose of these services is to provide information and preliminary geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Site earthwork
- Excavation considerations
- Seismic Site Classification
- Foundation design parameters
- Floor slab design and construction
- Pavement design and construction
- Lateral earth pressures & retaining walls
- Settlement estimates
- Permeability Testing

2.0 PROJECT INFORMATION

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Location	1610 Fort Fisher Boulevard S, Kure Beach, North Carolina 33.9720º N, 77.9175º W
Existing Improvements	The existing Fort Fisher Visitor Center.
Current Ground Cover	The ground surface consists of asphalt paved parking areas, landscape areas, and driveways within the southern portion of the project site, and grass turf with surrounding trees within the site's northern portion.
Existing Topography	The project area is relatively flat, except near existing mound fortifications south of the existing Fort Fisher Visitor Center building.

Our current understanding of the project conditions is as follows:

Item	Description
Structures	**New Visitor's Center Building**: two-story, footprint size of 125 by 195 feet, with open ground floor spaces. **Underwater Archeological Building**: single-story, footprint size of 50 by 140 feet.
Finished Floor Grade	Not provided but assumed to be near existing grade.
Maximum loads	**New Visitor's Center Building:** Walls: 3-6 kips per lineal foot (assumed) Columns: 620 kips (provided) Slabs: 100 to 150 pounds per square foot (assumed) **New Underwater Archeological Building:** Walls: 1-3 kips per lineal foot (assumed) Columns: 26 kips (provided) Slabs: 100 to 150 pounds per square foot (assumed)
Max. allowable settlement	(up to 1 inch total assumed).
Site Features and Pavements	New earth mounds (Bombproofs) and berms will be constructed south of the existing building. Sally Ports and other buried features will be constructed in or around Bombproofs. New Parking Lots with Heavy-Duty Asphalt Drive Aisles and Bus Parking. Plazas and automobile parking spaces to be paved with permeable pavers. New concrete sidewalks and heavy-duty concrete pavements for service yards. New boardwalks.
Stormwater Control	New stormwater devices (including permeable pavers) will be constructed at scattered locations across project area.
Grading/Slopes	A project grading plan has not been provided; however, due to the relatively flat nature of the site, we anticipate only minor site grading for site development. Maximum cut and fill depths are anticipated to be less than 3 feet of existing grades across most of the site. Earthfill and retaining walls may be constructed around Bombproofs and Sally Ports. Bombproofs will likely be constructed with two levels of earth slopes, each no higher than 10 to 15 feet. Desired slope configurations approach 1H:1V.

If any of the project information outlined above is inconsistent with the proposed construction, or if the design changes, Terracon requests the opportunity to review our recommendations.

3.0 SUBSURFACE CONDITIONS

3.1 Site Geology

Kure Beach, North Carolina is in the outer Coastal Plain Physiographic Province, which consists of marine sediments that were deposited during successive periods of fluctuating sea level and laterally repositioned shorelines. Marine deposited sediments consist of sands, silts, and clays with irregularly distributed zones of shells. The 1985 Geologic Map of North Carolina indicates the site is located in an area mapped as undivided Quaternary marine sediments, which are typically located along low-lying recent and existing coastlines. The site is located 150 miles northeast of the Charleston, South Carolina Seismic Source Zone.

3.2 Typical Profile

We developed a general characterization of subsurface soil conditions based upon our review of the data and our understanding of the geologic setting and planned construction:

Stratum	Approximate Depth to Bottom of Stratum	Material Description	Consistency/Density
1	37' to 39'	**Poorly Graded Sand**, with trace to little silt, shell fragments in deeper sands	Very Loose to Medium Dense
2	42'	**Sandy Clay,** approx. 5 feet thick, with shell fragments (B-2, B-3, B-5 and B-6)	Very Soft to Soft
3	50'+	**Poorly Graded to Well Graded Sand**, with trace to little silt or clay, shell fragments, occasionally cemented	Loose to Very Dense

For a detailed description of the conditions encountered in the borings, refer to the boring logs in Appendix A of this report. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual.

3.3 Groundwater

The boreholes were observed during and after drilling for the presence and level of groundwater. Groundwater levels were measureable in all test borings at depths ranging between 7.0 and 9.0 feet below existing grade. Measured water levels observed in the boreholes are indicated on boring logs.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff, tidal patterns, and other factors not evident at the time the borings were performed. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

4.0 SEISMIC CONSIDERATIONS

4.1 Seismic Evaluation

According to the 2015 International Building Code (IBC 2015), structures are required to avoid collapse during a design earthquake event. The design earthquake has a 50-year exposure period with a 2% probability of exceedance (i.e. a 2,500-year design earthquake with a Moment Magnitude (Mw) of 7.3). The seismic evaluation of the site identified potentially liquefiable soils. According to both the IBC 2015 and ASCE 7-10, the potential for liquefaction classifies the site as Site Class F.

ASCE 7-10 (Section 20.3.1) provides an exception to the Site Class determination procedures for structure(s) with a fundamental period equal to or less than 0.5 seconds. This exception states that a site can be classified without considering liquefaction to determine spectral accelerations for structural design. If proposed structures meet requirements of the exception, Seismic Site Class D would be applicable and the following seismic design parameters can be used for the site:

Description	Value, 0.5 sec Exception[2]	Value, With Liquefaction[3]
2015 International Building Code Site Classification	D	F
Site Latitude	33.976	33.976
Site Longitude	-77.917	-77.917
S_{DS} Spectral Acceleration for a Short Period [3]	0.243g	TBD
S_{D1} Spectral Acceleration for a 1-Second Period [3]	0.15g	TBD

1. The ASCE 7 method uses a site profile extending to a depth of 100 feet for seismic site classification. Borings at this site were extended to a maximum depth of 50 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area.
2. These values were obtained using online seismic design maps and tools provided by the USGS (http://earthquake.usgs.gov/hazards/designmaps/).
3. Site Specific Seismic Analysis required to determine seismic site parameters

4.2 Liquefaction Potential

Very loose to loose, uniformly graded, shallow, clean (less than 10 percent fines), saturated sands that comprise a large part of the site's subgrade are particularly susceptible to the effects of liquefaction. A triggering event such as a large earthquake is necessary to initiate liquefaction. Southeastern North Carolina is not a known source zone of significant earthquakes, however, it is affected by earthquakes originating from the Charleston, South Carolina Seismic Source Zone, which is located 150 miles southwest of the site.

Ground shaking, and liquefaction of soil under foundations, are the principal seismic hazards to be considered in design of earthquake-resistant structures. Liquefaction occurs when a rapid buildup in water pressure, caused by ground motion, pushes sand particles apart, resulting in a loss of shear strength and later densification, after water pressure dissipates. Loss of shear strength can cause bearing capacity failure, while densification can cause excessive settlement.

The amount of liquefaction settlement is dependent on the magnitude and distance from a seismic event, and geologic age and relative density of sandy deposits. Based on SCPT data, we estimate that liquefaction settlements resulting from a design earthquake event may range between **2 to 3 inches**. Differential settlements may range between 50% and 75% of total liquefaction settlement.

Design under the IBC allows for buildings to sustain damage during the design earthquake event, but remain standing. Therefore, liquefaction settlement estimates should be reviewed by the project structural engineer from the standpoint of risk of total collapse of a proposed structure.

4.3 Liquefaction Mitigation

If deemed necessary, methods for liquefaction mitigation include: earthquake drains, rammed aggregate compaction, deep foundation systems, vibro-floatation, vibro-replacement, dynamic compaction, etc. Terracon can explore these options with the owner and design team if desired. Subgrade modification is generally recommended for sites with estimated liquefaction settlement greater than 4 inches.

5.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

5.1 General

The project includes construction of a new Visitors' Center building, a new Underwater Archeological building, and new earth mounds and berms for the proposed Sally Port and Bombproof site features. The project may require subgrade improvement techniques, and an existing conditions survey of structures and site features. General information of these geotechnical considerations is discussed below.

5.1.1 New Visitors' Center Building

The new Visitors' Center Building will consist of a two-level structure with maximum column loads on the order of 620 kips. For coastal plain sites located within the coastal plain, deep foundations such as driven pre-stressed concrete piles or concrete auger cast piles are normally required to support column loads exceeding 300 kips. Vertical load capacity of driven piles in coastal plain soils generally range between 15 and 75 tons; however, loss of shear strength during liquefaction can significantly reduce vertical load capacities of piles. Recommended allowable capacities for 12-inch and 14-inch precast concrete piles driven to 50 to 60 feet deep range between 27 to 52 tons. If piles driven deeper than 60 feet are considered, we recommend additional SPT drilling. See Section 5.1.3 for subgrade improvement techniques that can provide alternatives to a deep pile foundation for the new Visitors' Center Building.

5.1.2 New Underwater Archeological Building

The new Underwater Archeological Building will consist of a single-story structure with a maximum column load of 26 kips. Lightly loaded, single-story structures can typically be designed with shallow, conventional spread or column foundations. For the Underwater Archeological building, conventional shallow foundations can be designed with a bearing pressure of 2,500 pounds per square foot, with less than 1 inch of anticipated settlement due to static structural loads. However, estimated seismic settlement of 2 to 3 inches can cause some damage to slab-on-grade floor and the building structure. See Section 5.1.3 for subgrade improvement techniques that can possibly mitigate liquefaction potential.

5.1.3 Subgrade Improvement Techniques

Subgrade improvement techniques such as vibrocompaction or rammed aggregate piers, designed and installed/performed by specialty ground improvement contractors can create a densified subgrade zone under building footprints. A building subgrade modified as described above can generally support light to heavy column loads with tolerable attendant settlements (generally less than 1 inch) from both structural and seismic loads. Terracon can explore these options with the owner and design team if desired.

5.1.4 Sally Port and Bombproof

New earth mounds and berms will be constructed south of the existing Visitor Center building. Approximately 25 feet of earthfill will be placed for the construction of the Bombproof (earth fortification to absorb artillery impact) and Sally Port (fortified gateway). Interior sections of the Bombproof and Sally Port will be constructed with precast segmental culvert sections with interior height clearances of 15 feet and 8.5 feet, respectively. Cast-in-place concrete walls, headwalls, and wingwalls will be constructed around culvert sections to retain surrounding soil. Architectural timber will be placed over exposed concrete for historical appearance.

Boring data of test boring B-20 indicates subsurface conditions consist mostly of loose sands to a depth of 45 feet. The weight of new earthfill will induce ground settlements on the order of 2 to 4 inches. The degree of settlement will vary directly with height of earthfill, which will cause higher settlements at the center of the earthfill and less settlement at outer edges. Most settlement will occur quickly (less than 1 week) as most of the affected subgrade consists of predominately sandy soils.

If constructed before or during placement of earthfill, precast and cast-in-place concrete structures of the Bombproof and Sally Port can be directly affected by induced ground settlement caused by earthfill placement. We recommend that the full height of earthfill be initially used as surcharge to induce ground settlement before placement or construction of the concrete structures. Shortly after full earthfill placement and after subsidence of ground settlement, the subgrade of precast and cast-in-place concrete structures of the Bombproof and Sally Port features can then be excavated and prepared. Temporary shoring or temporary slopes may be necessary during construction. Ground improvement techniques, as described in section 5.1.3., can also be used to reduce settlement cause by weight of earthfill.

Desired slope configuration of new earth mounds may be steeper than a 2H:1V configuration and approach a 1H:1V configuration. Earth slopes constructed of clean or silty sands cannot maintain slopes steeper than a 2H:1V without reinforcement as they are especially prone to surface sloughing and erosion. Earth slopes constructed of clay or clayey sands (20 percent minimum of plastic fines with minimum PI of 15), with a slope height of less than 15 feet, may be able to maintain slopes approaching a 1H:1V, but will require establishment of appropriate temporary and permanent erosion control or vegetative cover, and continual maintenance.

5.1.5 Consideration of Existing Structures or Site Features

Existing structures and site features should be surveyed prior to pile installation or subgrade improvement procedures to document existing conditions. Existing structures should also be monitored during pile installation or subgrade improvement procedures for indications of movement. Pile installation or subgrade improvement procedures should be stopped, and Terracon contacted if movement or cracking of the existing structures is observed. Monitoring vibration levels during site activities should also be considered.

5.2 Earthwork

Earthwork will include clearing and grubbing, excavation and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria necessary to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

5.2.1 Site Preparation

Complete stripping of existing vegetation, topsoil, and root mat should be performed in proposed building and parking/driveway areas. After site clearing and prior to fill placement, the exposed subgrade soils in structure footprints should then be densified in-place using a medium weight smooth drum vibratory roller. The medium weight vibratory smooth-drum roller should make at least six passes, with the second set of three passes perpendicular to the first set of three passes. The purpose of the vibratory rolling is to improve the exposed subgrade soils for floor slab support and to improve the foundation bearing soils. Vibratory rolling should be completed during dry weather. If water is brought to the surface by the vibratory rolling, the operation should be discontinued until the water subsides

After site stripping and vibratory rolling is completed, the site should be thoroughly proof-rolled in all areas to receive fill and in building or pavement areas that are close to design grade. Proof-rolling should be performed with a loaded, tandem-axle dump truck with a minimum gross weight of 10,000 lb or similar rubber-tired construction equipment. After a period of dry weather, a representative of the geotechnical engineer should observe the proof-roll. If the exposed soil surface exhibits excessive deflection, pumping or rutting under the proof-rolling operation, we recommend over-excavation of the loose, unstable soil and replacement with moisture-conditioned soil fill or crushed aggregate base course.

Placing a 4- to 6-inch thick layer of aggregate base stone (NCDOT ABC) or NCDOT Class III material over a prepared subgrade or geotextile fabric also will protect the subgrade from damage from construction traffic.

5.2.2 Existing Fill

Evidence of existing fill was not encountered in test borings; however, as the site has been previously developed, existing fill may be present in unexplored areas. Support of footings, floor slabs, and pavements on or above existing fill soils is discussed in this report. However, even with the recommended construction procedures, there is an inherent risk for the owner that compressible fill or unsuitable material within or buried by the fill will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by following the recommendations contained in this report.

5.2.3 Engineered Fill Material Types

Fill required to achieve design grade should be classified as structural fill and general fill. Structural fill is material used below, or within 10 feet of structures, pavements or constructed slopes. General fill is material used to achieve grade outside of these areas. Earthen materials used for structural and general fill should meet the following material property requirements:

Fill Material	USCS Classification	Acceptable Location for Placement
Imported or On-Site Low- to Moderate-Plasticity Soil (max. 20% fines)	SM, SP, SP-SC, SP-SM	All locations and elevations
Sand / Gravel with less than 10% fines	GW/GP, SW/SP	NCDOT ABC – suitable beneath pavement sections and floor slabs
Imported or On-site Low- to Moderate-Plasticity Soil (min. 20% fines)	CL, SM, SC	All locations and elevations except as backfill behind retaining walls or mechanically stabilized earth walls.
Imported or On-site Low- to Moderate-Plasticity Soil (min. 20% fines & minimum PI of 15)	CL, SM, SC	Bombproof exterior slopes

1. Controlled, compacted fill should consist of approved materials that are free of organic matter and debris. A sample of each material type should be submitted to the geotechnical engineer for evaluation.

5.2.4 Fill Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Description
Fill Lift Thickness	9-inches or less in loose thickness (4-inch to 6-inch lifts when hand-operated equipment is used).
Structural Fill Compaction Requirements [1]	Minimum of 95% of the material's standard Proctor maximum dry density (ASTM D698). The top lift of engineered fill should be compacted to a minimum of 98% of the material's standard Proctor maximum dry density (ASTM D698) for retaining walls, buildings and pavements.
General Fill Compaction Requirements [1]	Minimum of 92% of the material's standard Proctor maximum dry density (ASTM D698).
Moisture Content	Within the range of -2% to +3% of optimum moisture content as determined by the standard Proctor test at the time of placement and compaction.

1. Engineered fill should be tested for moisture content and compaction during placement. If in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the tests should be reworked and retested as required until the specified moisture and compaction requirements are achieved.

5.2.5 Grading and Drainage

During construction, grades should be sloped to promote runoff away from the construction area. Final grades should be sloped away from any structure on all sides to prevent ponding. If gutters / downspouts do not discharge directly onto pavement, they should not discharge directly adjacent to any building in landscaped areas. This can be accomplished through the use of splash-blocks, downspout extensions, and flexible pipes that are designed to attach to the end of the downspout if necessary. Flexible pipe should only be used if it is day-lighted in such a manner that it gravity-drains collected water. Splash-blocks should also be considered below hose bibs and water spigots. Paved surfaces which adjoin any building should be sealed with caulking or other sealant to prevent moisture infiltration at the building envelope; maintenance should be performed as necessary to maintain the seal.

5.2.6 Excavations

We anticipate that on-site materials can be excavated with conventional earth moving equipment. All temporary excavations that may be required during construction should comply with applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards to provide stability and safe working conditions.

Water was measured at depths of 7 to 9 feet at test boring locations. Dewatering of any excavations below a depth of 5 feet may be required.

5.2.7 Construction Considerations

Near surface soils are moisture sensitive and will soften and become unstable with increasing moisture content. Site earthwork should be performed during the summer and early fall months when improved drying conditions and the shorter duration of rainfall events reduce the risk of moisture related earthwork difficulties. This does not preclude earthwork during other times of the year, but performing site earthwork during the late fall, winter, and spring can increase the need for remedial earthwork.

A qualified geotechnical engineer should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation; to monitor proof-rolling, placement and compaction of controlled compacted fills, backfilling of excavations to the completed subgrade; and to observe prior to placing reinforcing steel in the footing excavations.

5.3 Foundation Recommendations

Subgrade modification techniques described in Section 5.1.3 can be considered to densify the soil sufficiently to reduce post-construction static settlements and seismic settlement, allowing structures to be supported by traditional shallow foundations. Deep foundations, consisting of pre-stressed concrete piles or auger cast in place piles transfer building loads to deeper load-bearing stratums, eliminating static settlement issues and potential risk associated with liquefaction. A specialty ground improvement contractor can provide recommendations for appropriate types of ground improvement, based on subsurface data contained in this report.

5.3.1 Shallow Foundations

When prepared as described in this report, we anticipate the site will be suitable for support of the Underwater Archeology building on shallow foundations. Shallow foundations can consist of either isolated column and wall footings or thickened sections of a monolithic slab. For the Underwater Archeology building, a design bearing pressure of 2,500 pounds per square foot (psf) is suitable for shallow foundations bearing on native, surface densified, sand subgrade or properly placed structural fill. Possible liquefaction settlement of 2 to 3 inches could cause some structural damage.

If the subgrade of the Visitors' Center building footprint is improved with techniques described in section 5.1.3, the building may be supported on conventional shallow foundations. An allowable bearing pressure greater than 4,000 psf may be possible on improved ground but will be dependent on ground modification design determined by the specialty ground improvement contractor.

A representative of the geotechnical engineer should be retained during foundation subgrade preparation to carefully evaluate foundation excavations through a combination of hand auger borings, dynamic cone penetrometer (DCP) testing, and probing. The materials within a depth of

at least 4 feet below foundation bearing elevations should be evaluated. Soft, loose, or otherwise unsuitable materials, if encountered, should be over-excavated and replaced with compacted engineered fill. If groundwater is encountered, backfill may consist of tamped washed, crushed stone (NCDOT No. 57).

The base of all foundation excavations should be free of water and loose soil prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Should the soils at bearing level become excessively disturbed or saturated, the affected soil should be removed prior to placing concrete.

5.3.2 Deep Foundations

For the Visitors' Center building, deep foundations consisting of driven pre-stressed concrete piles, or augered cast-in-place (ACIP) piles installed by the displacement method, are appropriate.

The structural capacity of piles should be checked to assure they can safely accommodate the combined stresses induced by axial and lateral forces. Lateral deflections of piles should be evaluated using an appropriate analysis method, and will depend upon the pile's diameter, length, configuration, stiffness and "fixed head" or "free head" condition. We can provide additional analyses and estimates of lateral deflections for specific loading conditions upon request.

5.3.2.1 Driven Pre-Stressed Concrete Pile Construction Considerations

The contractor should select a driving hammer and cushion combination that can install the selected piling without overstressing the pile material. The hammer should have a rated energy in foot-pounds at least equal to 15% of the design compressive load capacity in pounds. The contractor should submit the pile driving plan and the pile hammer-cushion combination to the engineer for evaluation of the driving stresses in advance of pile installation. During driving, a maximum of 10 blows per inch is recommended to reduce the potential of pile damage. Recommended allowable axial capacities of concrete piles are summarized in the table below:

Recommended Allowable Axial Capacities
(36- and 40-ton Downdrag Force Considered for 12- and 14-inch PSC Pile, respectively)

Pile Tip Depth BGS (feet)	**12-inch PSC Pile**	**14-inch PSC Pile**
Allowable Compression Capacities (tons)		
50	27	38
55	33	45
60	38	52
Allowable Tension Capacities (tons)		
50	15	19
55	19	23
60	22	28

If practical refusal is experienced above the pile tip elevation, a replacement pile should be driven. If this occurs, the situation should be evaluated by Terracon during pile driving operations.

Pile driving conditions, hammer efficiency, and stress on the pile during driving, restriking, and redriving could be better evaluated during installation using a Pile Driving Analyzer (PDA). A Terracon representative should observe pile driving operations. Each pile should be observed and checked for cracking and alignment in addition to recording penetration resistance, depth of embedment, and general pile driving operations.

5.3.2.2 Augered Cast-in-Place Piles Considerations

ACIP piles installed by the displacement method (soil cuttings are pushed outward and compact the soils adjacent to the pile grout column) can provide higher capacities than those installed by the non-displacement method. A minimum center-to-center spacing of three pile diameters should be maintained to limit the possibility of damage to adjacent piles during installation. Compressive stresses in the piles should not exceed 25% of the grout's 28-day compressive strength and steel reinforcement should meet the structural requirements of the pile as determined by the structural engineer. Typically, a minimum set time of 18 hours should be provided prior to installation of adjacent piles.

The successful performance of ACIP piles is highly dependent on the quality of installation. In soft/loose ground conditions, there is a risk of soil inclusions or "necking" of the grout column that can significantly reduce the structural capacity of the grout column. We recommend that the pile installation contractor for the project be pre-selected on a qualification basis. As a minimum the contractor's personnel should have at least 5 years of total experience in the piling industry. All personnel and equipment should be subject to the review of the geotechnical engineer.

We recommend that a test pile be installed within the building footprint. The load test for compression capacity should be conducted in accordance with ASTM Standard D-1143, "*Standard Test Method For Piles under Static Axial Compressive Load*". The reaction frames and hydraulic jacks by which load will be applied to the pile should have a capacity equivalent to at least 2.5 times the design capacity of the piles. A representative of the geotechnical engineer monitor the installation of the test and reaction piles, the load test program, and evaluate the load test data.

During production installation of the piles, acceptance of the individual piles depends on a number of criteria, including installation time, withdrawal rate during pumping, grout take, tested compressive strength of the grout, etc. Each pile should contain a minimum of 115% of the theoretical "neat-line" volume of grout for its individual length. Each pile must be evaluated separately because of the anticipated variables at the site.

Field monitoring of the pile installation is a direct extension of the design process. Pile installation techniques must be observed, weighed against load test data, and evaluated to determine the acceptance of each pile. Understanding of the subsurface conditions and pile design requirements are necessary to make the routine engineering judgments required during installation. Therefore, the preceding foundation recommendations should be considered valid only if the geotechnical engineer monitors the pile installation.

5.4 Floor Slabs

When prepared as described in this report, we anticipate the site will be suitable for support of building floor slabs; however, seismic considerations may require structurally supported slabs and grade beams, or subgrade improvement techniques as described in section 5.1.3. As part of the normal recommended preparation, in-place compaction by vibratory roller should be performed to densify the near surface materials and should be followed by proofrolling and further evaluation of the subgrade. Design and construction recommendations for concrete floor slab supported are presented in the following table and paragraphs.

Item	Description
Floor slab support	Approved existing soils or new engineered fill.
Modulus of subgrade reaction (k)	150 pounds per square inch per inch (psi/in) can be used for lightly loaded floors. The recommended k value(s) for heavily loaded floors will require further evaluation.
Stone Base Course	4 inches of stone base course (NCDOT CABC or NCDOT No. 57)

We recommend floor subgrades be maintained in a relatively moist yet stable condition until floor slabs are constructed. If the subgrade should become excessively desiccated or wet prior to construction of floor slabs and pavements, the affected material should be removed or the materials scarified, moisture conditioned, and recompacted. Upon completion of grading operations in the building areas, care should be taken to maintain the recommended subgrade moisture content and density prior to construction of the building floor slabs. Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations, refer to the ACI Design Manual.

The use of a vapor retarder should be considered beneath concrete slabs on grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings. The slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

5.5 Lateral Earth Pressures

Lateral earth pressures will be influenced by structural design of walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).

5.5.1 Preliminary Retaining Wall Considerations

See **Foundation Recommendations** for preparation of retaining wall subgrade if retaining walls are included in project sitework. If mechanically supported earth (MSE) walls or conventional cantilevered retaining walls are to be constructed, we recommend that these walls be designed with the cooperation of the project civil engineer and geotechnical engineer to:

- Identify conflicts from proposed foundations or utilities potentially impacting walls;
- Consider site constraints that might influence required construction activities such as excavation behind the wall;
- Integrate site grading to direct surface water flow away from the wall;
- Select appropriate wall types;
- Identify additional subsurface exploration to determine foundation and retained soil conditions;
- Consider effects of ground settlement on structures and utilities
- Perform analyses of global stability and external wall stability;
- Recommend guidelines for retained soils to use in wall design;
- Evaluate structures to be located near or over the reinforced zone;
- Describe need for and type of fences at the top of the wall;
- Review possible contracting procedures for design and wall construction.

To provide effective coordination we recommend that the site civil engineer, geotechnical engineer, and owner meet to identify issues influencing retaining wall designs and identify responsible parties to reduce costs and minimize the chance of unexpected difficulties during both design and construction.

Native soils that may be excavated on-site are generally not acceptable for use as backfill against retaining walls or for use as backfill for mechanically stabilized earth walls. On-site materials, however, can be used as backfill for wall heights of less than 4 feet. With greater wall heights, clean granular material becomes the preferred choice due to both the reduction in lateral pressures and better drainage characteristics. Assuming level backfill, the following equivalent fluid pressures are recommended for unrestrained cantilever retaining walls:

Active:

Cohesive soil backfill (clays and silts)..... 55 psf/ft
Granular soil backfills (sand/gravel with less than 20% fines)..... 35 psf/ft

Passive:

Cohesive soil backfill (clays and silts)..... 200 psf/ft
Granular soil backfill (sand/gravel with less than 20% fines)..... 375 psf/ft

For a cantilever type wall restrained from rotation at the top, and assuming level backfill, recommended equivalent fluid pressures for retaining wall design are:

At-Rest:

Cohesive soil backfill (clays and silts)..... 75 psf/ft
Granular soil backfill (sand/gravel with less than 20% fines)..... 55 psf/ft

The lateral earth pressures presented above do not include any factor of safety and are not applicable for submerged soils/hydrostatic loading. A sliding coefficient of 0.35 can be used for design.

To reduce the potential for perched groundwater and surface water infiltration impacting foundation-bearing soils and to reduce hydrostatic loading on retaining walls, a wall drain system should be placed behind cantilever type retaining walls. The drain system should consist of free-draining, granular soils containing less than 5 percent fines (by weight) passing a No. 200 sieve placed adjacent to the wall. The free-draining, granular material should be graded to prevent the intrusion of fines or encapsulated in a suitable filter fabric. Crushed, washed stone should be considered in areas where space is limited for compaction equipment such as between shoring and retaining walls. A relatively impervious soil should be used in the upper layer of backfill to reduce the potential for water infiltration. As an alternative, a prefabricated drainage structure such as geo-composite may be used as a substitute for the granular backfill adjacent to the wall. The drain system against walls should be hydraulically connected to weep holes or to an outlet drain at the base of the wall.

5.6 Pavements

When prepared as described in this report, we anticipate the site will be suitable for support of the proposed pavements. As part of the recommended preparation, in-place compaction should be performed to densify the near surface materials and should be followed by proofrolling and further evaluation of the subgrade. Design and construction recommendations for pavements supported on an approved subgrade are presented in the following paragraphs.

Pavement thickness design is dependent upon:

- the anticipated traffic conditions during the life of the pavement;
- subgrade and paving material characteristics; and
- climatic conditions of the region.

Most near surface soils at the site consist of predominately sandy soils. Areas that do not pass proofroll may require overexcavation and replacement with structural fill, and/or use of geosynthetic material. California Bearing Ratio (CBR) test results of sandy bulk samples collected at test borings B-14 and B-19 were 7.1 and 8.7 respectively. We used a CBR value of 7 as the design CBR value for pavement thickness design. Typical pavement sections for similar subgrade soil conditions are listed in the following table:

		Thickness (inches)	
Pavement Type	**Material**	**Light-Duty**	**Heavy-Duty**
Flexible	Asphalt Concrete (NCDOT Type S9.50B)	3.0	1.0
	Asphalt Concrete (NCDOT Type I-19.0C)	NA	3.0
	Crushed Stone (NCDOT ABC)	6.0	6.0
Rigid	Portland Cement Concrete (4000 psi)	5.5	7.0
	Crushed Aggregate Base Course (NCDOT ABC)	4.0	4.0

Light-duty pavements should be designated for car parking areas and lightly traveled service roads. Heavy-duty pavements should be designated for entrances and exits, access roads, driveways, truck lanes, and areas in front of loading docks and dumpsters. The design of heavy duty pavements is very dependent on the anticipated volume and axle weights of truck traffic. For areas subject to concentrated and repetitive loading conditions, i.e. dumpster pads we recommend using a Portland cement concrete pavement with a thickness of at least 7 inches underlain by at least 4 inches of aggregate base course.

Light-Duty and Heavy-Duty pavements were based on design 20-year design ESAL values of 50,000, and 400,000, respectively. ESAL values were assumed to be typical for the type of proposed facility.

Recommendations for pavement construction presented depend upon compliance with recommended material specifications. To assess compliance, observation and testing should be performed under the direction of the geotechnical engineer.

Asphalt concrete aggregates and base course materials should conform to the North Carolina Department of Transportation (NCDOT) "Standard Specifications for Roads and Structures." Concrete pavement should be air-entrained and have a minimum compressive strength of 4,000 psi after 28 days of laboratory curing per ASTM C-31.

The performance of all pavements can be enhanced by minimizing excess moisture which can reach the subgrade soils. The following recommendations should be considered a minimum:

- site grading at a minimum 2 percent grade away from the pavements;
- subgrade and pavement surface with a minimum 1/4 inch per foot slope to promote proper surface drainage; and
- installation of joint sealant to seal cracks immediately.

Preventative maintenance should be planned and provided for through an ongoing pavement management program to enhance future pavement performance. Preventative maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Preventative maintenance, which consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing), is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements.

6.0 GENERAL COMMENTS

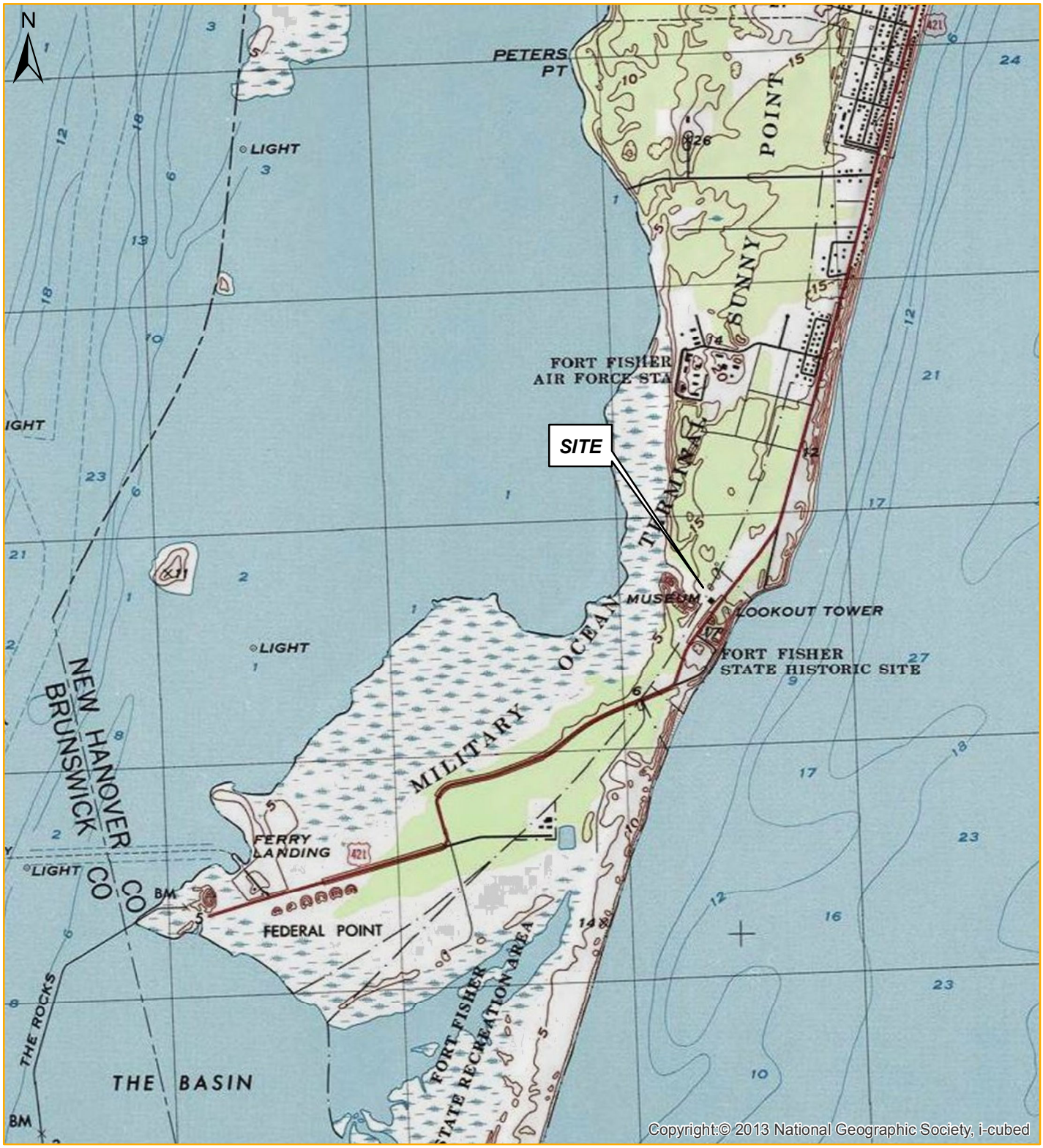
Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur across the site, or due to the modifying effects of weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

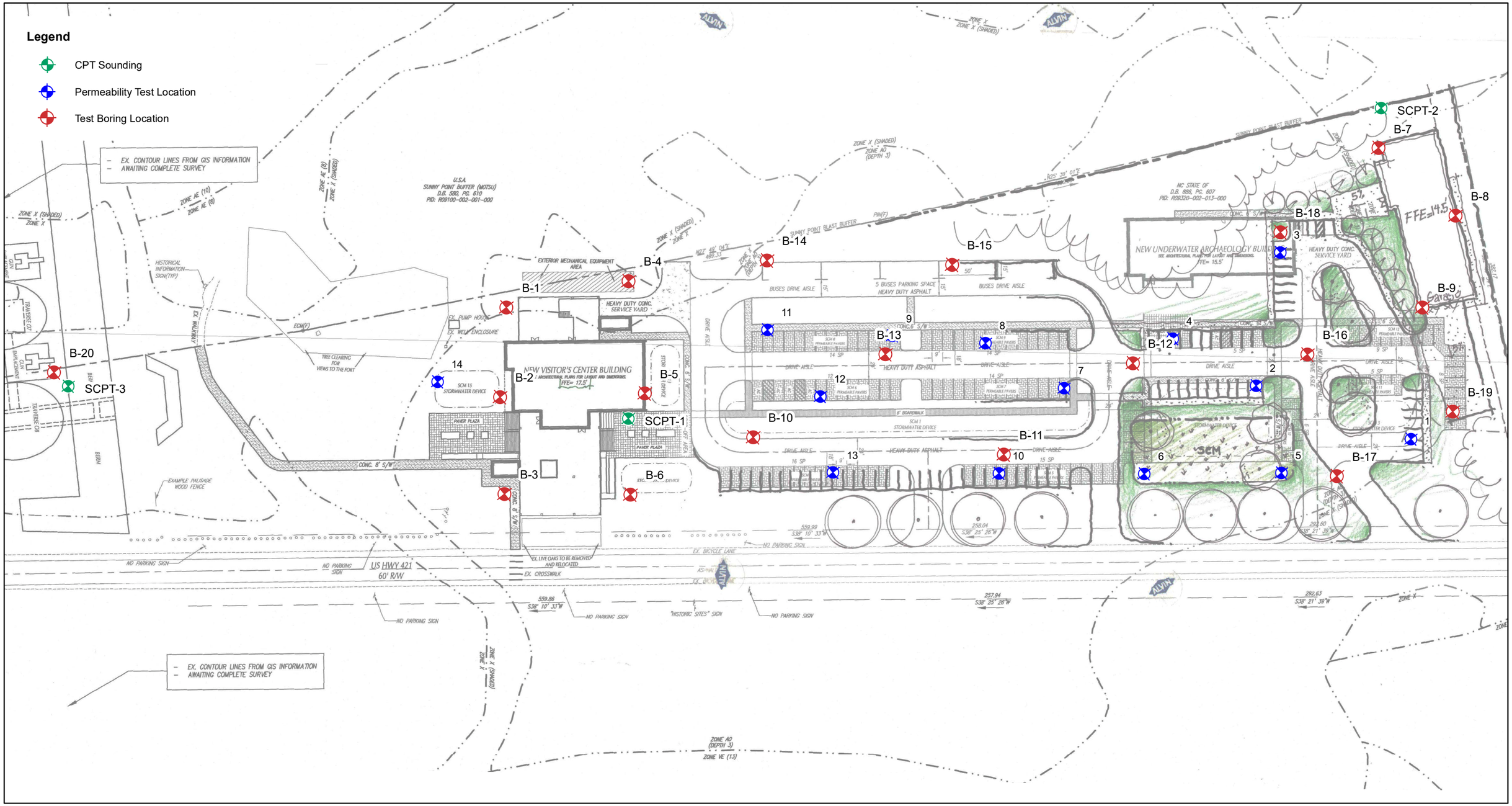
This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION



2,000 1,000 0 2,000 4,000 Feet

PM: MW	Project No. 70195145	Terracon	Site Map	EXHIBIT NO.
Drawn By: MW	Scale: 1 in = 2,000 ft		Fort Fisher State Historic Site 1610 Fort Fisher Boulevard Kure Beach, North Carolina	A-1
Checked By:	File Path:			
Approved By:	Date: 7/26/2019	2401 Brentwood Drive, Suite 107 Raleigh, NC 27604 Phone: (919) 873-2211 Fax: (919) 873-9555		



Project No.	70195145
Drawn By:	MW
Checked By:	AN
Date:	12/24/2019

Terracon

2401 Brentwood Road, Suite 107 Raleigh, NC 27604

Phone: (919) 873-2211 Fax: (919) 873-9555

Exploration Plan

Visitor Center & Underwater Archeological Building
Fort Fisher State Historic Site
1610 Fort Fisher Boulevard S
Kure Beach, North Carolina

Exhibit

A-2

Project No.	70195145
Drawn By:	MW
Checked By:	AN
Date:	12/24/2019

Terracon

2401 Brentwood Road, Suite 107 Raleigh, NC 27604
Phone: (919) 873-2211 Fax: (919) 873-9555

Exploration Plan - Aerial

Visitor Center & Underwater Archeological Building
Fort Fisher State Historic Site
1610 Fort Fisher Boulevard S
Kure Beach, North Carolina

Exhibit

A-3

Field Exploration Description

Exploration locations were established in the field by measuring from existing site features and estimating right angles or by GPS location. The locations of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

The borings were advanced with a track-mounted CME-55 rotary drill rig by mud rotary drilling. Samples of the soil encountered in the borings were obtained using the split barrel sampling procedures.

In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the final 12 inches of the typical total 18-inch penetration by means of a 140-pound automatic hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in-situ relative density of cohesionless soils and consistency of cohesive soils. Soil samples were taken at 2.5-foot intervals above a depth of 10 feet and at 5-foot intervals below 10 feet.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions. The borings were backfilled with soil cuttings.

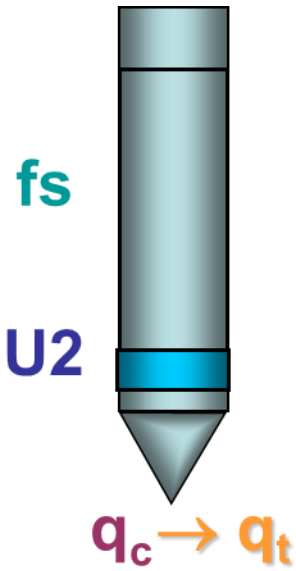
An automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the SPT values and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count (N) value by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

A field log of each boring was prepared by the drill crew. These logs included visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples. Final boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation of the samples.

Cone Penetration Test (CPT) & Seismic Cone Penetration Test (SCPT) Description

Field exploration consisting of SCPT soundings were performed at the site. The sounding locations were established by Terracon personnel using a sub-meter, handheld GPS. The reported location information should be considered accurate only to the degree implied by the means and methods used.

The CPT hydraulically pushes an instrumented cone through the soil while nearly continuous readings are recorded to a portable computer. The cone is equipped with electronic load cells to measure tip resistance and sleeve resistance and a pressure transducer to measure the generated ambient pore pressure. The face of the cone has an apex angle of 60° and an area of 10 cm^2. Digital data representing the tip resistance, friction resistance, pore water pressure, and probe inclination angle are recorded about every 2 centimeters while advancing through the ground at a rate between 1½ and 2½ centimeters per second. These measurements are correlated to various soil properties used for geotechnical design. No soil samples are gathered through this subsurface investigation technique.



CPT testing is conducted in general accordance with ASTM D5778 "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils."

The CPT data collected in the field were downloaded and processed using computer software.

The SCPT is a modification of the CPT which is used to determine shear wave velocity with depth. This additional information is collected via an accelerometer placed above the instrumented cone. A shear wave is generated at the ground surface, such as a hammer striking a steel plate on the end, which propagates through the soil and is recorded by the accelerometer at selected intervals (typically 1 meter). From this data, the interval shear wave velocities of the soil are calculated. These interval velocities can be used to develop the shear wave velocity profile for the site, and can be used to determine a seismic site classification.

BORING LOG NO. B-1

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9721° Longitude: -77.9177°

DEPTH	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5								
	TOPSOIL, root mat							
	POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, brown, and orange to gray, moist to wet, very loose to medium dense, shell fragments below 25 feet							
		5			1-1-1 N=2	5		
					3-2-3 N=5	12		
					2-2-2 N=4	19		
		10	▽		2-3-3 N=6			
		15			3-3-3 N=6			
		20			1/18"			
		25			2-1-1 N=2	27	NP	8
		30			3-5-4 N=9			
		35			5-7-9 N=16			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 9 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-13-2019 | Boring Completed: 06-13-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-5

BORING LOG NO. B-1

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9721° Longitude: -77.9177°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	37.0							
	WELL GRADED SAND WITH CLAY (SW-SC), with shell fragments, fine to coarse grained, gray, wet, loose to medium dense	40			4-13-12 N=25			
		45			4-3-3 N=6	32	38-18-20	9
	47.0							
	SILTY SAND (SM), fine to coarse grained, gray, wet, loose							
	50.0	50			2-3-5 N=8			
	Boring Terminated at 50 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

While drilling 9 feet

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-13-2019 | Boring Completed: 06-13-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-5

BORING LOG NO. B-2

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9791° Longitude: -77.9175°

DEPTH	GRAPHIC LOG	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3							
0							
			X	2-3-4 N=7	9		
5			X	3-2-3 N=5	14		
		▽	X	3-3-3 N=6	17		
			X	3-4-5 N=9			
10							
			X	1-1-2 N=3			
15							
			X	2-3-3 N=6			
20							
			X	2-1-2 N=3			
25							
			X	5-6-7 N=13			
30							
			X	5-5-9 N=14			
35							

TOPSOIL, root mat

POORLY GRADED SAND WITH SILT (SP-SM), fine to coarse grained, tan-brown to orange and gray, very moist to wet, very loose to medium dense

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with sand and hole plug.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 7 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-11-2019 | Boring Completed: 06-11-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-6

BORING LOG NO. B-2

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9791° Longitude: -77.9175°

GRAPHIC LOG	DEPTH		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	38.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, fine to coarse grained, tan-brown to orange and gray, very moist to wet, very loose to medium dense *(continued)*							
		SANDY LEAN CLAY (CL), fine grained, gray, very moist, soft	40			1-1-1 N=2	46	43-23-20	52
	42.0								
		WELL GRADED SAND WITH CLAY (SW-SC), with shell fragments, fine to coarse grained, gray, wet, loose				1-2-2 N=4			
	46.5		45						
		POORLY GRADED SAND (SP), fine to coarse grained, gray, wet, very dense							
	49.0					50/6"			
		Boring Terminated at 49 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with sand and hole plug.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

While drilling 7 feet

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-11-2019 | Boring Completed: 06-11-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-6

BORING LOG NO. B-3

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9718° Longitude: -77.9173°

DEPTH	GRAPHIC LOG	DESCRIPTION	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3		**TOPSOIL**, root mat						
		POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, brown, moist to wet, very loose to medium dense, shell fragments below 20 feet	▽		3-5-6 N=11			
5					2-2-4 N=6			
					2-3-3 N=6			
10					4-3-6 N=9			
15					1-1-1 N=2			
20					1-1-1 N=2			
25					2-1-2 N=3			
30					10-14-15 N=29			
35					11-16-13 N=29			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with sand and hole plug.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *After 24 hours 8 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-12-2019 | Boring Completed: 06-12-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-7

BORING LOG NO. B-3

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9718° Longitude: -77.9173°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	37.0							
	SANDY LEAN CLAY (CL), fine grained, gray, very moist, soft							
	42.0	40			1-1-1 N=2			
	WELL GRADED SAND WITH CLAY (SW-SC), fine to medium grained, gray, wet, loose				1-2-2 N=4			
	47.0	45						
	POORLY GRADED SAND WITH SILT (SP-SM), with cemented rock fragments, fine to coarse grained, gray, wet, dense				5-6-33 N=39			
	50.0	50						
	Boring Terminated at 50 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with sand and hole plug.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

After 24 hours 8 feet

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-12-2019 | Boring Completed: 06-12-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-7

BORING LOG NO. B-4

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9724° Longitude: -77.9175°

DEPTH	GRAPHIC LOG	DESCRIPTION	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.7		**TOPSOIL**, root mat						
		POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, dark brown to tan brown to olive gray, very moist to wet, very loose to medium dense, shell fragments below 30 feet	▽		1-1-1 N=2			
5					4-3-3 N=6			
					2-3-3 N=6			
10					3-3-4 N=7			
15					1-1-1 N=2			
20					1-1-2 N=3			
25					1/18"			
30					4-4-5 N=9			
35					7-13-15 N=28			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 8 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-13-2019 | Boring Completed: 06-13-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-8

BORING LOG NO. B-4

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9724° Longitude: -77.9175°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	38.0							
	WELL GRADED SAND WITH CLAY (SW-SC), with shell fragments, fine to coarse grained, gray, wet, loose, slightly plastic	40			2-1-2 N=3			
		45			4-5-4 N=9			
	47.0 **SILTY SAND (SM)**, fine to medium grained, gray, wet, medium dense				6-8-19 N=27			
	50.0 ***Boring Terminated at 50 Feet***	50						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

While drilling 8 feet

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-13-2019 | Boring Completed: 06-13-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-8

BORING LOG NO. B-5

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9722° Longitude: -77.9172°

DEPTH	GRAPHIC LOG	DESCRIPTION	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3		**TOPSOIL**, root mat						
		POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, brown and tan to rust brown, moist to wet, loose			2-4-3 N=7			
5					2-3-2 N=5			
			▽		1-2-2 N=4			
10					3-4-4 N=8			
12.0		**POORLY GRADED SAND WITH SILT (SP-SM)**, occasional shell fragments, fine to medium grained, light olive gray, wet, very loose to medium dense, shell fragments below 25 feet			1-1-1 N=2			
15								
20					1/18"			
25					1-1-2 N=3			
30					3-4-6 N=10			
35					6-5-6 N=11			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with sand and hole plug.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 7 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-11-2019 | Boring Completed: 06-11-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-9

BORING LOG NO. B-5

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9722° Longitude: -77.9172°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	37.0							
	SANDY LEAN CLAY (CL), shell fragments, fine grained, gray, very moist, very soft							
	42.0	40			WOH			
	WELL GRADED SAND WITH CLAY (SW-SC), with shell fragments, fine to coarse grained, gray, wet, loose				2-2-2 N=4			
	47.0	45						
	POORLY GRADED SAND WITH SILT (SP-SM), with cemented rock fragments, fine to coarse grained, gray, wet, medium dense				4-9-12 N=21			
	50.0	50						
	Boring Terminated at 50 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with sand and hole plug.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

While drilling 7 feet

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-11-2019 | Boring Completed: 06-11-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-9

BORING LOG NO. B-6

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.972° Longitude: -77.9171°

DEPTH	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5								
	TOPSOIL, root mat							
	POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, light olive gray, wet, very loose to medium dense, shell fragments below 25 feet							
				X	1-1-1 N=2	7		
				X	1-1-3 N=4	18		
		5		X	2-2-2 N=4	8	NP	10
			▽	X	3-3-4 N=7			
		10		X	3-3-3 N=6			
		15		X	1/18"			
		20		X	1-1-2 N=3			
		25		X	1-2-6 N=8			
		30		X	4-6-7 N=13			
		35						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with sand and hole plug.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *After 24 hours 7.5 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-12-2019 | Boring Completed: 06-12-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-10

BORING LOG NO. B-6

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.972° Longitude: -77.9171°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	37.0							
	SANDY LEAN CLAY (CL), shell fragments, fine grained, gray, very moist, soft							
	42.0	40			3-2-2 N=4			
	WELL GRADED SAND WITH CLAY (SW-SC), with shell fragments, fine to coarse grained, gray, wet, loose				2-2-2 N=4			
	47.0	45						
	POORLY GRADED SAND WITH SILT (SP-SM), with cemented rock fragments, fine to coarse grained, gray, wet, medium dense				7-6-5 N=11			
	50.0	50						
	Boring Terminated at 50 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with sand and hole plug.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

After 24 hours 7.5 feet

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-12-2019 | Boring Completed: 06-12-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-10

BORING LOG NO. B-7

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9739° Longitude: -77.9165°

DEPTH	GRAPHIC LOG	DESCRIPTION	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5		**TOPSOIL**, root mat						
		POORLY GRADED SAND (SP), fine to medium grained, gray tan and brown to rust brown, moist to wet, loose			4-4-4 N=8	9	NP	4
					3-4-5 N=9	14		
5			▽		2-3-6 N=9	20		
8.0								
		POORLY GRADED SAND WITH SILT (SP-SM), fine grained, gray tan to tan, wet, loose to medium dense, shell fragments below 15 feet			3-3-4 N=7	21		
10								
					1-2-2 N=4			
15								
					2-3-3 N=6			
20								
					4-4-4 N=8			
25								
					3-3-3 N=6			
30								
					5-9-11 N=20			
35								
35.0		***Boring Terminated at 35 Feet***						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *After 24 hours 7 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-11-2019 | Boring Completed: 06-11-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-11

BORING LOG NO. B-8

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9739° Longitude: -77.9162°

DEPTH	GRAPHIC LOG	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.7		**TOPSOIL**, root mat							
		POORLY GRADED SAND (SP), fine to medium grained, dark brown to brown, very moist, loose				2-2-3 N=5			
						2-2-4 N=6			
5.5		**POORLY GRADED SAND WITH SILT (SP-SM)**, fine to medium grained, tan to olive gray, very moist to wet, very loose to medium dense, shell fragments below 15 feet	5			4-5-4 N=9			
				▽		6-6-7 N=13			
			10						
						1-1-1 N=2			
			15						
						2-2-2 N=4			
			20						
						3-5-4 N=9			
			25						
						2-4-6 N=10			
			30						
35.0						11-9-7 N=16			
		Boring Terminated at 35 Feet	35						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *After 24 hours 8.5 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-12-2019 | Boring Completed: 06-12-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-12

BORING LOG NO. B-9

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9737° Longitude: -77.916°

DEPTH	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.2	**TOPSOIL**, root mat							
	POORLY GRADED SAND WITH SILT (SP-SM), fine grained, tan brown to olive gray, wet, very loose to loose, shell fragments below 20 feet				3-3-3 N=6			
		5			3-2-4 N=6			
			▽		3-2-3 N=5			
		10			1-3-4 N=7			
		15			2-1-2 N=3			
		20			4-6-5 N=11			
		25			4-2-4 N=6			
		30			4-5-3 N=8			
33.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, trace shell fragments, fine grained, olive gray, wet, medium dense							
35.0	***Boring Terminated at 35 Feet***	35			8-10-9 N=19			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *After 24 hours 7.5 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-12-2019 | Boring Completed: 06-12-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-13

BORING LOG NO. B-10

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9723° Longitude: -77.917°

DEPTH	GRAPHIC LOG	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3	**ASPHALT**, 1" asphalt, 3" stone base **POORLY GRADED SAND WITH SILT (SP-SM)**, fine to medium grained, dark gray-brown to brown and rust brown, wet, loose to medium dense			5-5-6 N=11			
5		▽		1-2-2 N=4			
				2-3-3 N=6			
10.0				3-3-4 N=7			
10	***Boring Terminated at 10 Feet***						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with sand and hole plug. Surface capped with asphalt cold patch.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 7.5 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-12-2019 | Boring Completed: 06-12-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-14

BORING LOG NO. B-11

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9728° Longitude: -77.9165°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.5 **TOPSOIL**, root mat							
	POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, gray, tan, and rust brown, moist to wet, loose to medium dense				2-2-2 N=4			
		5			4-5-6 N=11			
			▽		3-3-3 N=6			
					6-8-7 N=15			
	10.0 ***Boring Terminated at 10 Feet***	10						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 7.5 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-12-2019 | Boring Completed: 06-12-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-15

BORING LOG NO. B-12

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9731° Longitude: -77.9164°

DEPTH	GRAPHIC LOG	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5		**TOPSOIL**, root mat							
		POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, rust brown, moist to wet, very loose to loose				2-4-5 N=9			
						2-4-4 N=8			
			5	▽		4-5-4 N=9			
						1-1-2 N=3			
10.0			10						
		Boring Terminated at 10 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 7.5 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-12-2019 | Boring Completed: 06-12-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-16

BORING LOG NO. B-13

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9727° Longitude: -77.9169°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.3 **TOPSOIL**, root mat							
	POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, gray-brown and rust brown, moist, very loose to loose				1-2-1 N=3			
		5			2-2-3 N=5			
			▽		3-4-3 N=7			
					1-2-2 N=4			
	10.0	10						
	Boring Terminated at 10 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 7.5 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-12-2019 | Boring Completed: 06-12-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-17

BORING LOG NO. B-14

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9726° Longitude: -77.9173°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.7 **TOPSOIL**, root mat							
	SP - POORLY GRADED SAND (SP), fine to medium grained, gray-brown to brown, moist to wet, loose				1-2-2 N=4	8	NP	3
		5			1-3-3 N=6			
			▽		3-4-3 N=7			
					4-5-4 N=9			
	10.0 ***Boring Terminated at 10 Feet***	10						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 7.5 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-12-2019 | Boring Completed: 06-12-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-18

BORING LOG NO. B-15

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.973° Longitude: -77.917°

DEPTH	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5	**TOPSOIL**, root mat							
	POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, gray-brown and rust brown, moist to wet, loose to medium dense				3-4-5 N=9			
					3-5-6 N=11			
		5			3-4-4 N=8			
			▽					
10.0					2-3-3 N=6			
	Boring Terminated at 10 Feet	10						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 8 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-13-2019 | Boring Completed: 06-13-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-19

BORING LOG NO. B-16

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9735° Longitude: -77.9161°

DEPTH	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5								
	TOPSOIL, root mat **POORLY GRADED SAND WITH SILT (SP-SM)**, fine to medium grained, gray, brown, and rust brown, moist to wet, loose to medium dense			X	3-5-7 N=12			
				X	3-4-3 N=7			
		5	▽	X	3-2-3 N=5			
				X	2-3-2 N=5			
10.0		10						
	Boring Terminated at 10 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 7 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-13-2019 | Boring Completed: 06-13-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-20

BORING LOG NO. B-17

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9733° Longitude: -77.9158°

DEPTH	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5								
	TOPSOIL, root mat							
	POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, brown and rust brown, moist, loose to medium dense			X	3-6-5 N=11	8		
				X	3-5-5 N=10	15	NP	5
		5		X	4-2-3 N=5	9		
			▽	X	4-4-4 N=8	17		
10.0		10						
	Boring Terminated at 10 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 8 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-13-2019 | Boring Completed: 06-13-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-21

BORING LOG NO. B-18

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9736° Longitude: -77.9165°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.5 **TOPSOIL**, root mat							
	POORLY GRADED SAND WITH SILT (SP-SM), fine to coarse grained, rust brown and brown, moist to wet, loose to medium dense				3-3-3 N=6			
					2-2-3 N=5			
		5			3-5-7 N=12			
			▽					
					3-4-5 N=9			
	10.0	10						
	Boring Terminated at 10 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *After 24 hours 8 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-11-2019 | Boring Completed: 06-11-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-22

BORING LOG NO. B-19

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9736° Longitude: -77.9158°

DEPTH	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5								
	TOPSOIL, root mat							
	POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, gray brown to brown, very moist to wet, loose				2-2-2 N=4	7	NP	9
		5			2-2-2 N=4			
			▽		2-3-2 N=5			
					4-2-2 N=4			
10.0		10						
	Boring Terminated at 10 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 8 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-13-2019 | Boring Completed: 06-13-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-23

BORING LOG NO. B-20

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9712° Longitude: -77.9183°

DEPTH	GRAPHIC LOG	DESCRIPTION	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5		**TOPSOIL**, root mat						
		POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, brown, moist to wet, loose to medium dense			5-6-6 N=12			
					2-2-3 N=5			
			▽		3-2-3 N=5			
					4-4-4 N=8			
12.0		**POORLY GRADED SAND WITH SILT (SP-SM)**, shell fragments below 20 feet, fine grained, gray, wet, very loose to loose			2-2-1 N=3			
					1-1-1 N=2			
					5-3-3 N=6			
					3-3-6 N=9			
32.0		**POORLY GRADED SAND WITH SILT (SP-SM)**, fine grained, gray, wet, medium dense			5-10-13 N=23			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 7 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-11-2019 | Boring Completed: 06-11-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-24

BORING LOG NO. B-20

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9712° Longitude: -77.9183°

DEPTH	GRAPHIC LOG		WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
37.0		**CLAYEY SAND (SC)**, fine to coarse grained, gray, wet, loose						
					3-4-2 N=6			
40								
					2-1-6 N=7			
45								
47.0		**SILTY SAND (SM)**, fine to coarse grained, light gray, wet, medium dense						
					9-9-9 N=18			
50		***Boring Terminated at 50 Feet***						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

While drilling 7 feet

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-11-2019 | Boring Completed: 06-11-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-24

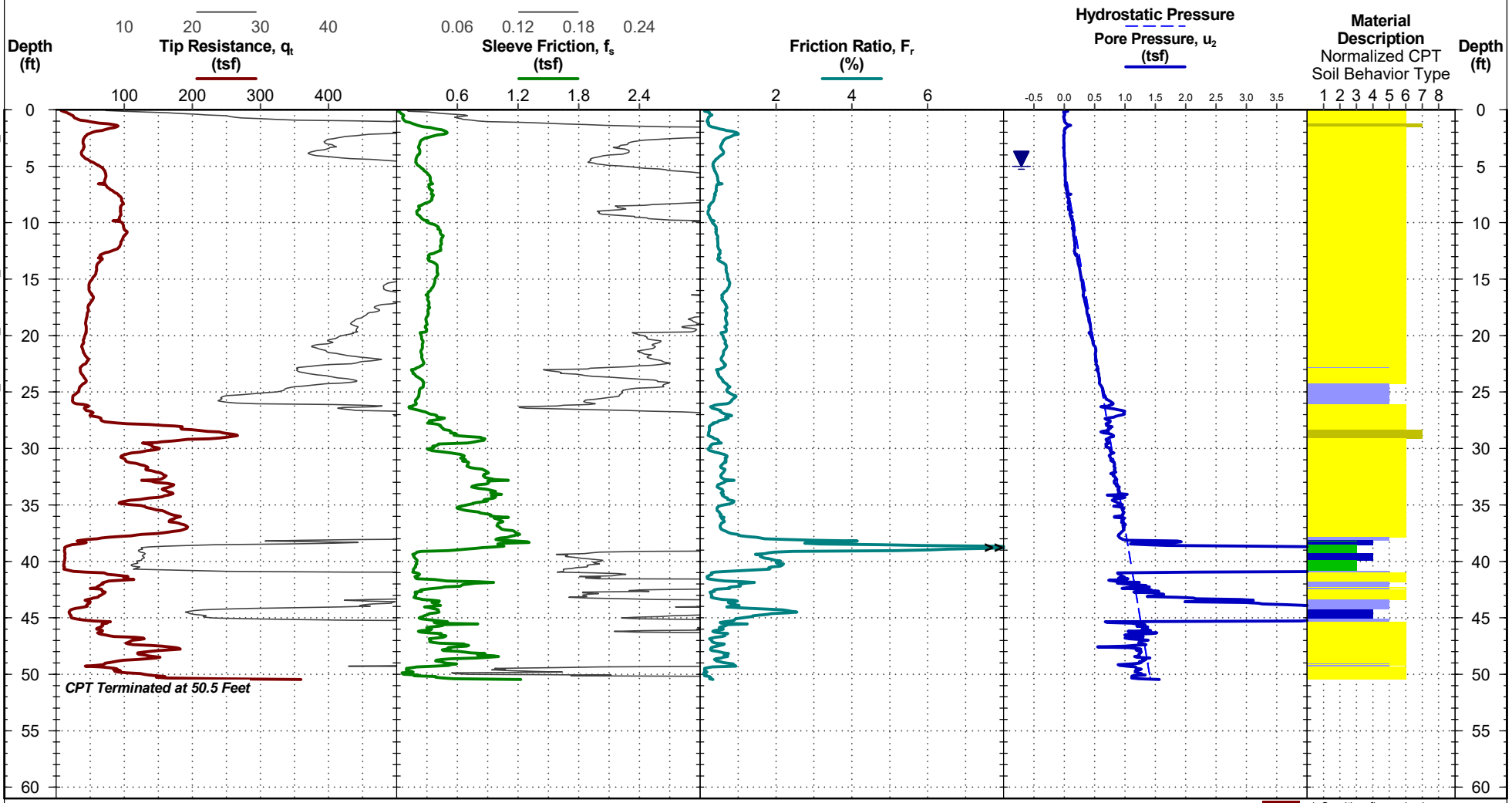
CPT LOG NO. SCPT1

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: NCDNCR
Raleigh, NC

TEST LOCATION: See Exhibit A-2

SITE: 1610 Fort Fisher Boulevard S
Kure Beach, NC



See Exhibit A-4 for description of field procedures.
See Appendix C for explanation of symbols and abbreviations.

CPT sensor calibration reports available upon request.

WATER LEVEL OBSERVATION
5 ft estimated water depth
(used in normalizations and correlations; see Appendix C)

Probe no. 5311

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

CPT Started: 9/10/2019
CPT Completed: 9/10/2019
Rig:
Operator: BR
Project No.: 70195145
Exhibit: A-25

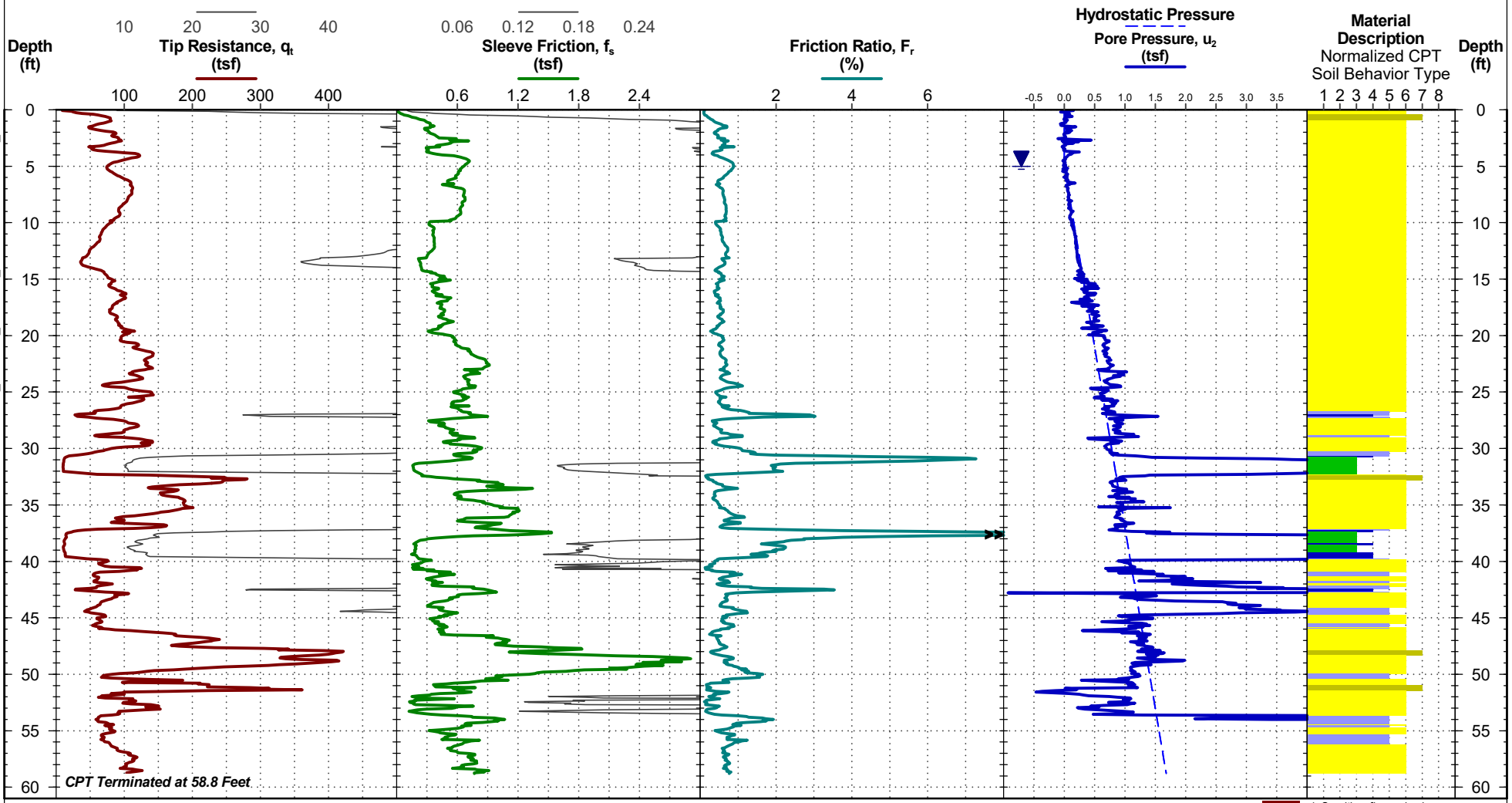
CPT LOG NO. SCPT2

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: NCDNCR
Raleigh, NC

TEST LOCATION: See Exhibit A-2

SITE: 1610 Fort Fisher Boulevard S
Kure Beach, NC



See Exhibit A-4 for description of field procedures.
See Appendix C for explanation of symbols and abbreviations.

CPT sensor calibration reports available upon request.

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

WATER LEVEL OBSERVATION
▼ 5 ft estimated water depth
(used in normalizations and correlations; see Appendix C)

Probe no. 5311

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

CPT Started: 9/10/2019
CPT Completed: 9/10/2019
Rig:
Operator: BR
Project No.: 70195145
Exhibit: A-26

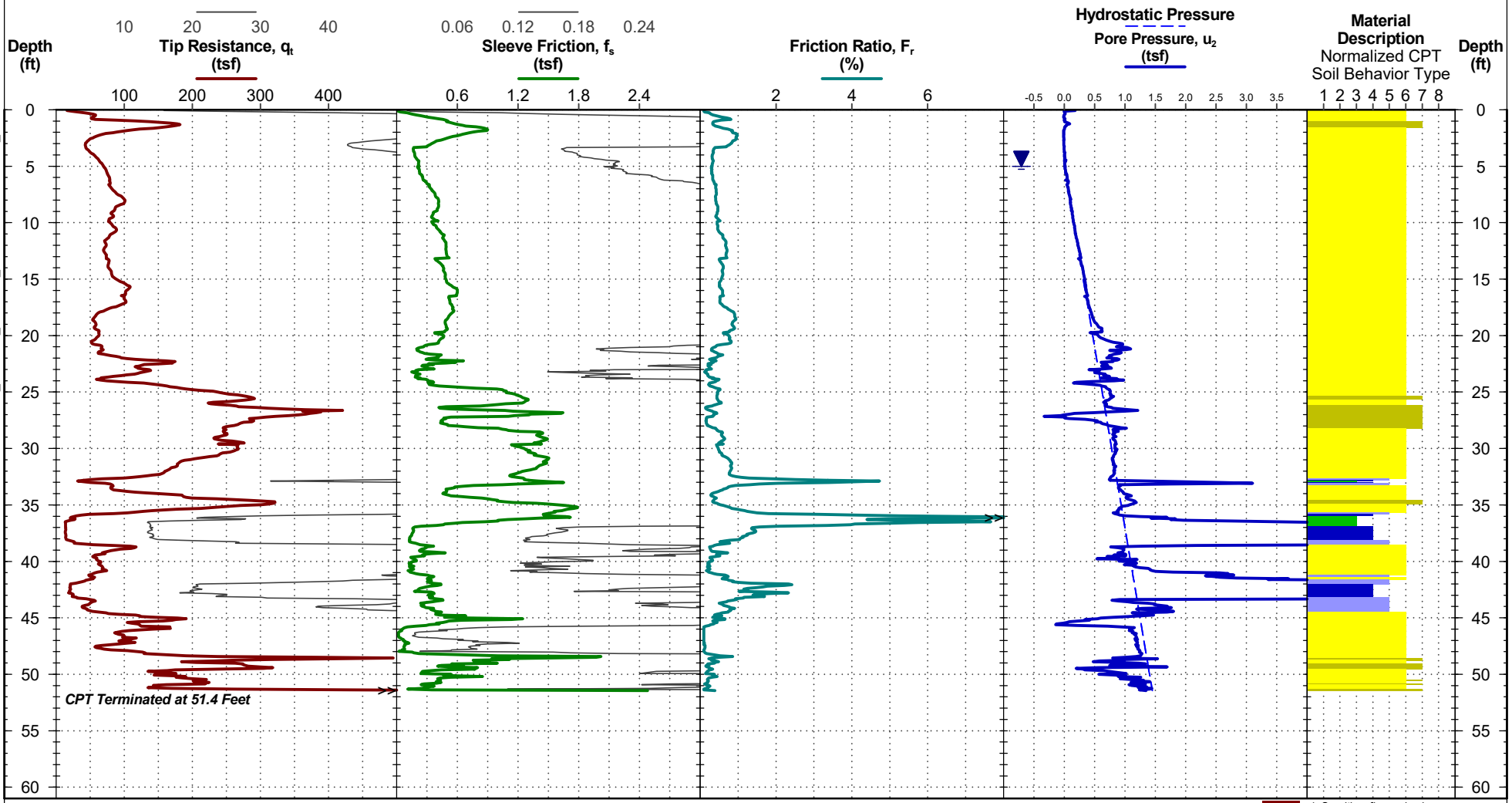
CPT LOG NO. SCPT3

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: NCDNCR
Raleigh, NC

TEST LOCATION: See Exhibit A-2

SITE: 1610 Fort Fisher Boulevard S
Kure Beach, NC



See Exhibit A-4 for description of field procedures.

See Appendix C for explanation of symbols and abbreviations.

CPT sensor calibration reports available upon request.

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

WATER LEVEL OBSERVATION

▼ 5 ft estimated water depth
(used in normalizations and correlations; see Appendix C)

Probe no. 5311

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

CPT Started: 9/10/2019	CPT Completed: 9/10/2019
Rig:	Operator: BR
Project No.: 70195145	Exhibit: A-27

APPENDIX B
LABORATORY TESTING

Laboratory Testing Description

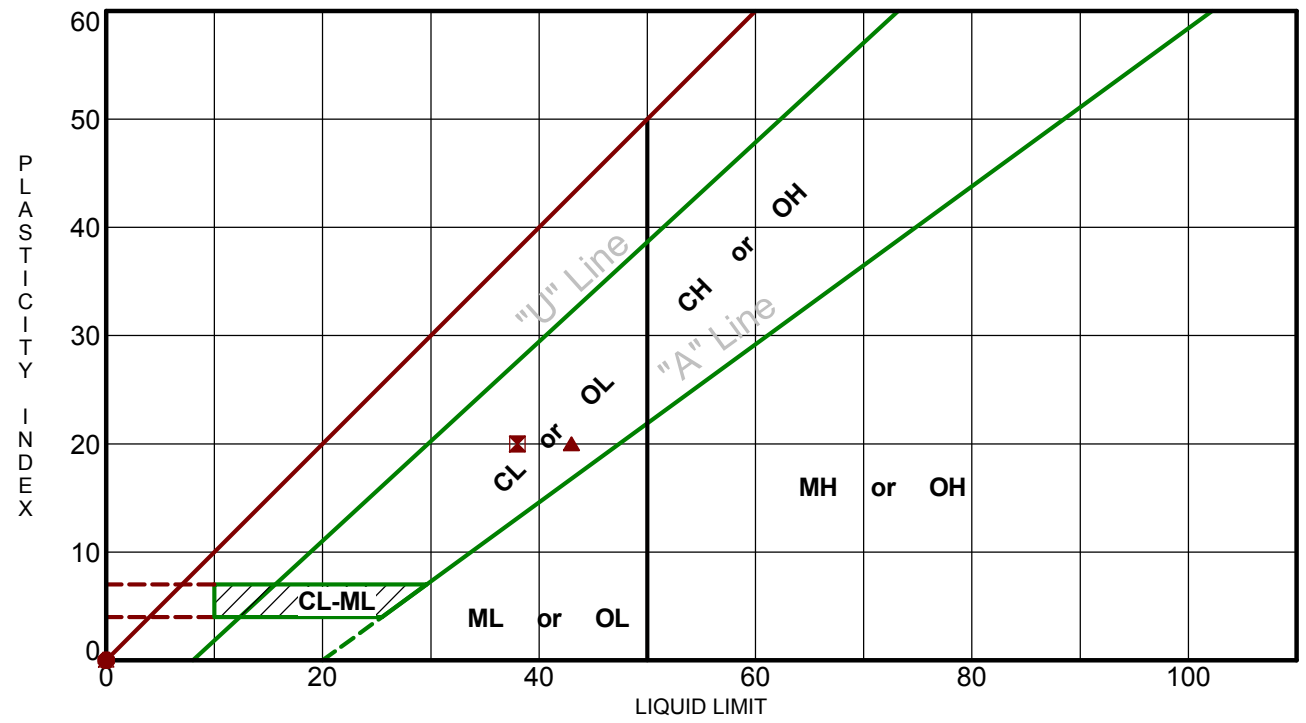
Descriptive classifications of the soils indicated on the boring logs are in accordance with the enclosed General Notes and the Unified Soil Classification System. Also shown are estimated Unified Soil Classification Symbols. A brief description of this classification system is attached to this report. Soils laboratory testing was performed under the direction of a geotechnical engineer and included visual classification, moisture content, grain size analysis, and Atterberg limits as appropriate. The results of the laboratory testing are shown on the borings logs and in Appendix B.

- ASTM D2216 Standard Test Method of Determination of Water Content of Soil and Rock by Mass
- ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- ASTM D2488 Standard Practice of Description and Identification of Soils (Visual Manual Method)
- ASTM D422 Standard Test Method for Particle Size Analysis of Soils
- ASTM D4318 Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils
- ASTM D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort
- ASTM D1883 Standard Test Method for California Bearing Ratio

Procedural standards noted above are for reference to methodology in general. In some cases variations to methods are applied as a result of local practice or professional judgment.

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
● B-1	23.5 - 25	NP	NP	NP	8	SP-SM	POORLY GRADED SAND with SILT
⊠ B-1	43.5 - 45	38	18	20	9	SW-SC	WELL-GRADED SAND with CLAY
▲ B-2	38.5 - 40	43	23	20	52	CL	SANDY LEAN CLAY
★ B-6	6 - 7.5	NP	NP	NP	10	SP-SM	POORLY GRADED SAND with SILT
⊙ B-7	1 - 2.5	NP	NP	NP	4	SP	POORLY GRADED SAND
✿ B-14	0.5 - 1.5	NP	NP	NP	3	SP	POORLY GRADED SAND
○ B-17	3.5 - 5	NP	NP	NP	5	SP-SM	POORLY GRADED SAND with SILT
△ B-19	0.5 - 1.5	NP	NP	NP	9	SP-SM	POORLY GRADED SAND with SILT

PROJECT: Visitor Center & Underwater Archeology Building

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

PROJECT NUMBER: 70195145

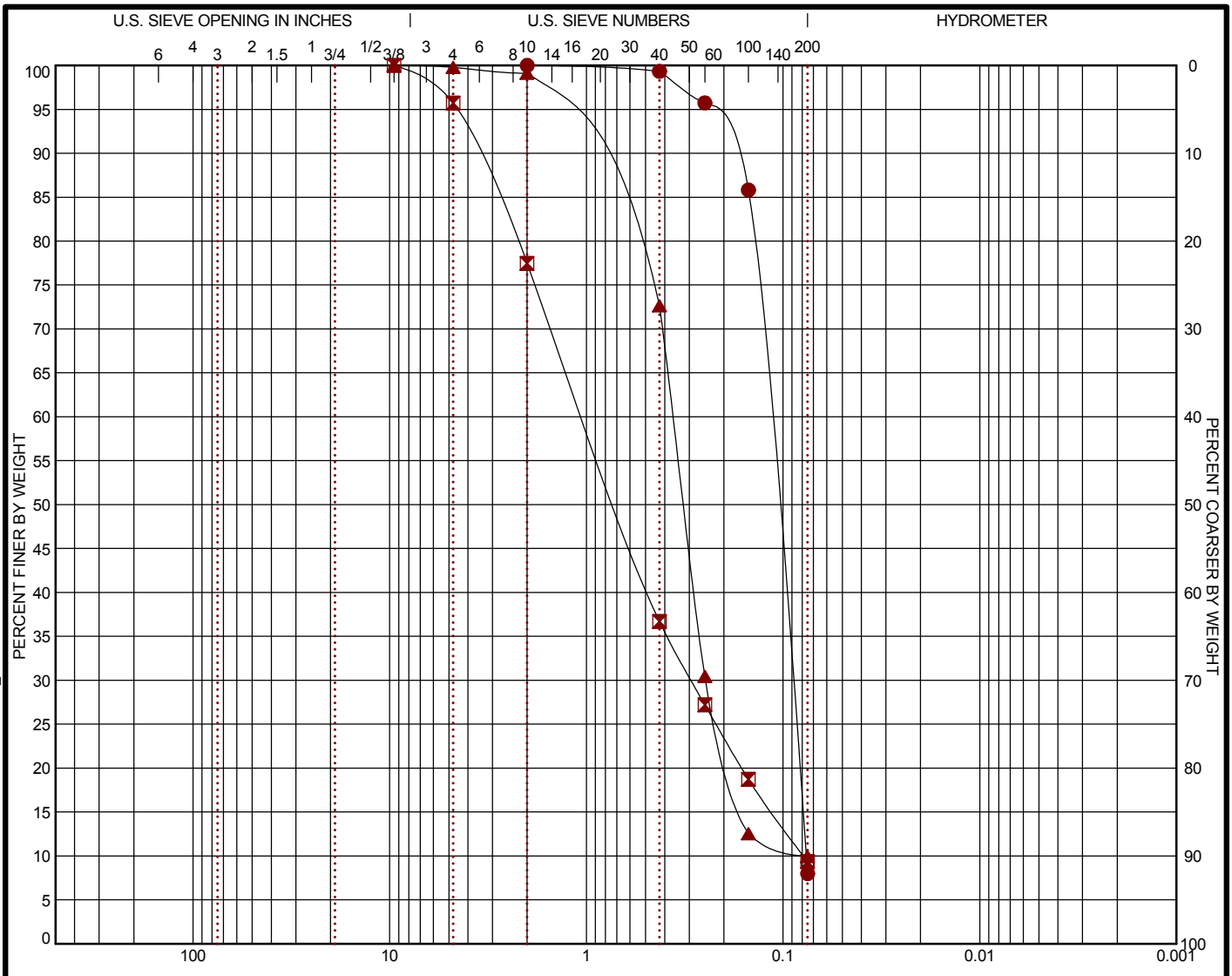
CLIENT: North Carolina Dept of Natural and Cultural Resources
Raleigh, NC

EXHIBIT: B-2

APPENDIX B-3
GRADATION TESTING RESULTS

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**B-1**	**23.5 - 25**	**0.0**	**0.0**	**92.0**		**8.0**		**SP-SM**
⊠	**B-1**	**43.5 - 45**	**0.0**	**4.3**	**86.3**		**9.4**		**SW-SC**
▲	**B-6**	**6 - 7.5**	**0.0**	**0.2**	**89.8**		**9.9**		**SP-SM**

	GRAIN SIZE		
	●	⊠	▲
D_{60}	**0.119**	**1.03**	**0.363**
D_{30}	**0.091**	**0.292**	**0.247**
D_{10}	**0.076**	**0.079**	**0.076**
	COEFFICIENTS		
C_C	**0.91**	**1.05**	**2.20**
C_U	**1.56**	**13.11**	**4.74**

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#10	100.0	3/8"	100.0	3/8"	100.0
#40	99.32	#4	95.71	#4	99.78
#60	95.74	#10	77.46	#10	99.12
#100	85.82	#40	36.68	#40	72.64
#200	8.0	#60	27.22	#60	30.45
		#100	18.73	#100	12.53
		#200	9.37	#200	9.93

SOIL DESCRIPTION

● POORLY GRADED SAND with SILT (SP-SM)

⊠ WELL-GRADED SAND with CLAY (SW-SC)

▲ POORLY GRADED SAND with SILT (SP-SM)

REMARKS

●

⊠

▲

PROJECT: Visitor Center & Underwater Archeology Building

SITE: 1610 Fort Fisher Boulevard S
Kure Beach, NC

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

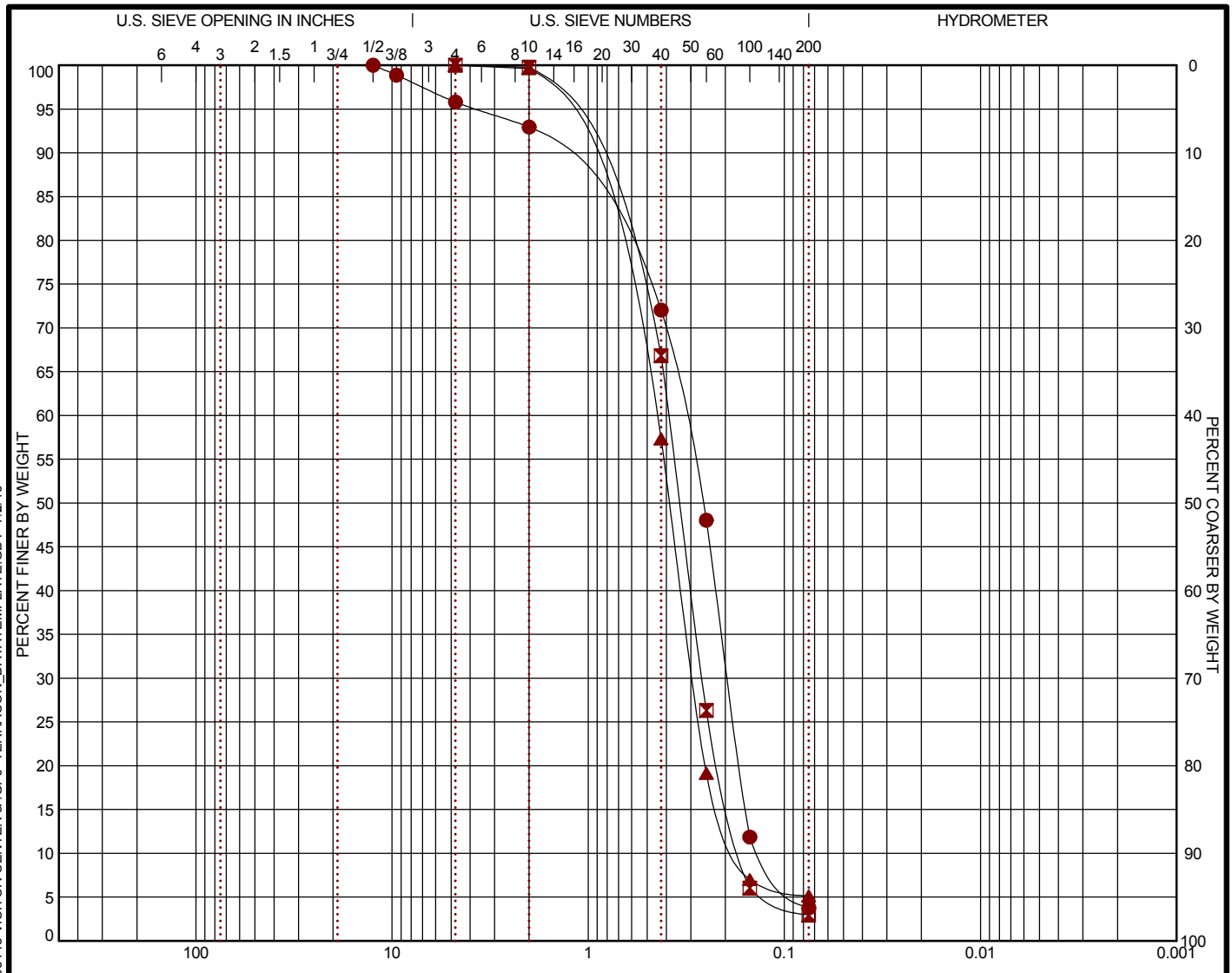
PROJECT NUMBER: 70195145

CLIENT: North Carolina Dept of Natural and Cultural Resources
Raleigh, NC

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 70195145 VISITOR CENTER & ..GPJ TERRACON_DATATEMPLATE.GDT 7/2/19

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**B-7**	**1 - 2.5**	**0.0**	**4.2**	**92.0**		**3.8**		**SP**
⊠	**B-14**	**0.5 - 1.5**	**0.0**	**0.0**	**97.0**		**3.0**		**SP**
▲	**B-17**	**3.5 - 5**	**0.0**	**0.0**	**94.9**		**5.1**		**SP-SM**

	GRAIN SIZE		
	●	⊠	▲
D_{60}	**0.326**	**0.389**	**0.469**
D_{30}	**0.194**	**0.262**	**0.291**
D_{10}	**0.128**	**0.166**	**0.17**
	COEFFICIENTS		
C_C	**0.90**	**1.07**	**1.06**
C_U	**2.55**	**2.34**	**2.75**

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
1/2"	**100.0**	**#4**	**100.0**	**#4**	**100.0**
3/8"	**98.86**	**#10**	**99.79**	**#10**	**99.63**
#4	**95.8**	**#40**	**66.82**	**#40**	**57.33**
#10	**92.93**	**#60**	**26.33**	**#60**	**19.14**
#40	**72.03**	**#100**	**6.03**	**#100**	**7.0**
#60	**48.04**	**#200**	**2.96**	**#200**	**5.14**
#100	**11.86**				
#200	**3.77**				

SOIL DESCRIPTION

● POORLY GRADED SAND (SP)

⊠ POORLY GRADED SAND (SP)

▲ POORLY GRADED SAND with SILT (SP-SM)

REMARKS

●

⊠

▲

PROJECT: Visitor Center & Underwater Archeology Building

SITE: 1610 Fort Fisher Boulevard S
Kure Beach, NC

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

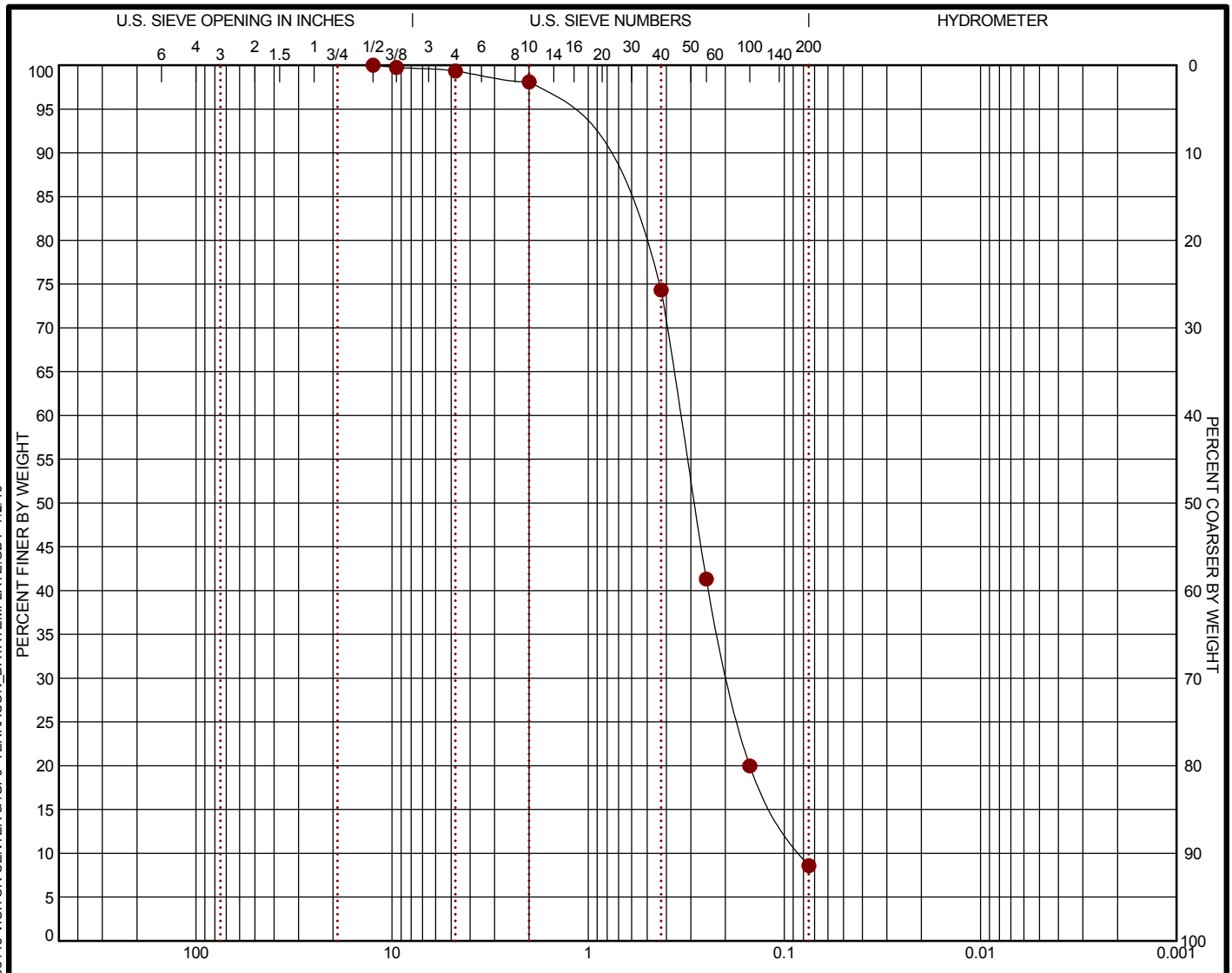
PROJECT NUMBER: 70195145

CLIENT: North Carolina Dept of Natural and Cultural Resources
Raleigh, NC

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 70195145 VISITOR CENTER & ..GPJ TERRACON_DATATEMPLATE.GDT 7/2/19

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**B-19**	**0.5 - 1.5**	**0.0**	**0.7**	**90.7**		**8.6**		**SP-SM**

	GRAIN SIZE
	●
D_{60}	**0.338**
D_{30}	**0.191**
D_{10}	**0.082**
	COEFFICIENTS
C_C	**1.32**
C_U	**4.13**

	●				
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
1/2"	**100.0**				
3/8"	**99.75**				
#4	**99.33**				
#10	**98.09**				
#40	**74.32**				
#60	**41.32**				
#100	**19.98**				
#200	**8.59**				

SOIL DESCRIPTION

● POORLY GRADED SAND with SILT (SP-SM)

REMARKS

●

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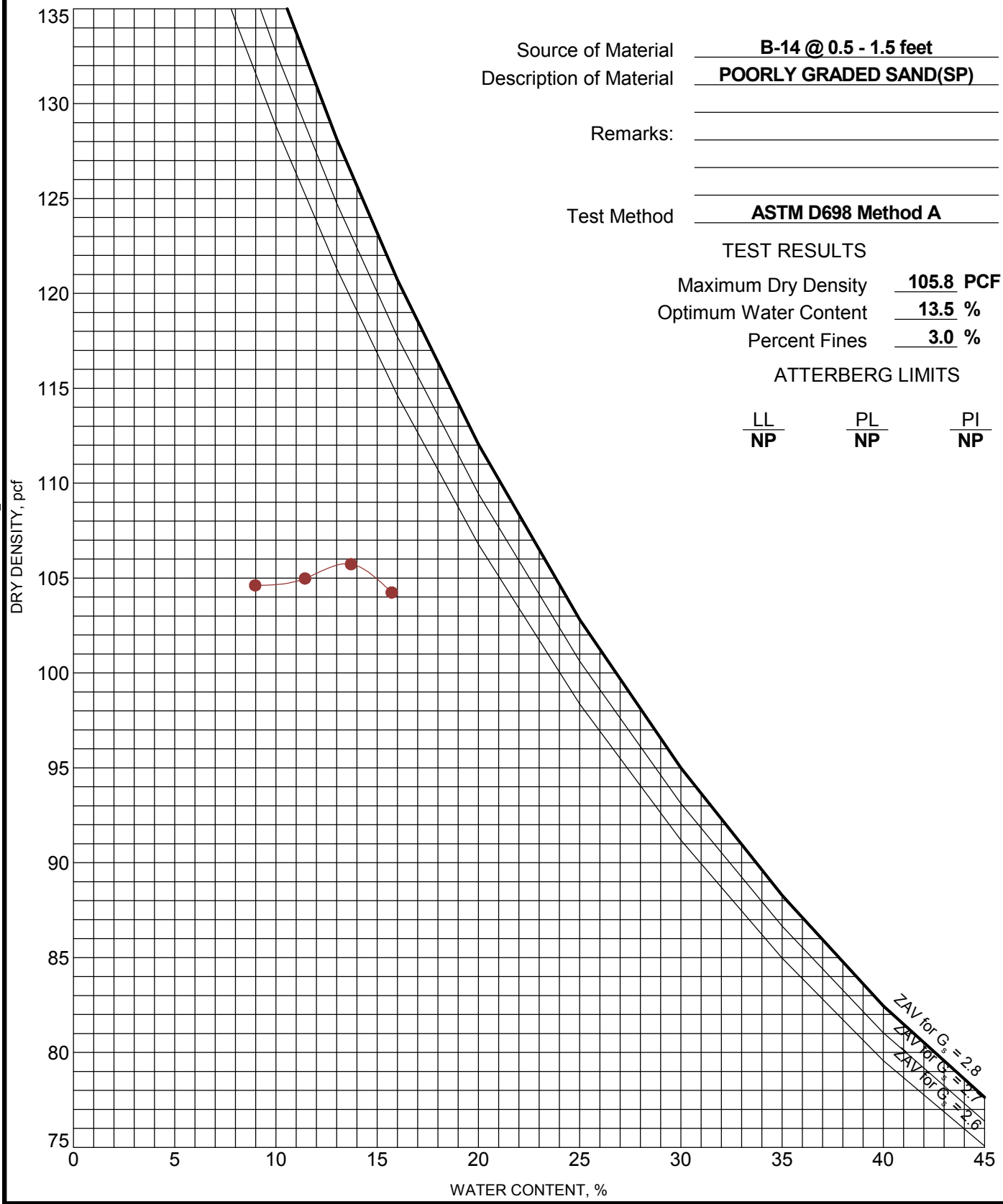
LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 70195145 VISITOR CENTER & ..GPJ TERRACON_DATATEMPLATE.GDT 7/2/19

APPENDIX B-4

CBR & STANDARD PROCTOR RESULTS

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: **B-14 @ 0.5 - 1.5 feet**

Description of Material: **POORLY GRADED SAND(SP)**

Remarks:

Test Method: **ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density	**105.8 PCF**
Optimum Water Content	**13.5 %**
Percent Fines	**3.0 %**

ATTERBERG LIMITS

LL	PL	PI
NP	**NP**	**NP**

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V2 70195145 VISITOR CENTER & .GPJ TERRACON_DATATEMPLATE.GDT 6/25/19

PROJECT: Visitor Center & Underwater Archeology Building

SITE: 1610 Fort Fisher Boulevard S
Kure Beach, NC

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

PROJECT NUMBER: 70195145

CLIENT: North Carolina Dept of Natural and Cultural Resources
Raleigh, NC

REPORT FOR CALIFORNIA BEARING RATIO

Service Date: 06/08/19
Report Date: 06/25/19

Terracon
2401 Brentwood Road, Suite 107
Raleigh, NC 27604
919-873-2211

Client

North Carolina Department of Natural and Cultural Resource
Attn: Tony Romaine, PE
4605 Mail Service Center
Raleigh, North Carolina 27699-4600

Project

Visitor Center and Underwater Archeology Building
1610 Fort Fisher Boulevard S
Kure Beach, North Carolina

Project No. 70195145

SAMPLE INFORMATION

Sample Number:	Bulk Sample	Proctor Method:	ASTM D698 - Method A
Boring Number:	B-14	Maximum Dry Density (pcf):	105.8
Sample Location:	Bulk Sample	Optimum Moisture:	13.5
Depth:	0.5 - 1.5'	Liquid Limit:	NP
Material Description:	Poorly Graded Sand	Plasticity Index:	NP

CBR TEST DATA

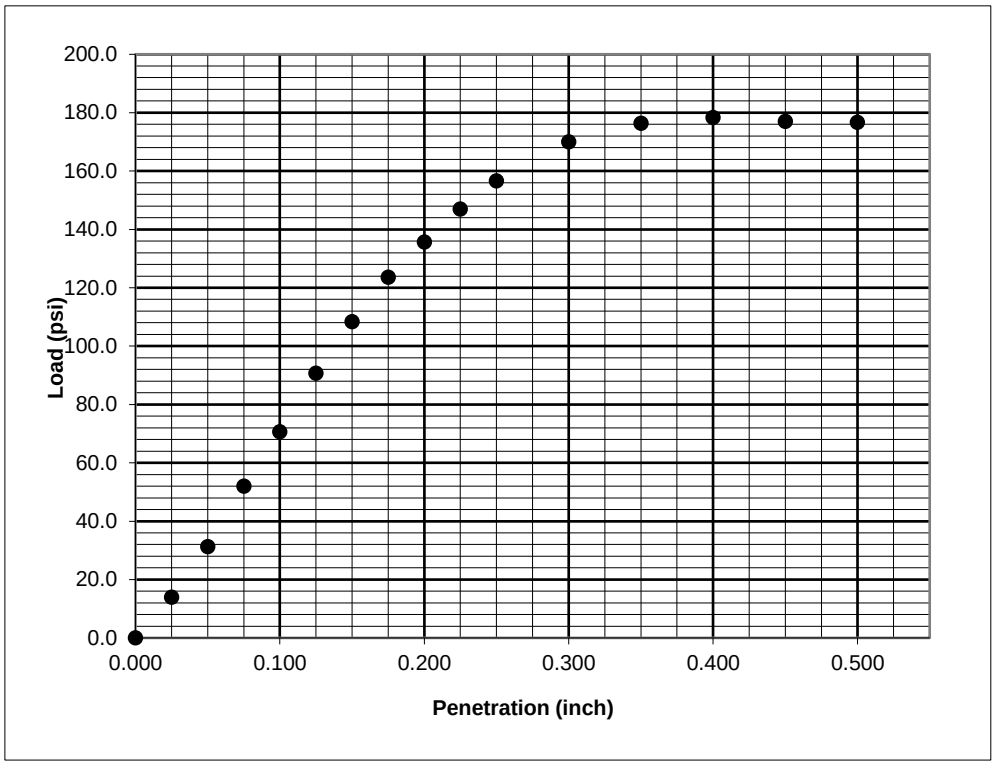
CBR Value at 0.100 inch	**7.1**
CBR Value at 0.200 inch	**9.0**
Surcharge Weight (lbs)	10
Soaking Condition	Soaked
Length of Soaking (hours)	96
Swell (%)	0.0

DENSITY DATA

Dry Density Before Soaking (pcf)	101.9
Compaction of Proctor (%)	96.3

MOISTURE DATA

Before Compaction (%)	13.6
After Compaction (%)	13.3
Top 1" After Soaking (%)	17.4
Average After Soaking (%)	18.6



Comments:

Services: Obtain soil sample and test for California Bearing Ratio

Terracon Rep: Stephanie Huffman
Reported To: Mark Weritz
Contractor:

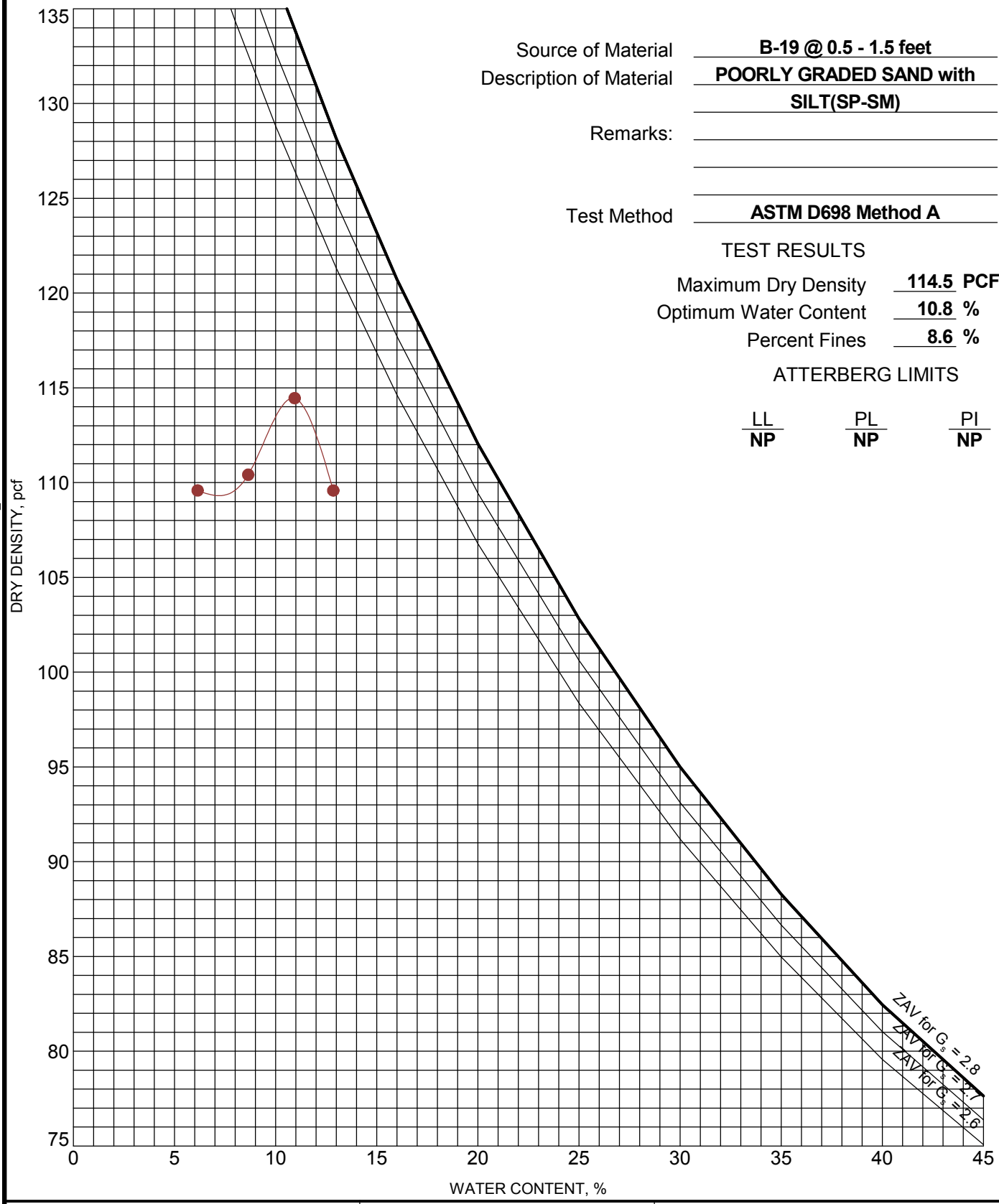
Report Distribution

Reviewed by:
Mark A. Weritz
Geotechnical Project Manager

Test Methods: ASTM D1883

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material	**B-19 @ 0.5 - 1.5 feet**
Description of Material	**POORLY GRADED SAND with SILT(SP-SM)**
Remarks:	
Test Method	**ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density	**114.5 PCF**
Optimum Water Content	**10.8 %**
Percent Fines	**8.6 %**

ATTERBERG LIMITS

LL	PL	PI
NP	**NP**	**NP**

PROJECT: Visitor Center & Underwater Archeology Building

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

PROJECT NUMBER: 70195145

CLIENT: North Carolina Dept of Natural and Cultural Resources
Raleigh, NC

REPORT FOR CALIFORNIA BEARING RATIO

Service Date: 06/08/19
Report Date: 06/25/19

Terracon
2401 Brentwood Road, Suite 107
Raleigh, NC 27604
919-873-2211

Client

North Carolina Department of Natural and Cultural Resource
Attn: Tony Romaine, PE
4605 Mail Service Center
Raleigh, North Carolina 27699-4600

Project

Visitor Center and Underwater Archeology Building
1610 Fort Fisher Boulevard S
Kure Beach, North Carolina

Project No. 70195145

SAMPLE INFORMATION

Sample Number:	Bulk Sample	Proctor Method:	ASTM D698 - Method A
Boring Number:	B-19	Maximum Dry Density (pcf):	114.5
Sample Location:	Bulk Sample	Optimum Moisture:	10.8
Depth:	0.5 - 1.5'	Liquid Limit:	NP
Material Description:	Poorly Graded Sand with Silt	Plasticity Index:	NP

CBR TEST DATA

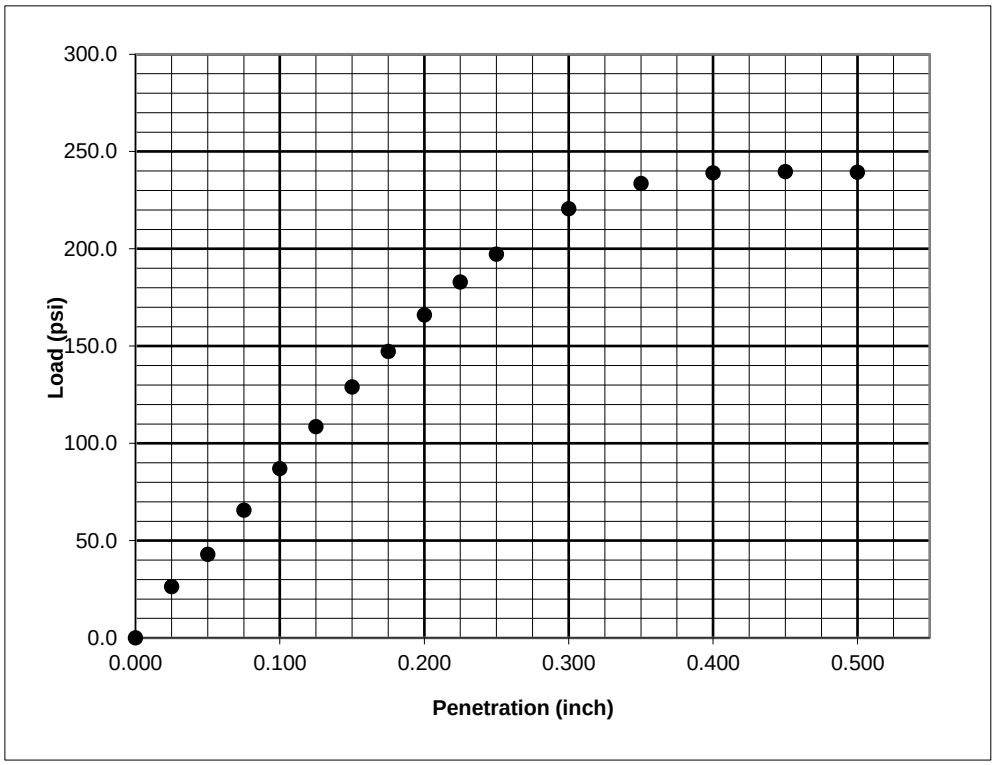
CBR Value at 0.100 inch	**8.7**
CBR Value at 0.200 inch	**11.1**
Surcharge Weight (lbs)	10
Soaking Condition	Soaked
Length of Soaking (hours)	96
Swell (%)	0.0

DENSITY DATA

Dry Density Before Soaking (pcf)	108.9
Compaction of Proctor (%)	95.1

MOISTURE DATA

Before Compaction (%)	11.0
After Compaction (%)	10.9
Top 1" After Soaking (%)	14.4
Average After Soaking (%)	14.3



Comments:

Services: Obtain soil sample and test for California Bearing Ratio

Terracon Rep: Stephanie Huffman
Reported To: Mark Weritz
Contractor:

Report Distribution

Reviewed by:
Mark A. Weritz
Geotechnical Project Manager

Test Methods: ASTM D1883

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

Split Spoon

WATER LEVEL

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

N	**Standard Penetration Test Resistance (Blows/Ft.)**
(HP)	**Hand Penetrometer**
(T)	**Torvane**
(DCP)	**Dynamic Cone Penetrometer**
(PID)	**Photo-Ionization Detector**
(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (psf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 500	0 - 1
Loose	4 - 9	Soft	500 to 1,000	2 - 4
Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8
Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15
Very Dense	> 50	Very Stiff	4,000 to 8,000	15 - 30
		Hard	> 8,000	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

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UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines Classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

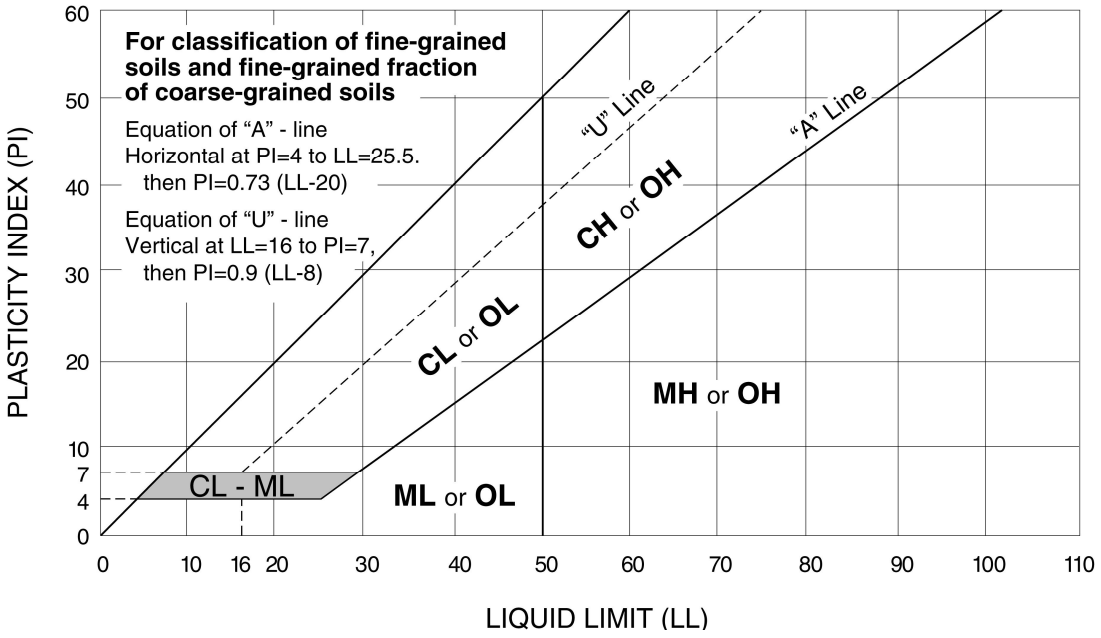
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



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CPT GENERAL NOTES

DESCRIPTION OF MEASUREMENTS AND CALIBRATIONS

To be reported per ASTM D5778:

Uncorrected Tip Resistance, q_c
Measured force acting on the cone divided by the cone's projected area

Corrected Tip Resistance, q_t
Cone resistance corrected for porewater and net area ratio effects
$q_t = q_c + U2(1 - a)$

Where a is the net area ratio, a lab calibration of the cone typically between 0.70 and 0.85

Pore Pressure, U1/U2
Pore pressure generated during penetration
U1 - sensor on the face of the cone
U2 - sensor on the shoulder (more common)

Sleeve Friction, fs
Frictional force acting on the sleeve divided by its surface area

Normalized Friction Ratio, FR
The ratio as a percentage of fs to q_t, accounting for overburden pressure

To be reported per ASTM D7400, if collected:

Shear Wave Velocity, Vs
Measured in a Seismic CPT and provides direct measure of soil stiffness

DESCRIPTION OF GEOTECHNICAL CORRELATIONS

Normalized Tip Resistance, Q_t
$Q_t = (q_t - \sigma_{v0})/\sigma'_{v0}$

Over Consolidation Ratio, OCR
$OCR\ (1) = 0.25(Q_t)^{1.25}$
$OCR\ (2) = 0.33(Q_t)$

Undrained Shear Strength, Su
$Su = Q_t \times \sigma'_{v0}/N_{kt}$
N_{kt} is a geographical factor (shown on Su plot)

Sensitivy, St
$St = (q_t - \sigma_{v0}/N_{kt}) \times (1/fs)$

Effective Friction Angle, ϕ'
$\phi'\ (1) = \tan^{-1}(0.373[\log(q_t/\sigma'_{v0}) + 0.29])$
$\phi'\ (2) = 17.6 + 11[\log(Q_t)]$

Unit Weight
$UW = (0.27[\log(FR)]+0.36[\log(q_t/atm)]+1.236) \times UW_{water}$
σ_{v0} is taken as the incremental sum of the unit weights

Small Strain Shear Modulus, G_0
$G_0\ (1) = \rho Vs^2$
$G_0\ (2) = 0.015 \times 10^{(0.55Ic + 1.68)}(q_t - \sigma_{v0})$

Soil Behavior Type Index, Ic
$Ic = [(3.47 - \log(Q_t))^2 + (\log(FR) + 1.22)^2]^{0.5}$

SPT N_{60}
$N_{60} = (q_t/atm) / 10^{(1.1268 - 0.2817Ic)}$

Elastic Modulus, Es (assumes $q/q_{ultimate} \sim 0.3$, i.e. FS = 3)
$Es\ (1) = 2.6\Psi G_0$ where $\Psi = 0.56 - 0.33\log Q_{t,clean\ sand}$
$Es\ (2) = G_0$
$Es\ (3) = 0.015 \times 10^{(0.55Ic + 1.68)}(q_t - \sigma_{v0})$
$Es\ (4) = 2.5q_t$

Constrained Modulus, M
$M = \alpha_M(q_t - \sigma_{v0})$
For Ic > 2.2 (fine-grained soils)
$\alpha_M = Q_t$ with maximum of 14
For Ic < 2.2 (coarse-grained soils)
$\alpha_M = 0.0188 \times 10^{(0.55Ic + 1.68)}$

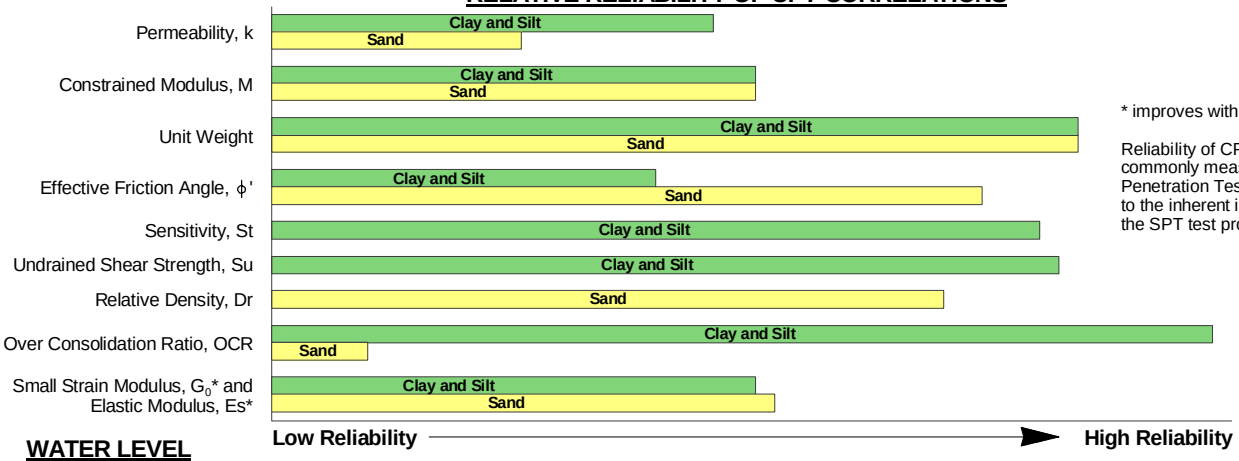
Hydraulic Conductivity, k
For $1.0 < Ic < 3.27$ $k = 10^{(0.952 - 3.04Ic)}$
For $3.27 < Ic < 4.0$ $k = 10^{(-4.52 - 1.37Ic)}$

Relative Density, Dr
$Dr = (Q_t / 350)^{0.5} \times 100$

REPORTED PARAMETERS

CPT logs as provided, at a minimum, report the data as required by ASTM D5778 and ASTM D7400 (if applicable). This minimum data include tip resistance, sleeve resistance, and porewater pressure. Other correlated parameters may also be provided. These other correlated parameters are interpretations of the measured data based upon published and reliable references, but they do not necessarily represent the actual values that would be derived from direct testing to determine the various parameters. The following chart illustrates estimates of reliability associated with correlated parameters based upon the literature referenced below.

RELATIVE RELIABILITY OF CPT CORRELATIONS



* improves with seismic Vs measurements

Reliability of CPT-predicted N_{60} values as commonly measured by the Standard Penetration Test (SPT) is not provided due to the inherent inaccuracy associated with the SPT test procedure.

WATER LEVEL

The groundwater level at the CPT location is used to normalize the measurements for vertical overburden pressures and as a result influences the normalized soil behavior type classification and correlated soil parameters. The water level may either be "measured" or "estimated:"

Measured - Depth to water directly measured in the field

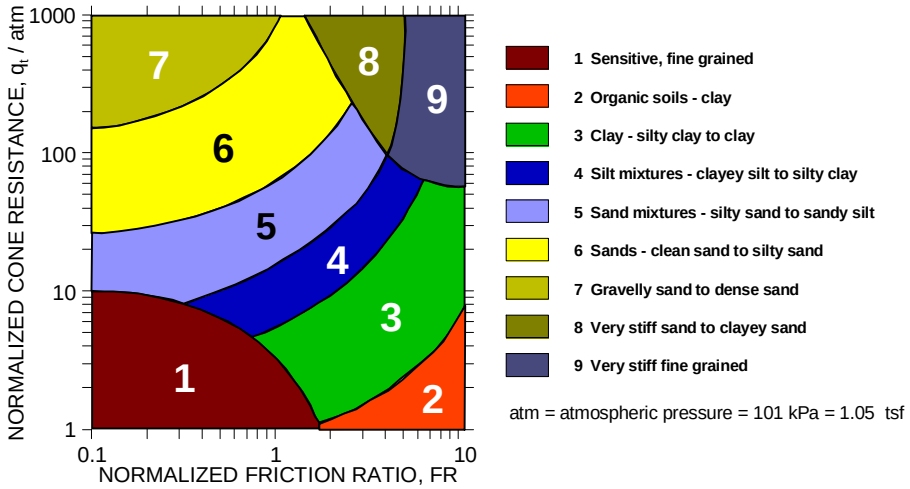
Estimated - Depth to water interpolated by the practitioner using pore pressure measurements in coarse grained soils and known site conditions

While groundwater levels displayed as "measured" more accurately represent site conditions at the time of testing than those "estimated," in either case the groundwater should be further defined prior to construction as groundwater level variations will occur over time.

CONE PENETRATION SOIL BEHAVIOR TYPE

The estimated stratigraphic profiles included in the CPT logs are based on relationships between corrected tip resistance (q_t), friction resistance (fs), and porewater pressure (U2). The normalized friction ratio (FR) is used to classify the soil behavior type.

Typically, silts and clays have high FR values and generate large excess penetration porewater pressures; sands have lower FRs and do not generate excess penetration porewater pressures. Negative pore pressure measurements are indicative of fissured fine-grained material. The adjacent graph (Robertson et al.) presents the soil behavior type correlation used for the logs. This normalized SBT chart, generally considered the most reliable, does not use pore pressure to determine SBT due to its lack of repeatability in onshore CPTs.



atm = atmospheric pressure = 101 kPa = 1.05 tsf

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Robertson, P.K., Cabal, K.L. (2012). "Guide to Cone Penetration Testing for Geotechnical Engineering," Signal Hill, CA.

Schmertmann, J.H., (1970). "Static Cone to Compute Static Settlement over Sand," *Journal of the Soil Mechanics and Foundations Division*, 96(SM3), 1011-1043.

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APPENDIX D
FIELD PERMEABILITY TESTING

Fred D. Smith Soil Scientist

July 1, 2019

Mr. Mark Weritz
Terracon Engineering
2401 Brentwood Rd Suite 107
Raleigh, NC 27604

Subject: Report of a Soil Evaluation for Stormwater Treatment
Visitor Center & Underwater Archeological Building
Ft Fisher
Kure Beach, NC

Dear Mr. Weritz,

This letter concerns the soil evaluation I performed at the above-mentioned site for stormwater BMPs. You authorized me to perform a soil evaluation to determine the depth to the 'seasonal high-water table' (SHWT) and to perform soil permeability testing at fourteen locations.

You provided me with a site drawing that shows the soil borings that Terracon performed at the site and your soil boring logs.

The soils were classified into the USDA Classification system and are presented in Table 1. The soil was evaluated for depth to soil layers, colors, texture, structure, and consistency. The depth to the seasonal high-water table (SHWT) was determined by evaluating colors as explained below. The deep boring logs were reviewed and provided depth to actual groundwater over the site.

Seasonal High-Water Table (SHWT)

The SHWT has become more frequently used as an indicator of the highest level of water table fluctuations due to agricultural considerations, regulations for septic system designs and, more recently, stormwater design. The SHWT is routinely estimated by Soil Scientists from soil morphology (soil forming factors) and landscape position. Soil colors are evaluated because gray colors are associated with saturated and chemically reducing soil environments- the presence or absence of iron. Red, reddish yellow, brown, and brownish yellow colors are associated with aerobic and chemically oxidizing conditions.

During weathering of soil minerals, over a period of time, soluble constituents are removed from the soil profile and more stable compounds will precipitate. Iron is released from minerals and coats soil particles with thin oxide coatings that give soils their red to yellow colors. The natural color of soil particles is gray until they are coated with iron.

Soils also contain microorganisms that generate energy from the oxidation of soil organic matter. When the soil becomes saturated from flooding or slowly percolating water, oxygen is removed from the soil layer and anaerobic conditions prevail. Under anaerobic conditions, other types of soil microbes can derive energy the chemical reduction of oxidized iron and change its state from ferric to ferrous iron (loss of an electron). The requirements for this chemical-microbiological process are the absence of oxygen for several weeks, a temperature of at least 41 degrees (F), and the presence of organic matter (roots, etc).

During periods of alternative wetting and drying cycles, or SHWT cycles, ferrous iron may move short distances and precipitate during the drying (reoxidation) process. These mottling patterns are called redoximorphic colors.

Soil Scientists use the Munsell Color System to evaluate the degree of color changes visible in the soil. Low chroma colors are considered to be gray or black in the Munsell System (chroma less than 2). We normally

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consider that once a soil layer has about 5% gray colors and redoximorphic patterns (red-yellow colored mottles), then that soil is saturated at least 21 days and qualifies as a SHWT.

Soil Permeability (Ksat) Equipment and Procedure

The soil permeability was measured using an Aardvark Soil Permeameter. This equipment has been approved by North Carolina and many other states to provide consistent saturated conductivities for septic designs, and spray irrigation studies, and stormwater evaluations. This equipment performs well where slowly permeable natural soil (not fill material) to rapidly permeable natural soil is to be tested.

The Aardvark Permeameter maintains a constant head of water in a bore hole by using a foot valve within the ground unit. First the hole is soaked for a period of time to allow pore spaces to fill with water to achieve a saturated flow. The length of soak time is related to the soil texture being evaluated, i.e., clays take much longer soak times than do loams and sands.

Then the flow of water out of the reservoir is visually measured over time on a graduated scale until a steady state flow is determined. Steady state is defined as the time during which the rate of flow reaches a constant value, usually when three consecutive measurements are the same. If steady state is not reached, then the data points are graphed and the mean is computed.

The test hole dimensions, soil parameters, and flow results are entered into an Excel spreadsheet program that computes the permeability value in inches per hour. The field forms are attached and the results are tabulated.

While this testing is approved by the North Carolina guidelines and accepted by industry standards, soils with permeability rates less than 0.01 inches per hour, such as compacted soils, expansive clays and clay liners for lagoons and wet stormwater impoundments may be evaluated more accurately through laboratory test methods.

Permeability Results

The permeability tests results are presented in Table 1. The field forms are attached. Table 1 also presents the soil descriptions and the depth to SHWT (if present) and approximate depth to groundwater (from Deep Boring Logs).

Soils and Groundwater

The soils at the site are classified into the USDA Soil Classification system as required by state and local stormwater regulations.

Soil horizons are horizontal surface soil layers that differ from layers above or below by physical characteristics mainly by texture and/or color. Master horizons are A, E, B, C, and R. The 'A' horizon is the topsoil that has accumulations of organic matter. 'E' horizons are elluviated layers where organic substances and other nutrients have been leached downward and usually are much lighter in color that the topsoil. The 'B' horizon has an accumulation of clay, iron, aluminum, carbonates, silica, or other mineral or organic chemicals. The 'C' horizon is the weathered parent material either from sediments or from the underlying rock. The 'R' layer is rock.

The soils at the site generally show a soil profile of very recent development in terms of geologic time. This is normal for beach areas where soils are formed by recent actions of wind and water. The soil horizons show mostly an A-C or A-E-C type profile.

A few borings (S-1, 8, 9, 11, 12) indicate an increase in clay and silt and/or organic matter that form a 'B' soil layer. These soils have a permeability in the 'B' horizon (loamy fine sand texture) of between 19.2 and 32.5 inches per hour. This layer is the most limiting for permeability in relation to the sandier layers in each soil.

Boring locations S-6, 10, and 13 show the presence of a 'spodic horizon'. These layers are a dark colored layer of organic matter and aluminum increase. Some of these horizons show some cementation within the

layer at the site. The permeability results for this layer is between 6.49 and 27.7 inches per hour. The wide range is probably caused by the degree of cementation within the soil horizon.

At other sites I have seen in southeastern NC, these horizons can be cemented very strongly. The degree of cementation at this site is intermittent and not very developed. Spodic horizons almost always show evidence of reduction of iron that is considered to be a SHWT. They will normally have reduced permeability rates from other sandy or loamy sand textured soil horizons. The permeability will be greatly influenced by the degree of cementation that is present.

Borings at S-5, 6, 10, and 13 have SHWT's between depths of 27 and 38 inches below the surface.

I appreciate the opportunity to work with you on this project. Please contact me if you have questions or need additional information.

Sincerely,

Fred D. Smith, LSS

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Table 1
Soil Descriptions and Permeability Results
Visitor Center at Ft Fisher
Kure Beach, NC

Note that the depth to SHWT is denoted on each soil description by "**".

S-1

Horizon/ Depth (inches)	Texture	Color and description	Ksat Test Depth (inches)	Ksat Results Inches per hour
A/ 0-6	Fine sand	Dark brown (10YR 4/3 and 6/3) topsoil with some disturbed soil		
E/ 6-14	sand	Pale brown		
B/ 14-38	Loamy fine sand	Reddish brown (5YR 5/4)		
**C/ 38-48+	Sand	Light brown with gray streaks (7.5YR 6/4 with 7/2 streaks)	38	30.4

SHWT @ 38. GROUNDWATER at about 8 feet

S-2

Horizon/ Depth (inches)	Texture	Color and description	Ksat Test Depth (inches)	Ksat Results Inches per hour
A/ 0-6	sand	Dark brown and pale brown (10YR 4/3 and 6/4); some disturbed soil with evidence of some compaction		
E/ 6-16	sand	Pale brown or light yellowish brown		
C/ 16 – 60+	Sand	Yellowish red (5YR 6/8)	60	70.4

NO SHWT TO 60 INCHES. GROUNDWATER at about 8 feet.

S-3

Horizon/ Depth (inches)	Texture	Color and description	Ksat Test Depth (inches)	Ksat Results Inches per hour
A / 0-5	sand	Dark brown and pale brown (10YR 4/3 and 6/4); some disturbed soil with evidence of some compaction		
E/ 6-12	sand	Light yellowish brown		
C/ 12 – 60+	Sand	Yellowish red (5YR 6/8)	40	71

NO SHWT TO 60 INCHES. GROUNDWATER at about 8 feet.

S-4

Horizon/ Depth (inches)	Texture	Color and description	Ksat Test Depth (inches)	Ksat Results Inches per hour
A/ 0-4	sand	Dark brown (10YR 4/3, 6/3)		
E/ 4-18	sand	Pale brown		
C/ 18-60+	Sand	Brownish red (2.5YR 5/4)	31	50.6

NO SHWT TO 60 INCHES. GROUNDWATER at about 7.5 feet.

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S-5

Horizon/ Depth (inches)	Texture	Color and description	Ksat Test Depth (inches)	Ksat Results Inches per hour
A/ 0-8	Loamy sand	Brownish gray and brown topsoil (10YR 5/4 and 4/4)		
E/ 8-27	Sand	Brown (7.5yr 6/4)		
**C/ 27-60+	sand	Yellowish brown and gray (10YR 6/4 and 7/1)	36	64.9

SHWT@ 27. GROUNDWATER at about 8 feet.

S-6

Horizon/ Depth (inches)	Texture	Color and description	Ksat Test Depth (inches)	Ksat Results Inches per hour
A/ 0-6	sand	Dark brown (10YR 4/3)		
E / 6-28	Sand	Pale brown		
**B/ 28-36+	Loamy sand	Black and gray (2.5yr 3/2) partially cemented spodic horizon.	33	6.49

SHWT @ 28. GROUNDWATER at about 7.5 feet.

S-7

Horizon/ Depth (inches)	Texture	Color and description	Ksat Test Depth (inches)	Ksat Results Inches per hour
A/ 0-4	sand	Dark brown (10YR 4/3)		
E/ 4-22	Sand	Pale brown and grayish brown		
C/ 22-60+	sand	Yellowish red (5YR 6/8)	46	55.1

NO SHWT TO 60 INCHES. GROUNDWATER at about 7.5 feet.

S-8

Horizon/ Depth (inches)	Texture	Color and description	Ksat Test Depth (inches)	Ksat Results Inches per hour
A/ 0-17	sand	Dark brown (10YR 4/3)		
E/ 17-30	Sand	Pale brown and brownish gray		
B / 30-60+	Loamy fine sand	Yellowish red (5YR 6/8)	44	32.47

NO SHWT TO 60 INCHES. GROUNDWATER at about 7.5 feet.

S-9

Horizon/ Depth (inches)	Texture	Color and description	Ksat Test Depth (inches)	Ksat Results Inches per hour
A/ 0-13	sand	Dark brown (10YR 4/3)		
E/ 13-30	Sand	Pale brown and brownish gray		
B / 30-60+	Loamy fine sand	Yellowish red (5yr 6/8)	36	27.9

NO SHWT TO 60 INCHES. GROUNDWATER at about 7.5 feet.

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S-10

Horizon/ Depth (inches)	Texture	Color and description	Ksat Test Depth (inches)	Ksat Results Inches per hour
A/ 0-6	sand	Dark brown (10YR 4/3)		
E / 6-28	Sand	Pale brown with brownish gray	25	10.6
**B/ 28-38+	Loamy sand	Black and gray (2.5yr 3/2) partially cemented spodic horizon. Organic content is high		

SHWT@ 28. GROUNDWATER at about 7.5 feet.

S-11

Horizon/ Depth (inches)	Texture	Color and description	Ksat Test Depth (inches)	Ksat Results Inches per hour
A/ 0-21	sand	Dark brown and pale brown (10YR 4/3)		
B/ 21-60+	Loamy Sand	Pale brown and reddish brown	38	32.4

NO SHWT TO 60 INCHES. GROUNDWATER at about 7.5 feet.

S-12

Horizon/ Depth (inches)	Texture	Color and description	Ksat Test Depth (inches)	Ksat Results Inches per hour
A/ 0-21	sand	Dark brown and pale brown (10YR 4/3)		
B/ 21-60+	Loamy Sand	Pale brown and reddish brown	50	19.2

NO SHWT TO 60 INCHES. GROUNDWATER at about 7.5 feet.

S-13

Horizon/ Depth (inches)	Texture	Color and description	Ksat Test Depth (inches)	Ksat Results Inches per hour
A/ 0-8	sand	Dark brown (10YR 4/3)		
E/ 8-38	Sand	Pale brown with brownish yellow and reddish yellow iron masses (10YR 6/3, 6/4, and 5YR 7/8); weak angular blocky; firm, sticky, plastic.		
**B/ 38-48	Loamy fine sand	Black and gray (2.5yr 3/2) partially cemented spodic horizon; organic content is high.	44	22.7

SHWT @ 38. GROUNDWATER at about 7.5 feet.

S-14

Horizon/ Depth (inches)	Texture	Color and description	Ksat Test Depth (inches)	Ksat Results Inches per hour
A + fill/ 36	sand	Dark brown, brown grayish brown fill and disturbed soil		
C/ 36- 50+	Sand	Pale brown and brownish gray.	40	22.4

NO SHWT TO 60 INCHES. GROUNDWATER at about 7 feet.

PHONE 252-908-4369 --1210 HADEL PL-KNIGHTDALE, NC 27545---EMAIL FDS4444@REAGAN.COM

BORING LOG NO. B-2

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9791° Longitude: -77.9175°

GRAPHIC LOG	DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		SILTY SAND (SM), fine to medium grained, gray-brown, very moist, loose				2-3-4 N=7			
	3.5	**POORLY GRADED SAND WITH SILT (SP-SM)**, fine to coarse grained, tan-brown, very moist to wet, loose	5	▽		3-2-3 N=5			
						3-3-3 N=6			
			10			3-4-5 N=9			
	12.0	**SILTY SAND (SM)**, fine to medium grained, orange and gray, wet, very loose to medium dense	15			1-1-2 N=3			
			20			2-3-3 N=6			
			25			2-1-2 N=3			
			30			5-6-7 N=13			
			35			5-5-9 N=14			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: Mud Rotary

Abandonment Method: Boring backfilled with sand and hole plug.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 7 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-11-2019	Boring Completed: 06-11-2019
Drill Rig: CME-45	Driller: Carolina Drilling, Inc.
Project No.: 70195145	Exhibit: A-5

BORING LOG NO. B-2

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9791° Longitude: -77.9175°

GRAPHIC LOG	DEPTH		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	38.0	**SILTY SAND (SM)**, fine to medium grained, orange and gray, wet, very loose to medium dense *(continued)*							
	42.0	**SANDY LEAN CLAY (CL)**, fine grained, gray, very moist, soft	40			1-1-1 N=2			
	46.5	**CLAYEY SAND (SC)**, fine to coarse grained, gray, wet, loose	45			1-2-2 N=4			
	49.0	**POORLY GRADED SAND (SP)**, fine to coarse grained, gray, wet, hard				50/6"			
		Boring Terminated at 49 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: Mud Rotary

Abandonment Method: Boring backfilled with sand and hole plug.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 7 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-11-2019 | Boring Completed: 06-11-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-5

BORING LOG NO. B-11

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9728° Longitude: -77.9165°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, gray, tan, and rust brown, moist to wet, loose to medium dense	5	▽		2-2-2 N=4 4-5-6 N=11 3-3-3 N=6			
	10.0	10			6-8-7 N=15			
	Boring Terminated at 10 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: Mud Rotary

Abandonment Method: Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 7.5 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-12-2019 | Boring Completed: 06-12-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-14

BORING LOG NO. B-12

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9731° Longitude: -77.9164°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, rust brown, moist to wet, very loose to loose				2-4-5 N=9			
		5			2-4-4 N=8			
			▽		4-5-4 N=9			
	10.0				1-1-2 N=3			
	Boring Terminated at 10 Feet	10						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 7.5 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-12-2019	Boring Completed: 06-12-2019
Drill Rig: CME-45	Driller: Carolina Drilling, Inc.
Project No.: 70195145	Exhibit: A-15

BORING LOG NO. B-13

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9727° Longitude: -77.9169°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, gray-brown and rust brown, moist, very loose to loose				1-2-1 N=3			
		5			2-2-3 N=5			
			▽		3-4-3 N=7			
	10.0				1-2-2 N=4			
	Boring Terminated at 10 Feet	10						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 7.5 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-12-2019	Boring Completed: 06-12-2019
Drill Rig: CME-45	Driller: Carolina Drilling, Inc.
Project No.: 70195145	Exhibit: A-16

BORING LOG NO. B-17

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9733° Longitude: -77.9158°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, brown and rust brown, moist, loose to medium dense				3-6-5 N=11			
		5			3-5-5 N=10			
			▽		4-2-3 N=5			
	10.0				4-4-4 N=8			
	Boring Terminated at 10 Feet	10						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: Mud Rotary

Abandonment Method: Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 8 feet*

Terracon

2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-13-2019 | Boring Completed: 06-13-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-20

BORING LOG NO. B-18

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9736° Longitude: -77.9165°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	POORLY GRADED SAND WITH SILT (SP-SM), fine to coarse grained, rust brown and brown, moist to wet, loose to medium dense	5	▽		3-3-3 N=6 2-2-3 N=5 3-5-7 N=12 3-4-5 N=9			
	10.0	10						
	Boring Terminated at 10 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *After 24 hours 8 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-11-2019 | Boring Completed: 06-11-2019

Drill Rig: CME-45 | Driller: Carolina Drilling, Inc.

Project No.: 70195145 | Exhibit: A-21

BORING LOG NO. B-19

PROJECT: Visitor Center & Underwater Archeology Building

CLIENT: North Carolina Dept of Natural and Cultural Resources Raleigh, NC

SITE: 1610 Fort Fisher Boulevard S
Kure Beach, NC

LOCATION See Exhibit A-2

Latitude: 33.9736° Longitude: -77.9158°

DEPTH	GRAPHIC LOG		DEPTH (FT.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5		**TOPSOIL**, root mat							
		SILTY SAND (SM), fine to medium grained, gray brown to brown, moist, loose				2-2-2 N=4	7	NP	9
						2-2-2 N=4			
5.0		**POORLY GRADED SAND WITH SILT (SP-SM)**, fine to medium grained, rust brown and brown, very moist to wet, loose	5	▽		2-3-2 N=5			
						4-2-2 N=4			
10.0		***Boring Terminated at 10 Feet***	10						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud Rotary

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling 8 feet*

Terracon
2401 Brentwood Rd, Ste 107
Raleigh, NC

Boring Started: 06-13-2019	Boring Completed: 06-13-2019
Drill Rig: CME-45	Driller: Carolina Drilling, Inc.
Project No.: 70195145	Exhibit: A-22

Percolation or Ksat Rates using Aardvark Soil Permeameter

Perc Rate: min/in | **Ksat:** in/hr | **LR:** gdsf

Site: Ft Fisher

Date: 6/22/2019 **Operator:** fds

Soil Series: **Soil Horizon:** B

Boring Number: 1

Boring Depth (in) : 38

Diameter of Hole(in): 3.5 **Water Column Height (in):** 3 **Head Conversion Factor (HCF):** 0.5

Boring Conversion Factor (BCF): 1.65 **Design Loading Rate = Ksat*14.96*safety factor of 0.05 to 0.5 system dependent**

Boring Conversion Factor (BCF) = (rad)squared/5.06 for Aardvark Reservoir

BCF of 4 in auger is 4.25 in diameter boring = 1

BCF of 3.25 in auger is 3.5 in diameter boring = 1.65

BCF of 2.75 in auger is 3.0 in diameter boring = 2.25

Head Conversion Factor (HCF) = Water Column Ht inches / 6 inches, or Htcm/15cm

Example is 3.5in boring with 7 in water column in boring, 0.5 in head drop over 45 minutes in a structureded clay loam soil

F Value (Radcliffe and West, 2000)

	Borehole diameter		
Texture	3.5 in	4.0 in	3.0 in
Sands	0.107	0.124	0.09
Structured loams and clays	0.082	0.096	0.068
Unstructured loams and clay	0.048	0.057	0.041

Time T0	Time x	Time	Hours	Reservoir	Reservoir	Reservoir	Percolation	BCF	HCF	Percolation	F value	Ksat	Design Loading
2400 hours	2400 hours	Elapsed	Elapsed	Reading, in	Reading in	Change	Rate (min/in)			Rate	from table	= F(1/P)	Rate gdsf
ti	t+1	(ti+1)-ti	dt/60min/hr	hi	h+1	(h+1)-hi	dt/dh			Adjusted			with a 0.10
		dt				dh				(P*HCF)/BCF			Safety Factor
	initial	next		initial	next		P			Adj P			of Ksat
		min	hr	in	in	in	min/in			min/in		in/hr	gdsf
Example 08:00	*8:45*	*45*	*0.75*	*14.5*	*14*	*0.5*	*90*	*1.65*	*1.17*	*64*	0.082	0.08	0.12
		1	*0.016667*	*7.5*	*5.9*	*1.6*	*0.625*	*1.65*	*0.5*	*0*	0.082	25.98	77.72
		1	*0.016667*	*5.9*	*4*	*1.9*	*0.526315789*	*1.65*	*0.5*	*0*	0.082	30.85	92.30
		1	*0.016667*	*4*	*1.9*	*2.1*	*0.476190476*	*1.65*	*0.5*	*0*	0.082	34.10	102.01
		1	*0.016667*	*1.9*	*0*	*1.9*	*0.526315789*	*1.65*	*0.5*	*0*	0.082	30.85	92.30
								1.65	*0.5*	*0*	0.082		0.00
								1.65	*0.5*	*0*	0.082		0.00
								1.65	*0.5*	*0*	0.082		0.00
								1.65	*0.5*	*0*	0.082		0.00
								1.65	*0.5*	*0*	0.082		0.00
									0.5		0.082		0.00

STEADY STATE ARITHMETIC AVERAGE of last 3 readings

30.4 in/hr

Pedon Description

Depth	Horizon	Color	Texture	Structure	Horizon Notes
			sand		

Site Notes:

Percolation or Ksat Rates using Aardvark Soil Permeameter

Perc Rate: min/in | **Ksat:** in/hr | **LR:** gdsf

Site: Ft Fisher

Date: 6/22/2019 **Operator:** fds

Soil Series: **Soil Horizon:** C

Boring Number: 2

Boring Depth (in) : 60

Diameter of Hole(in): 3.5 **Water Column Height (in):** 3 **Head Conversion Factor (HCF):** 0.5

Boring Conversion Factor (BCF): 1.65 **Design Loading Rate = Ksat*14.96*safety factor of 0.05 to 0.5 system dependent**

Boring Conversion Factor (BCF) = (rad)squared/5.06 for Aardvark Reservoir

BCF of 4 in auger is 4.25 in diameter boring = 1

BCF of 3.25 in auger is 3.5 in diameter boring = 1.65

BCF of 2.75 in auger is 3.0 in diameter boring = 2.25

Head Conversion Factor (HCF) = Water Column Ht inches / 6 inches, or Htcm/15cm

Example is 3.5in boring with 7 in water column in boring, 0.5 in head drop over 45 minutes in a structureded clay loam soil

F Value (Radcliffe and West, 2000)

	Borehole diameter		
Texture	3.5 in	4.0 in	3.0 in
Sands	0.107	0.124	0.09
Structured loams and clays	0.082	0.096	0.068
Unstructured loams and clay	0.048	0.057	0.041

Time T0	Time x	Time	Hours	Reservoir	Reservoir	Reservoir	Percolation	BCF	HCF	Percolation	F value	Ksat	Design Loading
2400 hours	2400 hours	Elapsed	Elapsed	Reading, in	Reading in	Change	Rate (min/in)			Rate	from table	= F(1/P)	Rate gdsf
ti	t+1	(ti+1)-ti	dt/60min/hr	hi	h+1	(h+1)-hi	dt/dh			Adjusted			with a 0.10
		dt				dh				(P*HCF)/BCF			Safety Factor
	initial	next		initial	next		P			Adj P			of Ksat
		min	hr	in	in	in	min/in			min/in		in/hr	gdsf
Example 08:00	*8:45*	*45*	*0.75*	*14.5*	*14*	*0.5*	*90*	*1.65*	*1.17*	*64*	0.082	0.08	0.12
		1	*0.016667*	*15*	*11*	*4*	*0.25*	*1.65*	*0.5*	*0*	0.082	64.94	194.31
		0.5	*0.008333*	*11*	*8*	*3*	*0.166666667*	*1.65*	*0.5*	*0*	0.082	97.42	291.47
		0.5	*0.008333*	*8*	*5.8*	*2.2*	*0.227272727*	*1.65*	*0.5*	*0*	0.082	71.44	213.74
		0.5	*0.008333*	*5.8*	*3.5*	*2.3*	*0.217391304*	*1.65*	*0.5*	*0*	0.082	74.69	223.46
		0.5	*0.008333*	*3.5*	*1*	*2.5*	*0.2*	*1.65*	*0.5*	*0*	0.082	81.18	242.89
		0.5	*0.008333*	*1*	*0*	*1*	*0.5*	*1.65*	*0.5*	*0*	0.082	32.47	97.16
								1.65	*0.5*		0.082		0.00
								1.65	*0.5*		0.082		0.00
								1.65	*0.5*		0.082		0.00

STEADY STATE ARITHMETIC AVERAGE of last 3 readings

70.4 in/hr

Pedon Description

Depth	Horizon	Color	Texture	Structure	Horizon Notes
			sand		

Site Notes:

Percolation or Ksat Rates using Aardvark Soil Permeameter

Perc Rate: min/in | **Ksat:** in/hr | **LR:** gdsf

Site: Ft Fisher

Date: 6/22/2019 **Operator:** fds

Soil Series: **Soil Horizon:** C

Boring Number: 3

Boring Depth (in) : 40

Diameter of Hole(in): 3.5 **Water Column Height (in):** 3 **Head Conversion Factor (HCF):** 0.5

Boring Conversion Factor (BCF): 1.65 **Design Loading Rate = Ksat*14.96*safety factor of 0.05 to 0.5 system dependent**

Boring Conversion Factor (BCF) = (rad)squared/5.06 for Aardvark Reservoir

BCF of 4 in auger is 4.25 in diameter boring = 1

BCF of 3.25 in auger is 3.5 in diameter boring = 1.65

BCF of 2.75 in auger is 3.0 in diameter boring = 2.25

Head Conversion Factor (HCF) = Water Column Ht inches / 6 inches, or Htcm/15cm

Example is 3.5in boring with 7 in water column in boring, 0.5 in head drop over 45 minutes in a structureded clay loam soil

F Value (Radcliffe and West, 2000)

	Borehole diameter		
Texture	3.5 in	4.0 in	3.0 in
Sands	0.107	0.124	0.09
Structured loams and clays	0.082	0.096	0.068
Unstructured loams and clay	0.048	0.057	0.041

Time T0	Time x	Time	Hours	Reservoir	Reservoir	Reservoir	Percolation	BCF	HCF	Percolation	F value	Ksat	Design Loading
2400 hours	2400 hours	Elapsed	Elapsed	Reading, in	Reading in	Change	Rate (min/in)			Rate	from table	= F(1/P)	Rate gdsf
ti	t+1	(ti+1)-ti	dt/60min/hr	hi	h+1	(h+1)-hi	dt/dh			Adjusted			with a 0.10
		dt				dh				(P*HCF)/BCF			Safety Factor
	initial	next		initial	next		P			Adj P			of Ksat
		min	hr	in	in	in	min/in			min/in		in/hr	gdsf
Example 08:00	*8:45*	*45*	*0.75*	*14.5*	*14*	*0.5*	*90*	*1.65*	*1.17*	*64*	0.082	0.08	0.12
		1	*0.016667*	*14*	*9.9*	*4.1*	*0.243902439*	*1.65*	*0.5*	*0*	0.082	66.57	199.17
		0.5	*0.008333*	*9.9*	*7.6*	*2.3*	*0.217391304*	*1.65*	*0.5*	*0*	0.082	74.69	223.46
		0.5	*0.008333*	*7.6*	*5.6*	*2*	*0.25*	*1.65*	*0.5*	*0*	0.082	64.94	194.31
		0.5	*0.008333*	*5.6*	*3.5*	*2.1*	*0.238095238*	*1.65*	*0.5*	*0*	0.082	68.19	204.03
		0.5	*0.008333*	*3.5*	*1*	*2.5*	*0.2*	*1.65*	*0.5*	*0*	0.082	81.18	242.89
								1.65	*0.5*		0.082		0.00
								1.65	*0.5*		0.082		0.00
								1.65	*0.5*		0.082		0.00
								1.65	*0.5*		0.082		0.00

STEADY STATE ARITHMETIC AVERAGE of last 3 readings

71.1 in/hr

Pedon Description

Depth	Horizon	Color	Texture	Structure	Horizon Notes
			sand		

Site Notes:

Percolation or Ksat Rates using Aardvark Soil Permeameter

Perc Rate: min/in | **Ksat:** in/hr | **LR:** gdsf

Site: Ft Fisher

Date: 6/22/2019 **Operator:** fds

Soil Series: **Soil Horizon:** C

Boring Number: 4

Boring Depth (in) : 31

Diameter of Hole(in): 3.5 **Water Column Height (in):** 3 **Head Conversion Factor (HCF):** 0.5

Boring Conversion Factor (BCF): 1.65 **Design Loading Rate = Ksat*14.96*safety factor of 0.05 to 0.5 system dependent**

Boring Conversion Factor (BCF) = (rad)squared/5.06 for Aardvark Reservoir

BCF of 4 in auger is 4.25 in diameter boring = 1

BCF of 3.25 in auger is 3.5 in diameter boring = 1.65

BCF of 2.75 in auger is 3.0 in diameter boring = 2.25

Head Conversion Factor (HCF) = Water Column Ht inches / 6 inches, or Htcm/15cm

Example is 3.5in boring with 7 in water column in boring, 0.5 in head drop over 45 minutes in a structureded clay loam soil

F Value (Radcliffe and West, 2000)

	Borehole diameter		
Texture	3.5 in	4.0 in	3.0 in
Sands	0.107	0.124	0.09
Structured loams and clays	0.082	0.096	0.068
Unstructured loams and clay	0.048	0.057	0.041

Time T0	Time x	Time	Hours	Reservoir	Reservoir	Reservoir	Percolation	BCF	HCF	Percolation	F value	Ksat	Design Loading
2400 hours	2400 hours	Elapsed	Elapsed	Reading, in	Reading in	Change	Rate (min/in)			Rate	from table	= F(1/P)	Rate gdsf
ti	t+1	(ti+1)-ti	dt/60min/hr	hi	h+1	(h+1)-hi	dt/dh			Adjusted			with a 0.10
		dt				dh				(P*HCF)/BCF			Safety Factor
	initial	next		initial	next		P			Adj P			of Ksat
		min	hr	in	in	in	min/in			min/in		in/hr	gdsf
Example 08:00	*8:45*	*45*	*0.75*	*14.5*	*14*	*0.5*	*90*	*1.65*	*1.17*	*64*	0.082	0.08	0.12
		1	*0.016667*	*13.9*	*8.3*	*5.6*	*0.178571429*	*1.65*	*0.5*	*0*	0.082	90.92	272.04
		0.5	*0.008333*	*8.3*	*7*	*1.3*	*0.384615385*	*1.65*	*0.5*	*0*	0.082	42.21	126.30
		0.5	*0.008333*	*7*	*5.5*	*1.5*	*0.333333333*	*1.65*	*0.5*	*0*	0.082	48.71	145.73
		0.5	*0.008333*	*5.5*	*4*	*1.5*	*0.333333333*	*1.65*	*0.5*	*0*	0.082	48.71	145.73
		0.5	*0.008333*	*4*	*2.4*	*1.6*	*0.3125*	*1.65*	*0.5*	*0*	0.082	51.96	155.45
		0.5	*0.008333*	*2.4*	*0.5*	*1.9*	*0.263157895*	*1.65*	*0.5*	*0*	0.082	61.70	184.60
								1.65	*0.5*		0.082		0.00
								1.65	*0.5*		0.082		0.00
								1.65	*0.5*		0.082		0.00

STEADY STATE ARITHMETIC AVERAGE of last 3 readings 50.6 in/hr

Pedon Description

Depth	Horizon	Color	Texture	Structure	Horizon Notes
			sand		

Site Notes:

Percolation or Ksat Rates using Aardvark Soil Permeameter	Perc Rate: min/in	Ksat: in/hr	LR: gdsf

Site: Ft Fisher

Date: 6/22/2019 **Operator:** fds

Soil Series: **Soil Horizon:** B

Boring Number: 5

Boring Depth (in) : 36

Diameter of Hole(in): 3.5 **Water Column Height (in):** 3 **Head Conversion Factor (HCF):** 0.5

Boring Conversion Factor (BCF): 1.65 **Design Loading Rate = Ksat*14.96*safety factor of 0.05 to 0.5 system dependent**

Boring Conversion Factor (BCF) = (rad)squared/5.06 for Aardvark Reservoir

BCF of 4 in auger is 4.25 in diameter boring = 1

BCF of 3.25 in auger is 3.5 in diameter boring = 1.65

BCF of 2.75 in auger is 3.0 in diameter boring = 2.25

Head Conversion Factor (HCF) = Water Column Ht inches / 6 inches, or Htcm/15cm

Example is 3.5in boring with 7 in water column in boring, 0.5 in head drop over 45 minutes in a structureded clay loam soil

F Value (Radcliffe and West, 2000)

	Borehole diameter		
Texture	3.5 in	4.0 in	3.0 in
Sands	0.107	0.124	0.09
Structured loams and clays	0.082	0.096	0.068
Unstructured loams and clay	0.048	0.057	0.041

Time T0	Time x	Time	Hours	Reservoir	Reservoir	Reservoir	Percolation	BCF	HCF	Percolation	F value	Ksat	Design Loading
2400 hours	2400 hours	Elapsed	Elapsed	Reading, in	Reading in	Change	Rate (min/in)			Rate	from table	= F(1/P)	Rate gdsf
ti	t+1	(ti+1)-ti	dt/60min/hr	hi	h+1	(h+1)-hi	dt/dh			Adjusted			with a 0.10
		dt				dh				(P*HCF)/BCF			Safety Factor
	initial	next		initial	next		P			Adj P			of Ksat
		min	hr	in	in	in	min/in			min/in		in/hr	gdsf
Example 08:00	*8:45*	*45*	*0.75*	*14.5*	*14*	*0.5*	*90*	*1.65*	*1.17*	*64*	0.082	0.08	0.12
		1	*0.016667*	*14.2*	*10.5*	*3.7*	*0.27027027*	*1.65*	*0.5*	*0*	0.082	60.07	179.74
		0.5	*0.008333*	*10.5*	*8.5*	*2*	*0.25*	*1.65*	*0.5*	*0*	0.082	64.94	194.31
		0.5	*0.008333*	*8.5*	*6.5*	*2*	*0.25*	*1.65*	*0.5*	*0*	0.082	64.94	194.31
		0.5	*0.008333*	*6.5*	*4.5*	*2*	*0.25*	*1.65*	*0.5*	*0*	0.082	64.94	194.31
		0.5	*0.008333*	*4.5*	*2.6*	*1.9*	*0.263157895*	*1.65*	*0.5*	*0*	0.082	61.70	184.60
		0.5	*0.008333*	*2.6*	*0.5*	*2.1*	*0.238095238*	*1.65*	*0.5*	*0*	0.082	68.19	204.03
								1.65	*0.5*		0.082		0.00
								1.65	*0.5*		0.082		0.00
								1.65	*0.5*		0.082		0.00

STEADY STATE ARITHMETIC AVERAGE of last 3 readings 64.94in/hr

Pedon Description

Depth	Horizon	Color	Texture	Structure	Horizon Notes
			sand		

Site Notes:

Percolation or Ksat Rates using Aardvark Soil Permeameter

Perc Rate: min/in | **Ksat:** in/hr | **LR:** gdsf

Site: Ft Fisher

Date: 6/22/2019 **Operator:** fds

Soil Series: **Soil Horizon:** B

Boring Number: 6

Boring Depth (in) : 33

Diameter of Hole(in): 3.5 **Water Column Height (in):** 3 **Head Conversion Factor (HCF):** 0.5

Boring Conversion Factor (BCF): 1.65 **Design Loading Rate = Ksat*14.96*safety factor of 0.05 to 0.5 system dependent**

Boring Conversion Factor (BCF) = (rad)squared/5.06 for Aardvark Reservoir

BCF of 4 in auger is 4.25 in diameter boring = 1

BCF of 3.25 in auger is 3.5 in diameter boring = 1.65

BCF of 2.75 in auger is 3.0 in diameter boring = 2.25

Head Conversion Factor (HCF) = Water Column Ht inches / 6 inches, or Htcm/15cm

Example is 3.5in boring with 7 in water column in boring, 0.5 in head drop over 45 minutes in a structureded clay loam soil

F Value (Radcliffe and West, 2000)

	Borehole diameter		
Texture	3.5 in	4.0 in	3.0 in
Sands	0.107	0.124	0.09
Structured loams and clays	0.082	0.096	0.068
Unstructured loams and clay	0.048	0.057	0.041

Time T0	Time x	Time	Hours	Reservoir	Reservoir	Reservoir	Percolation	BCF	HCF	Percolation	F value	Ksat	Design Loading
2400 hours	2400 hours	Elapsed	Elapsed	Reading, in	Reading in	Change	Rate (min/in)			Rate	from table	= F(1/P)	Rate gdsf
ti	t+1	(ti+1)-ti	dt/60min/hr	hi	h+1	(h+1)-hi	dt/dh			Adjusted			with a 0.10
		dt				dh				(P*HCF)/BCF			Safety Factor
	initial	next		initial	next		P			Adj P			of Ksat
		min	hr	in	in	in	min/in			min/in		in/hr	gdsf
Example 08:00	*8:45*	*45*	*0.75*	*14.5*	*14*	*0.5*	*90*	*1.65*	*1.17*	*64*	0.082	0.08	0.12
		1	*0.016667*	*13.2*	*10.5*	*2.7*	*0.37037037*	*1.65*	*0.5*	*0*	0.082	43.84	131.16
		1	*0.016667*	*10.5*	*10.4*	*0.1*	*10*	*1.65*	*0.5*	*3*	0.082	1.62	4.86
		0.5	*0.008333*	*10.4*	*10.3*	*0.1*	*5*	*1.65*	*0.5*	*2*	0.082	3.25	9.72
		0.5	*0.008333*	*10.3*	*10*	*0.3*	*1.666666667*	*1.65*	*0.5*	*1*	0.082	9.74	29.15
		0.5	*0.008333*	*10*	*9.9*	*0.1*	*5*	*1.65*	*0.5*	*2*	0.082	3.25	9.72
		0.5	*0.008333*	*9.9*	*9.7*	*0.2*	*2.5*	*1.65*	*0.5*	*1*	0.082	6.49	19.43
		0.5	*0.008333*	*9.7*	*9.5*	*0.2*	*2.5*	*1.65*	*0.5*	*1*	0.082	6.49	19.43
		0.5	*0.008333*	*9.5*	*9.3*	*0.2*	*2.5*	*1.65*	*0.5*	*1*	0.082	6.49	19.43
		0.5	*0.008333*			*0*		*1.65*	*0.5*		0.082		0.00

STEADY STATE ARITHMETIC AVERAGE of last 3 readings

6.49in/hr

Pedon Description

Depth	Horizon	Color	Texture	Structure	Horizon Notes
			loamy fins sand		

Site Notes:

Percolation or Ksat Rates using Aardvark Soil Permeameter

Perc Rate: min/in | **Ksat:** in/hr | **LR:** gdsf

Site: Ft Fisher

Date: 6/22/2019 **Operator:** fds

Soil Series: **Soil Horizon:** C

Boring Number: 7

Boring Depth (in) : 46

Diameter of Hole(in): 3.5 **Water Column Height (in):** 3 **Head Conversion Factor (HCF):** 0.5

Boring Conversion Factor (BCF): 1.65 **Design Loading Rate = Ksat*14.96*safety factor of 0.05 to 0.5 system dependent**

Boring Conversion Factor (BCF) = (rad)squared/5.06 for Aardvark Reservoir

BCF of 4 in auger is 4.25 in diameter boring = 1

BCF of 3.25 in auger is 3.5 in diameter boring = 1.65

BCF of 2.75 in auger is 3.0 in diameter boring = 2.25

Head Conversion Factor (HCF) = Water Column Ht inches / 6 inches, or Htcm/15cm

Example is 3.5in boring with 7 in water column in boring, 0.5 in head drop over 45 minutes in a structureded clay loam soil

F Value (Radcliffe and West, 2000)

	Borehole diameter		
Texture	3.5 in	4.0 in	3.0 in
Sands	0.107	0.124	0.09
Structured loams and clays	0.082	0.096	0.068
Unstructured loams and clay	0.048	0.057	0.041

Time T0	Time x	Time	Hours	Reservoir	Reservoir	Reservoir	Percolation	BCF	HCF	Percolation	F value	Ksat	Design Loading
2400 hours	2400 hours	Elapsed	Elapsed	Reading, in	Reading in	Change	Rate (min/in)			Rate	from table	= F(1/P)	Rate gdsf
ti	t+1	(ti+1)-ti	dt/60min/hr	hi	h+1	(h+1)-hi	dt/dh			Adjusted			with a 0.10
		dt				dh				(P*HCF)/BCF			Safety Factor
	initial	next		initial	next		P			Adj P			of Ksat
		min	hr	in	in	in	min/in			min/in		in/hr	gdsf
Example 08:00	*8:45*	*45*	*0.75*	*14.5*	*14*	*0.5*	*90*	*1.65*	*1.17*	*64*	0.082	0.08	0.12
		1	*0.016667*	*13.7*	*10.1*	*3.6*	*0.277777778*	*1.65*	*0.5*	*0*	0.082	58.45	174.88
		0.5	*0.008333*	*10.1*	*8.4*	*1.7*	*0.294117647*	*1.65*	*0.5*	*0*	0.082	55.20	165.17
		0.5	*0.008333*	*8.4*	*7.2*	*1.2*	*0.416666667*	*1.65*	*0.5*	*0*	0.082	38.97	116.59
		0.5	*0.008333*	*7.2*	*5*	*2.2*	*0.227272727*	*1.65*	*0.5*	*0*	0.082	71.44	213.74
		0.5	*0.008333*	*5*	*3.4*	*1.6*	*0.3125*	*1.65*	*0.5*	*0*	0.082	51.96	155.45
		0.5	*0.008333*	*3.4*	*1.8*	*1.6*	*0.3125*	*1.65*	*0.5*	*0*	0.082	51.96	155.45
		0.5	*0.008333*	*1.8*	*0*	*1.8*	*0.277777778*	*1.65*	*0.5*	*0*	0.082	58.45	174.88
		0.5	*0.008333*			*0*		*1.65*	*0.5*	*0*	0.082		0.00
		0.5	*0.008333*			*0*		*1.65*	*0.5*		0.082		0.00

STEADY STATE ARITHMETIC AVERAGE of last 3 readings

55.1in/hr

Pedon Description

Depth	Horizon	Color	Texture	Structure	Horizon Notes
			sand		

Site Notes:

Percolation or Ksat Rates using Aardvark Soil Permeameter

Perc Rate: min/in | **Ksat:** in/hr | **LR:** gdsf

Site: Ft Fisher

Date: 6/22/2019 **Operator:** fds

Soil Series: **Soil Horizon:** B

Boring Number: 8

Boring Depth (in) : 44

Diameter of Hole(in): 3.5 **Water Column Height (in):** 3 **Head Conversion Factor (HCF):** 0.5

Boring Conversion Factor (BCF): 1.65 **Design Loading Rate = Ksat*14.96*safety factor of 0.05 to 0.5 system dependent**

Boring Conversion Factor (BCF) = (rad)squared/5.06 for Aardvark Reservoir

BCF of 4 in auger is 4.25 in diameter boring = 1

BCF of 3.25 in auger is 3.5 in diameter boring = 1.65

BCF of 2.75 in auger is 3.0 in diameter boring = 2.25

Head Conversion Factor (HCF) = Water Column Ht inches / 6 inches, or Htcm/15cm

Example is 3.5in boring with 7 in water column in boring, 0.5 in head drop over 45 minutes in a structureded clay loam soil

F Value (Radcliffe and West, 2000)

	Borehole diameter		
Texture	3.5 in	4.0 in	3.0 in
Sands	0.107	0.124	0.09
Structured loams and clays	0.082	0.096	0.068
Unstructured loams and clay	0.048	0.057	0.041

Time T0	Time x	Time	Hours	Reservoir	Reservoir	Reservoir	Percolation	BCF	HCF	Percolation	F value	Ksat	Design Loading
2400 hours	2400 hours	Elapsed	Elapsed	Reading, in	Reading in	Change	Rate (min/in)			Rate	from table	= F(1/P)	Rate gdsf
ti	t+1	(ti+1)-ti	dt/60min/hr	hi	h+1	(h+1)-hi	dt/dh			Adjusted			with a 0.10
		dt				dh				(P*HCF)/BCF			Safety Factor
	initial	next		initial	next		P			Adj P			of Ksat
		min	hr	in	in	in	min/in			min/in		in/hr	gdsf
Example 08:00	*8:45*	*45*	*0.75*	*14.5*	*14*	*0.5*	*90*	*1.65*	*1.17*	*64*	0.082	0.08	0.12
		1	*0.016667*	*12.5*	*8.5*	*4*	*0.25*	*1.65*	*0.5*	*0*	0.082	64.94	194.31
		0.5	*0.008333*	*8.5*	*7.4*	*1.1*	*0.454545455*	*1.65*	*0.5*	*0*	0.082	35.72	106.87
		0.5	*0.008333*	*7.4*	*6.4*	*1*	*0.5*	*1.65*	*0.5*	*0*	0.082	32.47	97.16
		0.5	*0.008333*	*6.4*	*5.4*	*1*	*0.5*	*1.65*	*0.5*	*0*	0.082	32.47	97.16
		0.5	*0.008333*	*5.4*	*4.4*	*1*	*0.5*	*1.65*	*0.5*	*0*	0.082	32.47	97.16
		0.5	*0.008333*	*4.4*	*3.5*	*0.9*	*0.555555556*	*1.65*	*0.5*	*0*	0.082	29.22	87.44
		0.5	*0.008333*	*3.5*	*2.5*	*1*	*0.5*	*1.65*	*0.5*	*0*	0.082	32.47	97.16
		0.5	*0.008333*					*1.65*	*0.5*	*0*	0.082		0.00
		0.5	*0.008333*					*1.65*	*0.5*		0.082		0.00

STEADY STATE ARITHMETIC AVERAGE of last 3 readings

32.47in/hr

Pedon Description

Depth	Horizon	Color	Texture	Structure	Horizon Notes
			sand		

Site Notes:

Percolation or Ksat Rates using Aardvark Soil Permeameter	Perc Rate: min/in	Ksat: in/hr	LR: gdsf

Site: Ft Fisher
Date: 6/22/2019 **Operator:** fds
Soil Series: **Soil Horizon:** B
Boring Number: 9
Boring Depth (in) : 36
Diameter of Hole(in): 3.5 **Water Column Height (in):** 3 **Head Conversion Factor (HCF):** 0.5
Boring Conversion Factor (BCF): 1.65 **Design Loading Rate = Ksat*14.96*safety factor of 0.05 to 0.5 system dependent**

Boring Conversion Factor (BCF) = (rad)squared/5.06 for Aardvark Reservoir
BCF of 4 in auger is 4.25 in diameter boring = 1
BCF of 3.25 in auger is 3.5 in diameter boring = 1.65
BCF of 2.75 in auger is 3.0 in diameter boring = 2.25
Head Conversion Factor (HCF) = Water Column Ht inches / 6 inches, or Htcm/15cm
Example is 3.5in boring with 7 in water column in boring, 0.5 in head drop over 45 minutes in a structureded clay loam soil

F Value (Radcliffe and West, 2000)

	Borehole diameter		
Texture	3.5 in	4.0 in	3.0 in
Sands	0.107	0.124	0.09
Structured loams and clays	0.082	0.096	0.068
Unstructured loams and clay	0.048	0.057	0.041

Time T0	Time x	Time	Hours	Reservoir	Reservoir	Reservoir	Percolation	BCF	HCF	Percolation	F value	Ksat	Design Loading
2400 hours	2400 hours	Elapsed	Elapsed	Reading, in	Reading in	Change	Rate (min/in)			Rate	from table	= F(1/P)	Rate gdsf
ti	t+1	(ti+1)-ti	dt/60min/hr	hi	h+1	(h+1)-hi	dt/dh			Adjusted			with a 0.10
		dt				dh				(P*HCF)/BCF			Safety Factor
	initial	next		initial	next		P			Adj P			of Ksat
		min	hr	in	in	in	min/in			min/in		in/hr	gdsf
Example 08:00	*8:45*	*45*	*0.75*	*14.5*	*14*	*0.5*	*90*	*1.65*	*1.17*	*64*	0.082	0.08	0.12
		1	*0.016667*	*13.8*	*11.5*	*2.3*	*0.434782609*	*1.65*	*0.5*	*0*	0.082	37.34	111.73
		1	*0.016667*	*11.5*	*9.2*	*2.3*	*0.434782609*	*1.65*	*0.5*	*0*	0.082	37.34	111.73
		1	*0.016667*	*9.2*	*7.8*	*1.4*	*0.714285714*	*1.65*	*0.5*	*0*	0.082	22.73	68.01
		1	*0.016667*	*7.8*	*6.1*	*1.7*	*0.588235294*	*1.65*	*0.5*	*0*	0.082	27.60	82.58
		1	*0.016667*	*6.1*	*4.9*	*1.2*	*0.833333333*	*1.65*	*0.5*	*0*	0.082	19.48	58.29
		1	*0.016667*	*4.9*	*2.9*	*2*	*0.5*	*1.65*	*0.5*	*0*	0.082	32.47	97.16
		1	*0.016667*	*2.9*	*0.8*	*2.1*	*0.476190476*	*1.65*	*0.5*	*0*	0.082	34.10	102.01
		1	*0.016667*	*0.8*	*0*	*0.8*	*1.25*	*1.65*	*0.5*	*0*	0.082	12.99	38.86
		1	*0.016667*			*0*		*1.65*	*0.5*		0.082		0.00

STEADY STATE ARITHMETIC AVERAGE of last 3 readings 27.9in/hr

Pedon Description

Depth	Horizon	Color	Texture	Structure	Horizon Notes
			loamy fine sand		

Site Notes:

Percolation or Ksat Rates using Aardvark Soil Permeameter

Perc Rate: min/in | **Ksat:** in/hr | **LR:** gdsf

Site: Ft Fisher

Date: 6/22/2019 **Operator:** fds

Soil Series: **Soil Horizon:** E

Boring Number: 10

Boring Depth (in) : 25

Diameter of Hole(in): 3.5 **Water Column Height (in):** 3 **Head Conversion Factor (HCF):** 0.5

Boring Conversion Factor (BCF): 1.65 **Design Loading Rate = Ksat*14.96*safety factor of 0.05 to 0.5 system dependent**

Boring Conversion Factor (BCF) = (rad)squared/5.06 for Aardvark Reservoir

BCF of 4 in auger is 4.25 in diameter boring = 1

BCF of 3.25 in auger is 3.5 in diameter boring = 1.65

BCF of 2.75 in auger is 3.0 in diameter boring = 2.25

Head Conversion Factor (HCF) = Water Column Ht inches / 6 inches, or Htcm/15cm

Example is 3.5in boring with 7 in water column in boring, 0.5 in head drop over 45 minutes in a structureded clay loam soil

F Value (Radcliffe and West, 2000)

Texture	Borehole diameter 3.5 in	4.0 in	3.0 in
Sands	0.107	0.124	0.09
Structured loams and clays	0.082	0.096	0.068
Unstructured loams and clay	0.048	0.057	0.041

Time T0	Time x	Time	Hours	Reservoir	Reservoir	Reservoir	Percolation	BCF	HCF	Percolation	F value	Ksat	Design Loading
2400 hours	2400 hours	Elapsed	Elapsed	Reading, in	Reading in	Change	Rate (min/in)			Rate	from table	= F(1/P)	Rate gdsf
ti	t+1	(ti+1)-ti	dt/60min/hr	hi	h+1	(h+1)-hi	dt/dh			Adjusted			with a 0.10
		dt				dh				(P*HCF)/BCF			Safety Factor
	initial	next		initial	next		P			Adj P			of Ksat
		min	hr	in	in	in	min/in			min/in		in/hr	gdsf
Example 08:00	*8:45*	*45*	*0.75*	*14.5*	*14*	*0.5*	*90*	*1.65*	*1.17*	*64*	0.082	0.08	0.12
		1	*0.016667*	*13.8*	*11.2*	*2.6*	*0.384615385*	*1.65*	*0.5*	*0*	0.082	42.21	126.30
		0.5	*0.008333*	*11.2*	*10.9*	*0.3*	*1.666666667*	*1.65*	*0.5*	*1*	0.082	9.74	29.15
		0.5	*0.008333*	*10.9*	*10.5*	*0.4*	*1.25*	*1.65*	*0.5*	*0*	0.082	12.99	38.86
		0.5	*0.008333*	*10.5*	*10*	*0.5*	*1*	*1.65*	*0.5*	*0*	0.082	16.24	48.58
		0.5	*0.008333*	*10*	*9.6*	*0.4*	*1.25*	*1.65*	*0.5*	*0*	0.082	12.99	38.86
		0.5	*0.008333*	*9.6*	*9.3*	*0.3*	*1.666666667*	*1.65*	*0.5*	*1*	0.082	9.74	29.15
		0.5	*0.008333*	*9.3*	*9*	*0.3*	*1.666666667*	*1.65*	*0.5*	*1*	0.082	9.74	29.15
		0.5	*0.008333*	*9*	*8.5*	*0.5*	*1*	*1.65*	*0.5*	*0*	0.082	16.24	48.58
		0.5	*0.008333*			*0*		*1.65*	*0.5*		0.082		0.00

STEADY STATE ARITHMETIC AVERAGE of last 3 readings

10.6in/hr

Pedon Description

Depth	Horizon	Color	Texture	Structure	Horizon Notes
			sand		

Site Notes:

Percolation or Ksat Rates using Aardvark Soil Permeameter

Perc Rate: min/in | **Ksat:** in/hr | **LR:** gdsf

Site: Ft Fisher

Date: 6/22/2019 **Operator:** fds

Soil Series: **Soil Horizon:** C

Boring Number: 11

Boring Depth (in) : 38

Diameter of Hole(in): 3.5 **Water Column Height (in):** 3 **Head Conversion Factor (HCF):** 0.5

Boring Conversion Factor (BCF): 1.65 **Design Loading Rate = Ksat*14.96*safety factor of 0.05 to 0.5 system dependent**

Boring Conversion Factor (BCF) = (rad)squared/5.06 for Aardvark Reservoir

BCF of 4 in auger is 4.25 in diameter boring = 1

BCF of 3.25 in auger is 3.5 in diameter boring = 1.65

BCF of 2.75 in auger is 3.0 in diameter boring = 2.25

Head Conversion Factor (HCF) = Water Column Ht inches / 6 inches, or Htcm/15cm

Example is 3.5in boring with 7 in water column in boring, 0.5 in head drop over 45 minutes in a structureded clay loam soil

F Value (Radcliffe and West, 2000)

	Borehole diameter		
Texture	3.5 in	4.0 in	3.0 in
Sands	0.107	0.124	0.09
Structured loams and clays	0.082	0.096	0.068
Unstructured loams and clay	0.048	0.057	0.041

Time T0	Time x	Time	Hours	Reservoir	Reservoir	Reservoir	Percolation	BCF	HCF	Percolation	F value	Ksat	Design Loading
2400 hours	2400 hours	Elapsed	Elapsed	Reading, in	Reading in	Change	Rate (min/in)			Rate	from table	= F(1/P)	Rate gdsf
ti	t+1	(ti+1)-ti	dt/60min/hr	hi	h+1	(h+1)-hi	dt/dh			Adjusted			with a 0.10
		dt				dh				(P*HCF)/BCF			Safety Factor
	initial	next		initial	next		P			Adj P			of Ksat
		min	hr	in	in	in	min/in			min/in		in/hr	gdsf
Example 08:00	*8:45*	*45*	*0.75*	*14.5*	*14*	*0.5*	*90*	*1.65*	*1.17*	*64*	0.082	0.08	0.12
		1	*0.016667*	*11.3*	*7.1*	*4.2*	*0.238095238*	*1.65*	*0.5*	*0*	0.082	68.19	204.03
		0.5	*0.008333*	*7.1*	*6.1*	*1*	*0.5*	*1.65*	*0.5*	*0*	0.082	32.47	97.16
		0.5	*0.008333*	*6.1*	*5.1*	*1*	*0.5*	*1.65*	*0.5*	*0*	0.082	32.47	97.16
		0.5	*0.008333*	*5.1*	*4.1*	*1*	*0.5*	*1.65*	*0.5*	*0*	0.082	32.47	97.16
		0.5	*0.008333*	*4.1*	*2.9*	*1.2*	*0.416666667*	*1.65*	*0.5*	*0*	0.082	38.97	116.59
		0.5	*0.008333*	*2.9*	*1.9*	*1*	*0.5*	*1.65*	*0.5*	*0*	0.082	32.47	97.16
		0.5	*0.008333*	*1.9*	*0.8*	*1.1*	*0.454545455*	*1.65*	*0.5*	*0*	0.082	35.72	106.87
		0.5	*0.008333*					*1.65*	*0.5*		0.082		0.00
		0.5	*0.008333*					*1.65*	*0.5*		0.082		0.00

STEADY STATE ARITHMETIC AVERAGE of last 3 readings

32.4in/hr

Pedon Description

Depth	Horizon	Color	Texture	Structure	Horizon Notes
			sand		

Site Notes:

Percolation or Ksat Rates using Aardvark Soil Permeameter	Perc Rate: min/in	Ksat: in/hr	LR: gdsf

Site: Ft Fisher
Date: 6/22/2019 **Operator:** fds
Soil Series: **Soil Horizon:** B
Diameter of Hole(in): 3.5
Boring Conversion Factor (BCF): 1.65

Boring Number: 12
Boring Depth (in) : 50
Water Column Height (in): 3
Head Conversion Factor (HCF): 0.5

Design Loading Rate = Ksat*14.96*safety factor of 0.05 to 0.5 system dependent

Boring Conversion Factor (BCF) = (rad)squared/5.06 for Aardvark Reservoir
BCF of 4 in auger is 4.25 in diameter boring = 1
BCF of 3.25 in auger is 3.5 in diameter boring = 1.65
BCF of 2.75 in auger is 3.0 in diameter boring = 2.25
Head Conversion Factor (HCF) = Water Column Ht inches / 6 inches, or Htcm/15cm
Example is 3.5in boring with 7 in water column in boring, 0.5 in head drop over 45 minutes in a structureded clay loam soil

F Value (Radcliffe and West, 2000)

	Borehole diameter		
Texture	3.5 in	4.0 in	3.0 in
Sands	0.107	0.124	0.09
Structured loams and clays	0.082	0.096	0.068
Unstructured loams and clay	0.048	0.057	0.041

Time T0	Time x	Time	Hours	Reservoir	Reservoir	Reservoir	Percolation	BCF	HCF	Percolation	F value	Ksat	Design Loading
2400 hours	2400 hours	Elapsed	Elapsed	Reading, in	Reading in	Change	Rate (min/in)			Rate	from table	= F(1/P)	Rate gdsf
ti	t+1	(ti+1)-ti	dt/60min/hr	hi	h+1	(h+1)-hi	dt/dh			Adjusted			with a 0.10
		dt				dh				(P*HCF)/BCF			Safety Factor
	initial	next		initial	next		P			Adj P			of Ksat
		min	hr	in	in	in	min/in			min/in		in/hr	gdsf
Example 08:00	*8:45*	*45*	*0.75*	*14.5*	*14*	*0.5*	*90*	*1.65*	*1.17*	*64*	0.082	0.08	0.12
		1	*0.016667*	*14.1*	*12.8*	*1.3*	*0.769230769*	*1.65*	*0.5*	*0*	0.082	21.11	63.15
		1	*0.016667*	*12.8*	*10.9*	*1.9*	*0.526315789*	*1.65*	*0.5*	*0*	0.082	30.85	92.30
		1	*0.016667*	*10.9*	*9*	*1.9*	*0.526315789*	*1.65*	*0.5*	*0*	0.082	30.85	92.30
		1	*0.016667*	*9*	*8*	*1*	*1*	*1.65*	*0.5*	*0*	0.082	16.24	48.58
		1	*0.016667*	*8*	*6.8*	*1.2*	*0.833333333*	*1.65*	*0.5*	*0*	0.082	19.48	58.29
		1	*0.016667*	*6.8*	*5.9*	*0.9*	*1.111111111*	*1.65*	*0.5*	*0*	0.082	14.61	43.72
		1	*0.016667*	*5.9*	*4.6*	*1.3*	*0.769230769*	*1.65*	*0.5*	*0*	0.082	21.11	63.15
		1	*0.016667*					*1.65*	*0.5*	*0*	0.082		0.00
		1	*0.016667*					*1.65*	*0.5*		0.082		0.00

STEADY STATE ARITHMETIC AVERAGE of last 3 readings

19.2in/hr

Pedon Description

Depth	Horizon	Color	Texture	Structure	Horizon Notes
			loamy sand		

Site Notes:

Percolation or Ksat Rates using Aardvark Soil Permeameter	Perc Rate: min/in	Ksat: in/hr	LR: gdsf

Site: Ft Fisher
Date: 6/22/2019 **Operator:** fds
Soil Series: **Soil Horizon:** B
Boring Number: 13
Boring Depth (in) : 44
Diameter of Hole(in): 3.5 **Water Column Height (in):** 3 **Head Conversion Factor (HCF):** 0.5
Boring Conversion Factor (BCF): 1.65 **Design Loading Rate = Ksat*14.96*safety factor of 0.05 to 0.5 system dependent**

Boring Conversion Factor (BCF) = (rad)squared/5.06 for Aardvark Reservoir
BCF of 4 in auger is 4.25 in diameter boring = 1
BCF of 3.25 in auger is 3.5 in diameter boring = 1.65
BCF of 2.75 in auger is 3.0 in diameter boring = 2.25
Head Conversion Factor (HCF) = Water Column Ht inches / 6 inches, or Htcm/15cm
Example is 3.5in boring with 7 in water column in boring, 0.5 in head drop over 45 minutes in a structureded clay loam soil

F Value (Radcliffe and West, 2000)

	Borehole diameter		
Texture	3.5 in	4.0 in	3.0 in
Sands	0.107	0.124	0.09
Structured loams and clays	0.082	0.096	0.068
Unstructured loams and clay	0.048	0.057	0.041

Time T0	Time x	Time	Hours	Reservoir	Reservoir	Reservoir	Percolation	BCF	HCF	Percolation	F value	Ksat	Design Loading
2400 hours	2400 hours	Elapsed	Elapsed	Reading, in	Reading in	Change	Rate (min/in)			Rate	from table	= F(1/P)	Rate gdsf
ti	t+1	(ti+1)-ti	dt/60min/hr	hi	h+1	(h+1)-hi	dt/dh			Adjusted			with a 0.10
		dt				dh				(P*HCF)/BCF			Safety Factor
	initial	next		initial	next		P			Adj P			of Ksat
		min	hr	in	in	in	min/in			min/in		in/hr	gdsf
Example 08:00	*8:45*	*45*	*0.75*	*14.5*	*14*	*0.5*	*90*	*1.65*	*1.17*	*64*	0.082	0.08	0.12
		1	*0.016667*	*12.5*	*10.9*	*1.6*	*0.625*	*1.65*	*0.5*	*0*	0.082	25.98	77.72
		1	*0.016667*	*10.9*	*9.5*	*1.4*	*0.714285714*	*1.65*	*0.5*	*0*	0.082	22.73	68.01
		1	*0.016667*	*9.5*	*8.3*	*1.2*	*0.833333333*	*1.65*	*0.5*	*0*	0.082	19.48	58.29
		1	*0.016667*	*8.3*	*6.9*	*1.4*	*0.714285714*	*1.65*	*0.5*	*0*	0.082	22.73	68.01
		1	*0.016667*	*6.9*	*5.1*	*1.8*	*0.555555556*	*1.65*	*0.5*	*0*	0.082	29.22	87.44
		1	*0.016667*	*5.1*	*4*	*1.1*	*0.909090909*	*1.65*	*0.5*	*0*	0.082	17.86	53.44
		1	*0.016667*	*4*	*2.7*	*1.3*	*0.769230769*	*1.65*	*0.5*	*0*	0.082	21.11	63.15
			0					*1.65*	*0.5*	*0*	0.082		0.00
			0					*1.65*	*0.5*		0.082		0.00

STEADY STATE ARITHMETIC AVERAGE of last 3 readings

22.7 in/hr

Pedon Description

Depth	Horizon	Color	Texture	Structure	Horizon Notes
			Loamy fine sand		spodic horizon partially cemented

Site Notes:

Percolation or Ksat Rates using Aardvark Soil Permeameter

Perc Rate: min/in | **Ksat:** in/hr | **LR:** gdsf

Site: Ft Fisher

Date: 6/22/2019 **Operator:** fds

Soil Series: **Soil Horizon:** C

Boring Number: 14

Boring Depth (in) : 40

Diameter of Hole(in): 3.5 **Water Column Height (in):** 3 **Head Conversion Factor (HCF):** 0.5

Boring Conversion Factor (BCF): 1.65

Design Loading Rate = Ksat*14.96*safety factor of 0.05 to 0.5 system dependent

Boring Conversion Factor (BCF) = (rad)squared/5.06 for Aardvark Reservoir

BCF of 4 in auger is 4.25 in diameter boring = 1

BCF of 3.25 in auger is 3.5 in diameter boring = 1.65

BCF of 2.75 in auger is 3.0 in diameter boring = 2.25

Head Conversion Factor (HCF) = Water Column Ht inches / 6 inches, or Htcm/15cm

Example is 3.5in boring with 7 in water column in boring, 0.5 in head drop over 45 minutes in a structureded clay loam soil

F Value (Radcliffe and West, 2000)

	Borehole diameter		
Texture	3.5 in	4.0 in	3.0 in
Sands	0.107	0.124	0.09
Structured loams and clays	0.082	0.096	0.068
Unstructured loams and clay	0.048	0.057	0.041

Time T0	Time x	Time	Hours	Reservoir	Reservoir	Reservoir	Percolation	BCF	HCF	Percolation	F value	Ksat	Design Loading
2400 hours	2400 hours	Elapsed	Elapsed	Reading, in	Reading in	Change	Rate (min/in)			Rate	from table	= F(1/P)	Rate gdsf
ti	t+1	(ti+1)-ti	dt/60min/hr	hi	h+1	(h+1)-hi	dt/dh			Adjusted			with a 0.10
		dt				dh				(P*HCF)/BCF			Safety Factor
	initial	next		initial	next		P			Adj P			of Ksat
		min	hr	in	in	in	min/in			min/in		in/hr	gdsf
Example 08:00	*8:45*	*45*	*0.75*	*14.5*	*14*	*0.5*	*90*	*1.65*	*1.17*	*64*	0.082	0.08	0.12
		1	*0.016667*	*13.7*	*12.4*	*1.3*	*0.769230769*	*1.65*	*0.5*	*0*	0.082	21.11	63.15
		1	*0.016667*	*12.4*	*10.8*	*1.6*	*0.625*	*1.65*	*0.5*	*0*	0.082	25.98	77.72
		1	*0.016667*	*10.8*	*9.2*	*1.6*	*0.625*	*1.65*	*0.5*	*0*	0.082	25.98	77.72
		1	*0.016667*	*9.2*	*7.8*	*1.4*	*0.714285714*	*1.65*	*0.5*	*0*	0.082	22.73	68.01
		1	*0.016667*	*7.8*	*6.4*	*1.4*	*0.714285714*	*1.65*	*0.5*	*0*	0.082	22.73	68.01
		1	*0.016667*	*6.4*	*5.1*	*1.3*	*0.769230769*	*1.65*	*0.5*	*0*	0.082	21.11	63.15
		1	*0.016667*	*5.1*	*4*	*1.1*	*0.909090909*	*1.65*	*0.5*	*0*	0.082	17.86	53.44
								1.65	*0.5*	*0*	0.082		0.00
								1.65	*0.5*		0.082		0.00

STEADY STATE ARITHMETIC AVERAGE of last 3 readings

22.4in/hr

Pedon Description

Depth	Horizon	Color	Texture	Structure	Horizon Notes
			sand		fill or disturbed soil

Site Notes:

1 inch = 80 feet

0 20 40 80 Feet

Project No.	70195145
Drawn By:	MW
Checked By:	AN
Date:	6/8/2019

Terracon

▲ KEAT & SHWT

2401 Brentwood Road, Suite 107 Raleigh, NC 27604

Phone: (919) 873-2211 Fax: (919) 873-9555

Exploration Plan - Aerial

Visitor Center & Underwater Archeological Building
Fort Fisher State Historic Site
1610 Fort Fisher Boulevard S
Kure Beach, North Carolina

Exhibit

A-3

Wetland Delineation Report

Proposed Visitor's Center
Site Name: Fort Fisher Visitor's Center
1610 Fort Fisher Boulevard South
Kure Beach, Hanover County, North Carolina

September 9, 2019
Terracon Project No. 70197357

Prepared for:
North Carolina Department of Natural and Cultural Resources (NCDNCR)
Raleigh, NC

Prepared by:
Terracon Consultants, Inc.
Raleigh, NC

Terracon

September 9, 2019

North Carolina Department of Natural and Cultural Resources (NCDNCR)
109 East Jones Street
Raleigh, NC 27601

Attn: Mr. Tony Romaine, PE

Re: Wetland Delineation Report
Fort Fisher Visitor's Center
Site Name: Fort Fisher
1610 Fort Fisher Blvd South
Kure Beach, New Hanover County, North Carolina
Terracon Project No. 70197357

Dear Mr. Romaine,

Terracon is pleased to submit the wetland delineation report for the above referenced site. Based on the results of the assessment, Terracon did not observe evidence of Waters of the U.S. (WOTUS) within the site boundary. This report summarizes our findings and recommendations for the site.

Terracon appreciates the opportunity to have worked for you on this project. If you have any questions regarding the content of this report, please contact me at (984) 202-4065 or via email at cory.darnell@terracon.com.

Sincerely,
Terracon Consultants, Inc.

Cory Darnell, PWS
Department Manager, Natural Resources

for Andy Ruocco, PWS
Environmental Department Manager, APR

for Emma Craig
Environmental Intern

TABLE OF CONTENTS

1.0 INTRODUCTION

Terracon Consultants, Inc. (Terracon) was retained by NCDNCR to perform a wetland delineation to determine if WOTUS, under the jurisdiction of the United States Army Corps of Engineers (USACE) are present within the approximate 12-acre site. The project site is located along Fort Fisher Boulevard South in Kure Beach, New Hanover County, North Carolina. According to the New Hanover County Geographic Information Systems (GIS) website and client provided details, the site is located within a parcel identified as New Hanover County Parcel Identification Number (PIN) R09320-002-013-000 (32.56 acres). The site consists of undeveloped, wooded and cleared land as well as a visitor center. The project site location is depicted on Exhibit 1 in Appendix A.

The purpose of performing this wetland delineation was to characterize the existing site conditions, observe the project site for suspected waterbodies including but not limited to wetlands, streams, and ponds that could be considered jurisdictional by the USACE and the North Carolina Department of Natural Resources Department of Water Resources (NCDWR).

It is important to note that the findings presented in this report represent Terracon's professional opinion, based upon field observations made during the site visit and our experience with current regulatory guidance under the Clean Water Act. In order to verify the delineation boundaries and jurisdictional classifications presented in this report, the USACE and NCDWR must review this report and make a jurisdictional determination.

2.0 SCOPE OF SERVICES

Terracon performed the following scope of work:

- Reviewed the United States Geologic Survey (USGS) Topographical Maps, the United States Department of Agriculture (USDA) Natural Resources Conservation Services (NRCS) Soil Survey for New Hanover County, United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) Maps, Federal Emergency Management Agency (FEMA) Flood Insurance Risk Maps (FIRM), and aerial photographs to assist with identifying suspected jurisdictional WOTUS within the site boundary.
- Mobilized to the project site to conduct a wetland/stream delineation.
- Prepared a map showing approximate locations of WOTUS.
- Completed a wetland delineation report that included site characterization information, a discussion of applicable data, and recommendations for the project site.

3.0 PRELIMINARY DATA GATHERING AND ANALYSIS

Prior to performing the delineation, several maps and aerial photograph resources were reviewed to assist in identifying potential wetland areas at the project site. Each source of data is described in detail below.

3.1 USGS Topographic Map

The USGS 7.5-minute Kure Beach, North Carolina Topographic Map of the project site was accessed through the USGS Web Map Service and reviewed to identify potential drainages, wetlands, streams, and ponds within the site boundary. The USGS map does not depict surface waters on site. Elevation ranges from approximately 0 to 10 feet throughout the site. Surface waters in the vicinity of the site appear to drain to the southwest towards Cape Fear Sound. Additionally, the Atlantic Ocean is depicted to the east of the site. The USGS Topographic Map is included in Appendix A, Exhibit 2.

3.2 USDA-NRCS Soil Survey Map

Data from the 1992 soil survey of New Hanover County, North Carolina was reviewed to identify soil types, including hydric soils. Hydric soils information was gathered from the 'National Hydric Soils List' USDA Natural Resource Conservation Service. A soil survey map is included in Appendix A, Exhibit 3.

The following soil types were identified within the project site on the soil survey map:

- Urban land (Ur) is formed from a non-agricultural, manmade surface layer more than 50 cm thick, that has been produced by mixing or filling of land surface in urban and suburban areas.
- Wakulla sand (Wa) formed from sandy and loamy marine deposits and/or eolian sands and is somewhat excessively drained with slopes ranging from 1 to 8 percent.

According to the National Hydric Soils List for New Hanover County, NC Urban land and Wakulla sand soils are not identified as hydric. Reference section 5.2 for a more detailed description of soils found on site.

3.3 National Wetlands Inventory Map

The NWI Map of the project site was reviewed to identify potential wetland areas. The map was published by the U.S. Department of the Interior's USFWS and depicts probable wetland areas based on stereoscopic analysis of high altitude aerial photographs and analysis of infrared bands from remotely-sensed imagery. According to the NWI map for the site, surface waters including wetlands are not depicted on site. The NWI map for the project site is included in Appendix A, Exhibit 4.

3.4 FEMA-FIRM Floodplain Map

The Federal Emergency Management Act (FEMA) Flood Insurance Risk Map (FIRM) of the site boundary was reviewed to identify potential floodplain hazards on site. Based on data obtained from panel 3720302800K (dated 8/28/2018), the central and northern portions of the site are located in Zone AO, which are areas subject to inundation, and a northern portion and southwestern portion are located in Zone X, which are areas of minimal flood hazard. Additionally, most of the site is in an Otherwise Protected Area (OPA), which is a category of coastal barriers within the Coastal barrier Resources System (CBRS). OPAs are undeveloped coastal areas established under Federal, State, or local law, or held by a qualified organization, primarily for wildlife refuge, sanctuary, recreational, for natural resource conservation purposes. Flood insurance is restricted in OPAs, though OPAs may receive other forms of Federal assistance. The floodplain map is included in Appendix A, Exhibit 5.

4.0 FIELD TECHNIQUES

Terracon personnel conducted a reconnaissance of the site on June 6, 2019 to characterize the existing site conditions and evaluate the site for the presence of wetlands and potential jurisdictional WOTUS. Characteristics of jurisdictional waters and wetland areas were assessed utilizing the criteria detailed in sections 4.1 and 4.2 of this report. The evaluation methods generally followed the routine on-site determination method referenced in the 1987 USACE Manual and the Atlantic and Gulf Coastal Plain Regional Supplement, Version 2.0.

4.1 Wetland Observations

Wetlands have three essential characteristics: hydrophytic vegetation, hydric soils, and wetland hydrology. Based on NWI data, aerial imagery, and topographical data, on-site areas were investigated for potential WOTUS. Additional areas were investigated, based on field observations made during the site reconnaissance. Data regarding the three essential characteristics were gathered within suspected wetland, stream, and pond areas to further delineate wetland boundaries.

4.2 Plant Community Assessment

Suspect areas were visually observed to determine the species, when possible, and absolute percentage of ground cover for four stratum of plant community types. The four stratum, trees, shrubs/saplings, herbs, and vines were all observed within a thirty-foot radius of the observation location.

For each species of vegetation observed, their wetland indicator status was evaluated. Indicator status was determined using the NRCS Plants Database. Indicator categories for vegetation are presented below:

- Obligate Wetland (OBL) - occur almost always (estimated probability greater than 99%) under natural conditions in wetlands.
- Facultative Wetland (FACW) - usually occur in wetlands (estimated probability 67% - 99%) but occasionally found in non-wetlands.
- Facultative (FAC) - equally likely to occur in wetlands or non-wetlands (estimated probability 34% - 66%).
- Facultative Upland (FACU) - usually occur in non-wetlands (estimated probability 67% - 99%) but occasionally found in wetlands.
- Upland (UPL) – rarely occur in wetlands but occur almost always (estimated probability greater than 99%) under natural conditions in non-wetlands.

The percent cover of each stratum was determined and dominance was evaluated. Dominant species were the most abundant species that accounted for more than 20 percent of the absolute percent coverage of the stratum. The number of dominant species with an indicator status of OBL, FACW, and/or FAC was compared to the total number of dominant species across strata. Typically, when more than 50 percent of the dominant species had an indicator status of OBL, FACW, and/or FAC, hydrophytic vegetation was present.

If the percentage of dominant species with an indicator status of OBL, FACW, and/or FAC was less than 50 percent, prevalence index and morphological adaptations may have been evaluated to confirm if hydrophytic vegetation was present or absent.

4.3 Hydric Soils Assessment

After Terracon evaluated wetland vegetation, subsurface soil samples were collected using a soil probe or similar method. The samples were collected to a depth of approximately 20 inches below ground surface and were visually compared to Munsell Soil Color Charts (Munsell, 2009), which aided in the evaluation of hydric soil characteristics. The soil samples were further examined for hydric soil indicators including, but not limited to, histosol, thick dark surface, sandy gleyed matrix, sandy redox, loamy gleyed matrix, redox dark surface, and/or redox depressions. If these or other hydric soil indicators were observed in the subsurface soil sample, the observation location was considered to have hydric soil.

4.4 Wetland Hydrology Assessment

Visual indicators of wetland hydrology were evaluated. Examples of primary wetland hydrology indicators include, but are not limited to, surface water, high water table, soil saturation, water marks, sediment deposits, drift deposits, iron deposits, inundation visible on aerial imagery, sparsely vegetated concave surface, and water-stained leaves. If at least one primary or two secondary indicators were observed, the observation location was considered to have wetland hydrology.

4.5 Classification of Wetlands

Upon completion of the review of the three wetland criteria at each area, a wetland determination was made. Under normal circumstances, if one or more of the wetland criteria were not identified, the area was not considered to be a wetland. If the three wetland indicators were identified, the area was classified as a wetland. Additional observations were made throughout the wetland area to define the wetland/non-wetland boundaries. Vegetation, soil, and hydrology assessment data from at least one location within the wetland and one upland location outside of the wetland were recorded on a USACE Wetland Determination Data Form (Data Form Sheet).

4.6 Other Waters Observations

Terracon also made observations of site features that may be considered a jurisdictional waterbody. If a potential jurisdictional waterbody was identified, observations regarding its characteristics were recorded. Potential jurisdictional waterbodies were evaluated based on the observation of the following characteristics:

- Flow Characteristics:
  - Perennial: contains water year-round except during extreme drought.
  - Intermittent: carries water a considerable portion of the time but ceases to flow occasionally or seasonally.
  - Ephemeral: carries water only during and immediately after periods of rainfall or snowmelt.
- Ordinary High Water Mark:
  - The limit line on the shore established by the fluctuation of the water surface. It is shown by such things as a clear line impressed on the bank, shelving, changes in soil character, destruction of terrestrial vegetation, the presence of litter and debris or other features influenced by the surrounding area.
- Bank Shape Descriptions:
  - Undercut: banks that overhang the stream channel
  - Steep: bank slope of approximately greater than 30 degrees
  - Gradual: bank slope of approximately 30 degrees or less
- Aquatic Habitat Descriptions:
  - Pool: deeper portion of a stream where water flows slower than in neighboring, shallower portions, smooth surface, and finer substrate.
  - Riffle: shallow area in a stream where water flows swiftly over gravel and rock or other coarse substrate resulting in a rough flow and a turbulent surface.
  - Run: section of a stream with a low or high velocity and with little or no turbulence on the surface of the water.

5.0 FIELD OBSERVATION RESULTS

Field observations were collected on June 6, 2019 by Mr. Cory Darnell and Ms. Emma Craig with Terracon. The project site consists of undeveloped, wooded and cleared land, and a visitor's center. Data Forms included in Appendix B and Photographs included in Appendix C, provide an indication of the physical characteristics observed during the site visit. Descriptions of the observed areas are listed in the following sections.

5.1 Vegetation, Hydrology, and Soils Found at Project Site

Terracon evaluated multiple plant and soil types on site. To further help delineate wetlands from uplands, the below strata, hydrology, and soils were observed in the upland areas. The attached Data Forms (DP-1 through DP-4) describes in further detail the vegetation, hydrology, and soils encountered on site.

5.2 Uplands

The dominant tree species observed in the upland areas throughout the site were live oak (*Quercus virginiana*), water oak (*Quercus nigra*), red maple (*Acer rubrum*), laurel oak (*Quercus hemisphaerica),* wax myrtle (*Myrica cerifera*), yaupon holly (*Ilex vomitoria*), and Chinese privet (*Ligustrum sinese*). Herbaceous species observed included common greenbrier (*Smilax rotundifolia*), Japanese honeysuckle (*Lonicera japonica*), poison ivy (*Toxicodendron radicans),* muscadine (*Vitis rotundifolia*), wiregrass (*Aristida stricta*), trumpet vine (*Campsis radicans*), and tall fescue (*Festuca arundinacea*).

Terracon did not identify primary or secondary hydrology indicators on site. Examples of primary indicators that were not identified included but are not limited to surface water, high water table, or saturation. Additionally, secondary indicators including but not limited to drainage patterns and moss trim lines were not identified.

Soils encountered on site consisted of a sandy mixture. The soils appeared bright and well drained. Terracon did not observe evidence of hydric soil indicators on site.

5.3 Waters of the U.S. Description, Watershed Classification, and Buffers

Terracon did not identify WOTUS on site. Wetlands exhibiting hydrology, hydrophytic vegetation, and hydric soils were not identified on site. Data Forms (DP-1 through DP-4) are attached in Appendix B. Exhibit 6 in Appendix A depicts field observations. The data obtained during the site reconnaissance should be used for preliminary planning purposes.

The site is located in the Cape Fear River Basin. Surface waters within the Cape Fear River Basin are not subject to mandatory state riparian buffer requirements. The nearest downstream waterbodies are the Cape Fear River and the Atlantic Ocean. According the NC Surface Water

Classification Online GIS website, surface waters that drain to Cape Fear River are classified as SC waters, and surface waters that drain to the Atlantic Ocean are classified as SB waters. SC waters are tidal salt waters protected for secondary recreation such as fishing, boating, and other activities involving minimal skin contact; fish and noncommercial shellfish consumption; aquatic life propagation and survival; and wildlife. SB waters are tidal salt waters protected for all SC uses in addition to primary recreation. Primary recreational activities include swimming, skin diving, water skiing, and similar uses involving human body contact with water where such activities take place in an organized manner or on a frequent basis. Terracon recommends consultation with a civil engineer to determine if stormwater setbacks are required for the site.

Additionally, Terracon contacted the New Hanover County Planning Department to confirm local buffer requirements. Terracon spoke with Ms. Linda Painter, Zoning Compliance Official, on June 21, 2019. According to Ms. Painter, stream buffers are not locally governed and are regulated through coastal management.

Lastly, New Hanover County is located in a designated Coastal Area Management Act (CAMA) County. The NC Division of Coastal Management enforces CAMA, the Dredge and Fill Law, and the rules and policies of the NC Coastal Resource Commission. Terracon recommends consultation with the CAMA prior to site development activities. Based on our understanding of the proposed project, the site is located near an Area of Environmental Concern (AEC).

6.0 REGULATORY VERIFICATION

Terracon has submitted the regulatory jurisdictional determination package to the USACE for a WOTUS review. On August 29, 2019, Ms. Rachel Capito, USACE regulator, confirmed Terracon's findings. Based on Ms. Capito's email response, no WOTUS are present within the site boundary (Reference email dated August 29, 2019 in Appendix D). Additionally, an approved jurisdictional determination (AJD) letter is forthcoming from the USACE. Terracon will forward this correspondence once received from the USACE.

7.0 SUMMARY AND CONCLUSIONS

A wetland delineation was conducted at the approximate 12-acre Fort Fisher site located in Kure Beach, North Carolina on June 6, 2019. A review of the project site was conducted utilizing readily available information including, but not limited to, topographical, aerial, soils, floodplain, and wetland data. In addition, a preliminary site visit was performed to characterize the existing site conditions and observe the project site for suspected waterbodies and wetlands. According to our preliminary site investigation, no WOTUS including ponds, streams, and wetlands were observed on site. A summary of the field observations and conclusions concerning jurisdictional status is depicted on Exhibit 6 in Appendix A.

8.0 RECOMMENDATIONS

Terracon recommends our findings be verified by the CAMA prior to site development activities. Impacts to jurisdictional surface waters are regulated by the USACE, NCDWR, and CAMA and may require a section 10/404/401 permit from the USACE, NCDWR, and CAMA. Based on Terracon's understanding of future development planned for the site, a CAMA major permit may be applicable. Terracon understands that CAMA permitting for the proposed project will be conducted by others.

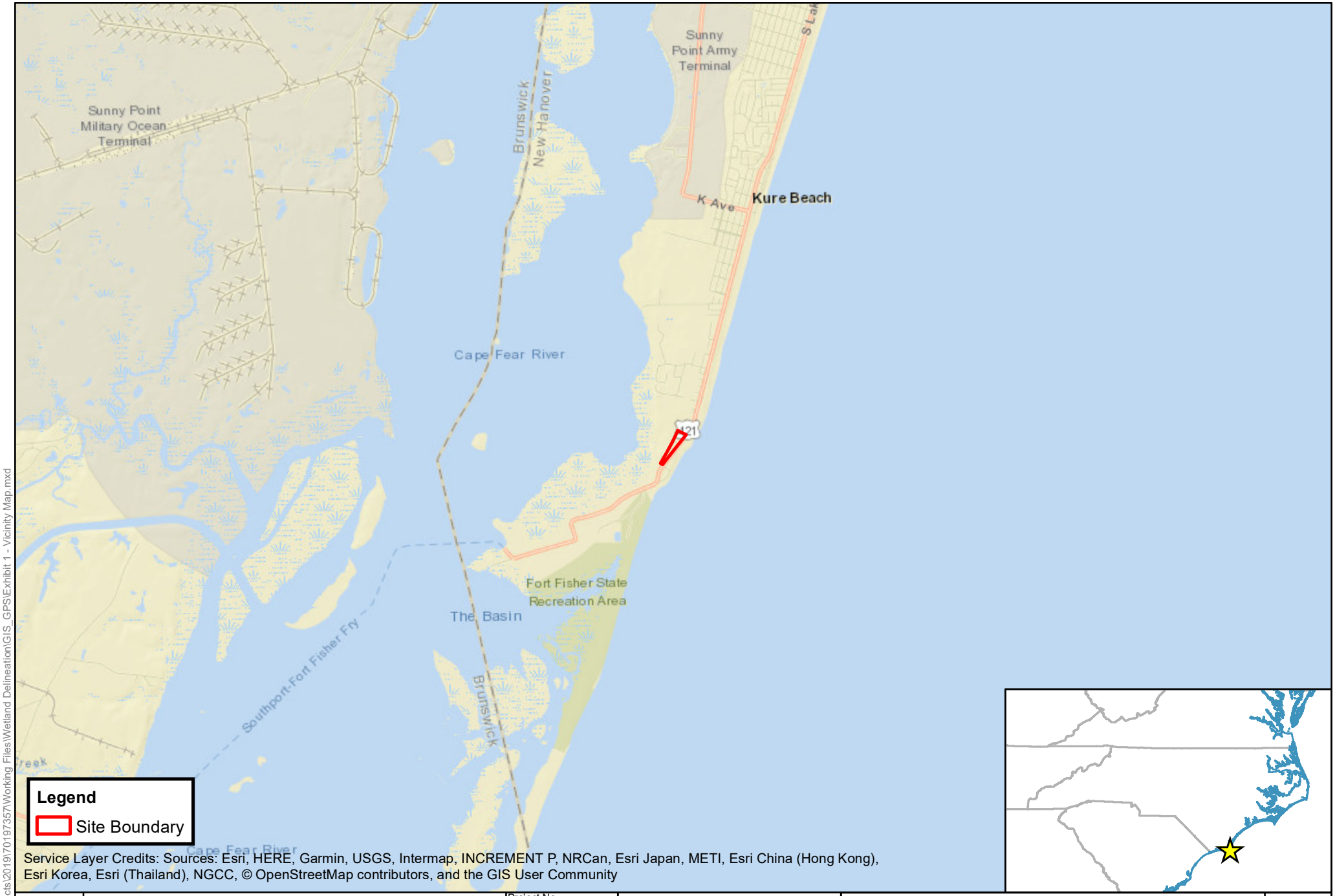
9.0 GENERAL COMMENTS

The wetland delineation was performed in accordance with generally accepted practices of this profession undertaken in similar studies at the same time and in the same geographical area. A wetland delineation, such as the one performed at this site, is of limited scope, is noninvasive, and cannot eliminate the potential that wetlands or waterbodies are present at the site beyond what is identified by the limited scope of this preliminary assessment. In conducting the limited scope of services described herein, certain sources of information and public records were not reviewed. No biological assessment can wholly eliminate uncertainty regarding the potential for concerns in connection with a project. The limitations of this preliminary assessment should be recognized.

This report has been prepared in accordance with generally accepted scientific and engineering evaluation practices. This report is for the exclusive use of the client for the project being discussed. No warranties, either expressed or implied, are intended or made.

APPENDIX A

EXHIBITS



Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

N

0 2,500 5,000 10,000 Feet

Source: ESRI World Street Map

Project No.	70197357
Drawn By:	MRW
Checked By:	CBD
Date:	June 2019

Terracon
2401 Brentwood Road, Suite 107 Raleigh, NC 27604
Phone: 919-873-2211 Fax: 919-873-9555

Vicinity Map

Fort Fisher Visitor Center
1610 Fort Fisher Boulevard
Kure Beach, New Hanover County, North Carolina

EXHIBIT NO. 1

Document Path: N:\Projects\2019\70197357\Working Files\Wetland Delineation\GIS_GPS\Exhibit 1 - Vicinity Map.mxd

N

0 1,000 2,000 4,000 Feet

Source: USGS QUADRANGLE - KURE BEACH, NC (1997)

Project No.	70197357
Drawn By:	MRW
Checked By:	CBD
Date:	June 2019

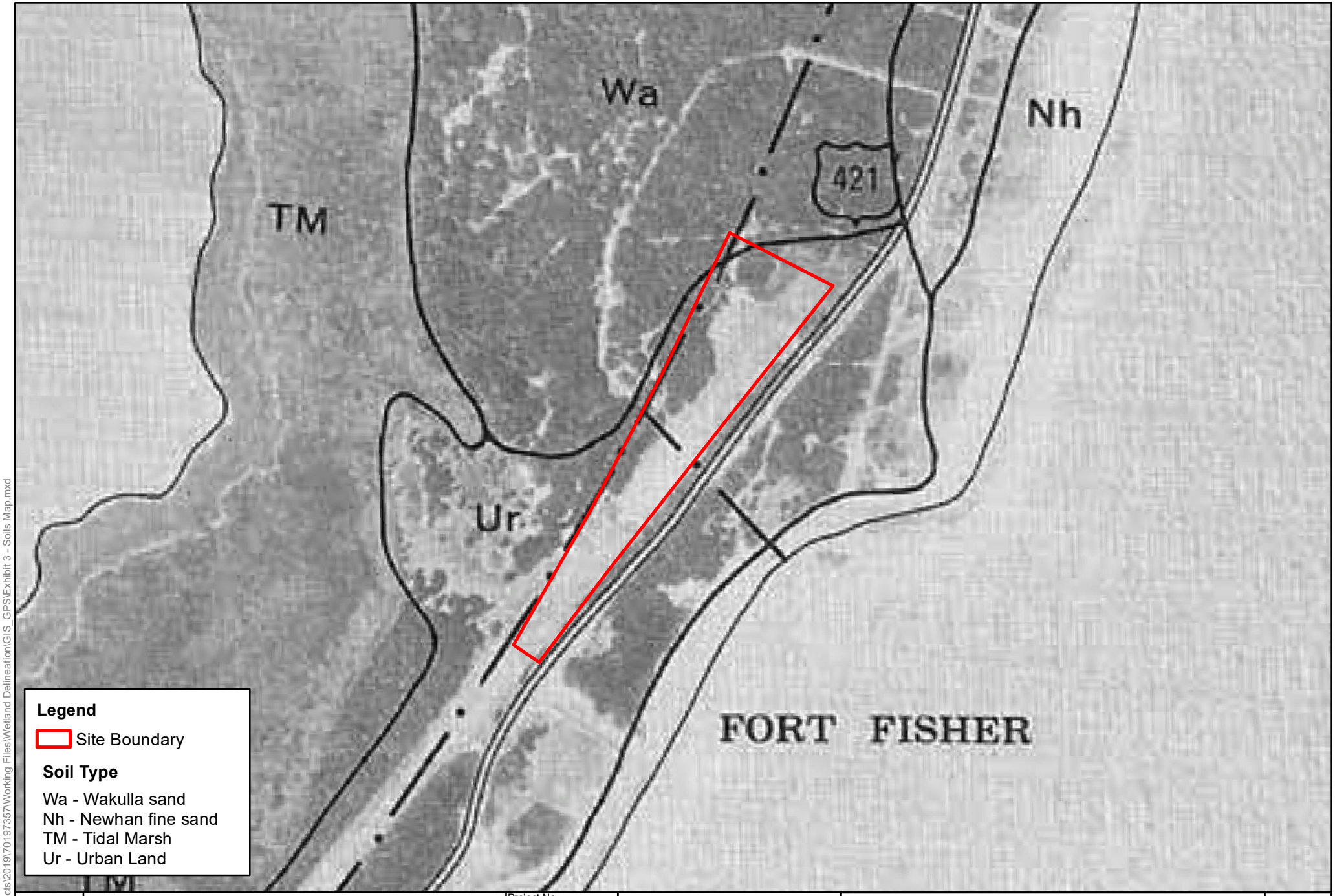
Terracon
2401 Brentwood Road, Suite 107 Raleigh, NC 27604
Phone: 919-873-2211 Fax: 919-873-9555

Topographic Map

Fort Fisher Visitor Center
1610 Fort Fisher Boulevard
Kure Beach, New Hanover County, North Carolina

EXHIBIT NO. **2**

Document Path: N:\Projects\2019\70197357\Working Files\Wetland Delineation\GIS_GPS\Exhibit 2 - Topographic Map.mxd



N

0 200 400 800 Feet

Source: NRCS USDA Soil Survey
New Hanover County - 1977 Sheet 31

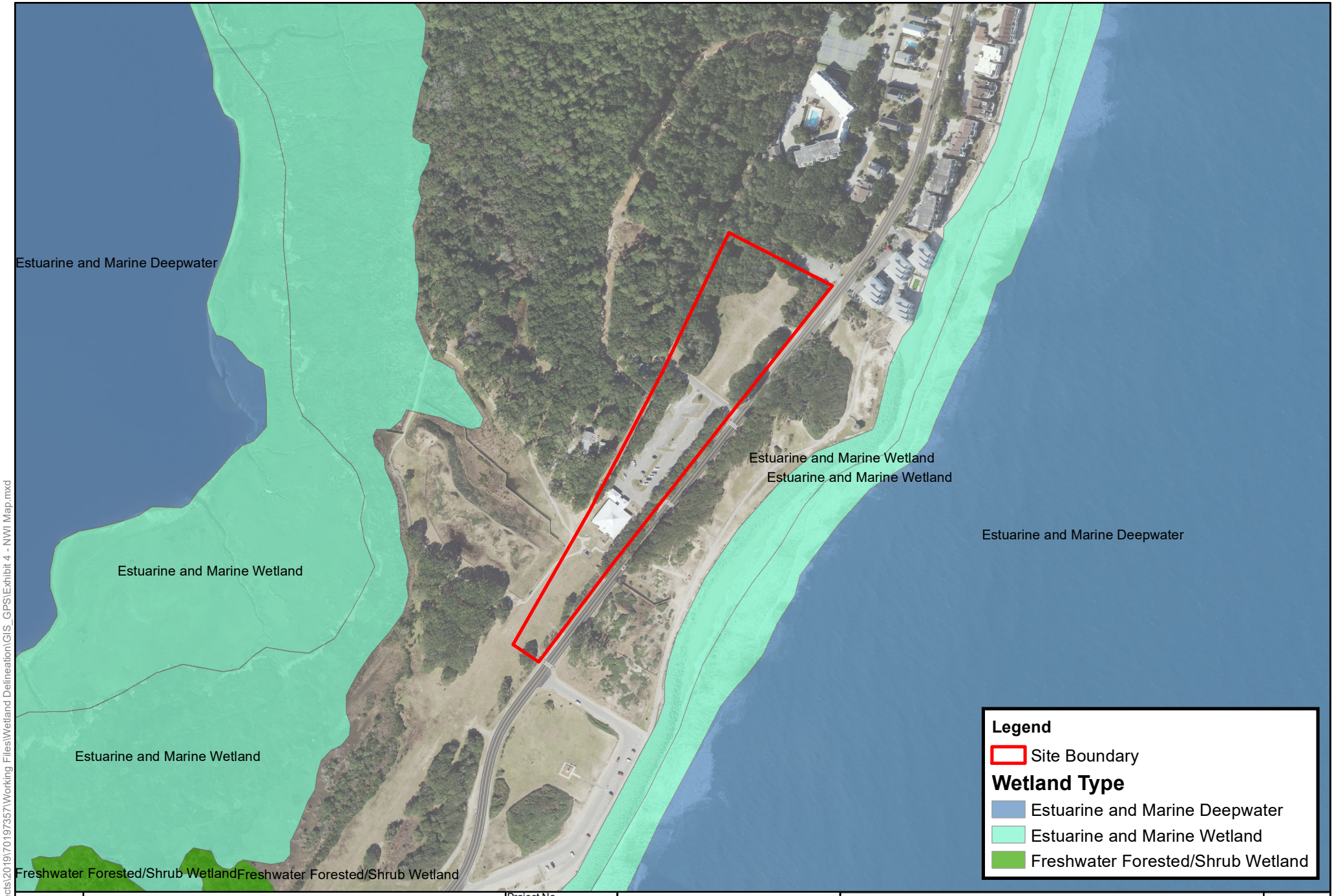
Project No.	70197357
Drawn By:	MRW
Checked By:	CBD
Date:	June 2019

Terracon
2401 Brentwood Road, Suite 107 Raleigh, NC 27604
Phone: 919-873-2211 Fax: 919-873-9555

NRCS USDA Soils Map

Fort Fisher Visitor Center
1610 Fort Fisher Boulevard
Kure Beach, New Hanover County, North Carolina

EXHIBIT NO. **3**



N

0 200 400 800 Feet

Source: National Wetland Inventory GIS Server

Project No.	70197357
Drawn By:	MRW
Checked By:	CBD
Date:	September 2019

Terracon

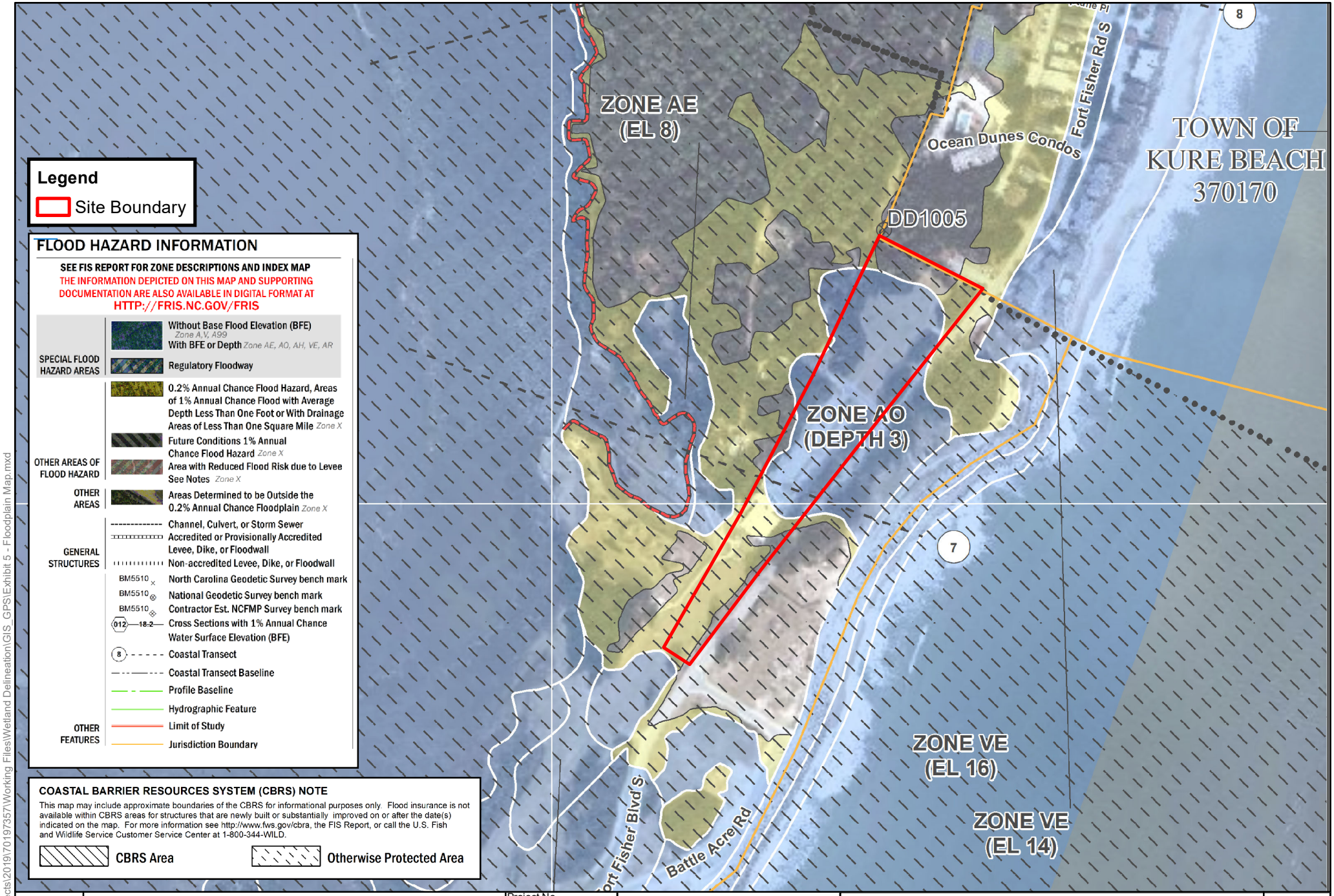
2401 Brentwood Road, Suite 107 Raleigh, NC 27604
Phone: 919-873-2211 Fax: 919-873-9555

National Wetland Inventory Map

Fort Fisher Visitor Center
1610 Fort Fisher Boulevard
Kure Beach, New Hanover County, North Carolina

EXHIBIT NO. **4**

Document Path: N:\Projects\2019\70197357\Working Files\Wetland Delineation\GIS_GPS\Exhibit 4 - NWI Map.mxd



Document Path: N:\Projects\2019\70197357\Working Files\Wetland Delineation\GIS_GPS\Exhibit 5 - Floodplain Map.mxd

N

0 200 400 800 Feet

Source: FEMA Flood Map Service Center
Panel: 3720302800K (eff. 8/28/2018)

Project No.	70197357
Drawn By:	MRW
Checked By:	CBD
Date:	September 2019

Terracon
2401 Brentwood Road, Suite 107 Raleigh, NC 27604
Phone: 919-873-2211 Fax: 919-873-9555

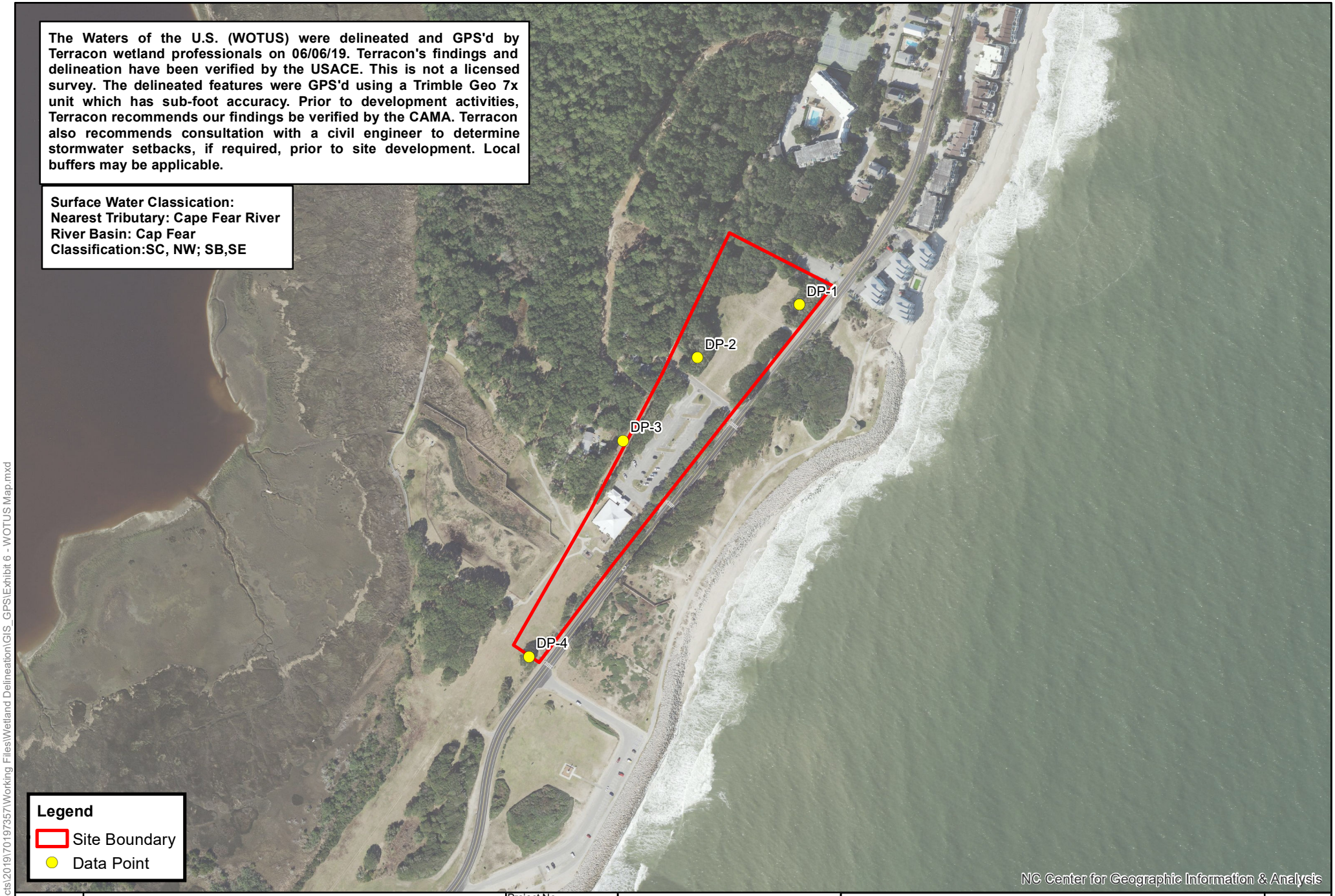
FEMA FIRM Floodplain Map

Fort Fisher Visitor Center
1610 Fort Fisher Boulevard
Kure Beach, New Hanover County, North Carolina

EXHIBIT NO. **5**

The Waters of the U.S. (WOTUS) were delineated and GPS'd by Terracon wetland professionals on 06/06/19. Terracon's findings and delineation have been verified by the USACE. This is not a licensed survey. The delineated features were GPS'd using a Trimble Geo 7x unit which has sub-foot accuracy. Prior to development activities, Terracon recommends our findings be verified by the CAMA. Terracon also recommends consultation with a civil engineer to determine stormwater setbacks, if required, prior to site development. Local buffers may be applicable.

Surface Water Classication:
Nearest Tributary: Cape Fear River
River Basin: Cap Fear
Classification:SC, NW; SB,SE



N

0 200 400 800 Feet

Source: Terracon GPS Data

Project No.	70197357
Drawn By:	MRW
Checked By:	CBD
Date:	September 2019

Terracon

2401 Brentwood Road, Suite 107 Raleigh, NC 27604
Phone: 919-873-2211 Fax: 919-873-9555

WOTUS Delineation Map

Fort Fisher Visitor Center
1610 Fort Fisher Boulevard
Kure Beach, New Hanover County, North Carolina

EXHIBIT NO. **6**

Document Path: N:\Projects\2019\70197357\Working Files\Wetland Delineation\GIS_GPS\Exhibit 6 - WOTUS Map.mxd

APPENDIX B

WETLAND DETERMINATION DATA FORMS

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Fort Fisher City/County: Kure Beach / New Hanover Sampling Date: 6/16/19

Applicant/Owner: NCDNCR State: NC Sampling Point: DP-1

Investigator(s): Darnell, Craig Section, Township, Range: Kure Beach

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): Flat Slope (%): 0

Subregion (LRR or MLRA): T Lat: 33.973477 Long: -77.91571 Datum: NAD83

Soil Map Unit Name: Ur NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No _____	**Is the Sampled Area within a Wetland?** Yes _____ No X
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes _____	No X	Depth (inches): 0
Water Table Present?	Yes _____	No X	Depth (inches): +24"
Saturation Present? (includes capillary fringe)	Yes _____	No X	Depth (inches): +24"

Wetland Hydrology Present? Yes _____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP-1

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Quercus virginiana	30	X	FU
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	30 = Total Cover		
50% of total cover: 15	20% of total cover: 6		
Sapling/Shrub Stratum (Plot size: 30')			
1. Ligustrum sinense	35	X	F
2. Ilex vomitoria	30	X	F
3. Myrica cerifera	20	X	F
4. Pinus taeda	5		F
5.			
6.			
7.			
8.			
	90 = Total Cover		
50% of total cover: 45	20% of total cover: 18		
Herb Stratum (Plot size: 30')			
1. Festuca arundinacea	10	X	U
2. Toxicondendron radicans	5	X	F
3. Lonicera japonica	5	X	FU
4. Smilax rotundifolia	5	X	F
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	25 = Total Cover		
50% of total cover: 13	20% of total cover: 5		
Woody Vine Stratum (Plot size: 30')			
1. Toxicodendron radicans	5	X	F
2. Smilax rotundifolia	5	X	F
3.			
4.			
5.			
	10 = Total Cover		
50% of total cover: 5	20% of total cover: 2		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 7 (A)

Total Number of Dominant Species Across All Strata: 10 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 70 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: (If observed, list morphological adaptations below).

SOIL

Sampling Point: DP-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-2	10yr 5/3	100					Sandy	
2-24	10yr 6/6	100					Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** _____ **No** X

Remarks:

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Fort Fisher City/County: Kure Beach / New Hanover Sampling Date: 6/16/19

Applicant/Owner: NCDNCR State: NC Sampling Point: DP-2

Investigator(s): Darnell, Craig Section, Township, Range: Kure Beach

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): Flat Slope (%): 0

Subregion (LRR or MLRA): T Lat: 33.973019 Long: -77.916796 Datum: NAD83

Soil Map Unit Name: Ur NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No _____	**Is the Sampled Area within a Wetland?** Yes _____ No X
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes _____	No X	Depth (inches): 0
Water Table Present?	Yes _____	No X	Depth (inches): +24"
Saturation Present? (includes capillary fringe)	Yes _____	No X	Depth (inches): +24"

Wetland Hydrology Present? Yes _____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP-2

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Quercus virginiana	30	X	FU
2. Acer rubrum	25	X	F
3. Quercus nigra	25	X	U
4. Quercus laurifolia	10		FW
5. Quercus cerris	5		FU
6. Pinus taeda	5		F
7.			
8.			
	100	= Total Cover	
50% of total cover: 50		20% of total cover: 20	

Sapling/Shrub Stratum (Plot size: 30')			
1. Ligustrum sinense	30	X	F
2. Illex vomitoria	15	X	F
3. Myrica cerifera	10		F
4. Sabal minor	5		FW
5.			
6.			
7.			
8.			
	60	= Total Cover	
50% of total cover: 30		20% of total cover: 12	

Herb Stratum (Plot size: 30')			
1. Smilax rotundifolia	20	X	F
2. Chasmanthium laxum	15	X	FW
3. Toxicondendron radicans	10		F
4. Vitis rotundifolia	5		F
5. Aristida stricta	5		F
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	55	= Total Cover	
50% of total cover: 28		20% of total cover: 11	

Woody Vine Stratum (Plot size: 30')			
1. Smilax rotundifolia	10	X	F
2. Lonicera japonica	5	X	FU
3. Toxicodendron radicans	5	X	F
4. Campsis radicans	5	X	F
5.			
	25	= Total Cover	
50% of total cover: 13		20% of total cover: 5	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 8 (A)

Total Number of Dominant Species Across All Strata: 11 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 72.72 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: (If observed, list morphological adaptations below).

SOIL Sampling Point: DP-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-3	10yr 5/3	100					Sandy	
3-24	10yr 6/6	100					Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** _____ **No** X

Remarks:

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Fort Fisher City/County: Kure Beach / New Hanover Sampling Date: 6/16/19

Applicant/Owner: NCDNCR State: NC Sampling Point: DP-3

Investigator(s): Darnell, Craig Section, Township, Range: Kure Beach

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): Flat Slope (%): 0

Subregion (LRR or MLRA): T Lat: 33.973769 Long: -77.916248 Datum: NAD83

Soil Map Unit Name: Ur NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No _____	**Is the Sampled Area within a Wetland?** Yes _____ No X
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): 0

Water Table Present? Yes _____ No X Depth (inches): +24"

Saturation Present? (includes capillary fringe) Yes _____ No X Depth (inches): +24"

Wetland Hydrology Present? Yes _____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP-3

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Quercus virginiana	20	X	FU
2. Acer rubrum	15	X	F
3. Quercus nigra	10	X	U
4. Pinus taeda	5		F
5.			
6.			
7.			
8.			
	50	= Total Cover	

50% of total cover: 25` 20% of total cover: 10

Sapling/Shrub Stratum (Plot size: 30')			
1. Ligustrum sinense	30	X	F
2. Illex vomitoria	10	X	F
3. Myrica cerifera	5		F
4. Sabal minor	5		FW
5.			
6.			
7.			
8.			
	50	= Total Cover	

50% of total cover: 25 20% of total cover: 10

Herb Stratum (Plot size: 30')			
1. Chasmanthium laxum	15	X	FW
2. Aristida stricta	15	X	F
3. Smilax rotundifolia	5		F
4. Vitis rotundifolia	5		F
5. Toxicondendron radicans	5		F
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	45	= Total Cover	

50% of total cover: 23 20% of total cover: 9

Woody Vine Stratum (Plot size: 30')			
1. Smilax rotundifolia	10	X	F
2. Lonicera japonica	5	X	FU
3. Toxicodendron radicans	5	X	F
4.			
5.			
	20	= Total Cover	

50% of total cover: 10 20% of total cover: 4

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 7 (A)

Total Number of Dominant Species Across All Strata: 10 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 70 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (If observed, list morphological adaptations below).

SOIL

Sampling Point: DP-3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-2	10yr 5/3	100					Sandy	
2-24	10yr 6/6	100					Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** _____ **No** X

Remarks:

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Fort Fisher City/County: Kure Beach / New Hanover Sampling Date: 6/16/19

Applicant/Owner: NCDNCR State: NC Sampling Point: DP-4

Investigator(s): Darnell, Craig Section, Township, Range: Kure Beach

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): Flat Slope (%): 0

Subregion (LRR or MLRA): T Lat: 33.970387 Long: -77.918623 Datum: NAD83

Soil Map Unit Name: Ur NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No _____	**Is the Sampled Area within a Wetland?** Yes _____ No X
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes _____	No X	Depth (inches): 0
Water Table Present?	Yes _____	No X	Depth (inches): +24"
Saturation Present? (includes capillary fringe)	Yes _____	No X	Depth (inches): +24"

Wetland Hydrology Present? Yes _____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP-4

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Quercus virginiana	20	X	FU
2. Pinus taeda	5	X	F
3.			
4.			
5.			
6.			
7.			
8.			
	25 = Total Cover		
50% of total cover: 12.5	20% of total cover: 5		
Sapling/Shrub Stratum (Plot size: 30')			
1. Ligustrum sinense	30	X	F
2. Illex vomitoria	20	X	F
3. Myrica cerifera	15		F
4.			
5.			
6.			
7.			
8.			
	65 = Total Cover		
50% of total cover: 33	20% of total cover: 13		
Herb Stratum (Plot size: 30')			
1. Chasmanthium laxum	40	X	FW
2. Smilax rotundifolia	15	X	F
3. Toxicondendron radicans	5		F
4. Vitis rotundifolia	5		F
5.	5		F
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	70 = Total Cover		
50% of total cover: 35	20% of total cover: 14		
Woody Vine Stratum (Plot size: 30')			
1. Smilax rotundifolia	10	X	F
2. Lonicera japonica	5	X	FU
3. Toxicodendron radicans	5	X	F
4.			
5.			
	20 = Total Cover		
50% of total cover: 10	20% of total cover: 4		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 7 (A)

Total Number of Dominant Species Across All Strata: 9 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 77.78 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: (If observed, list morphological adaptations below).

SOIL

Sampling Point: DP-4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-2	10yr 5/4	100					Sandy	
2-24	10yr 6/6	100					Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains.

[2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
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- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** _____ **No** X

Remarks:

APPENDIX C

PHOTOGRAPHS

Photo #1: View of the central portion of the site, facing northeast.

Photo #2: View of the northeastern portion of the site, facing northeast.

Photo #3: View of upland soil at DP-1, facing northeast.

Photo #4: View of an existing access road along the northwestern portion of the site, facing southwest.

Photo #5: View of the typical vegetation along the northwestern portion of the site, facing southeast.

Photo #6: Upland soil sampled at DP-3 located along the northwestern portion of the site, facing southwest.

Photo #7: View of the southern portion of the site facing west.

Photo #8: View of the southeastern portion of the site facing northeast.

Photo #9: View of the fort facing west.

Photo #8: View of the visitor's center facing southwest.

APPENDIX D

REGULATORY CORRESPONDENCE

Darnell, Cory B

From: Capito, Rachel A CIV USARMY CESAW (US) <Rachel.A.Capito@usace.army.mil>
Sent: Thursday, August 29, 2019 9:45 AM
To: Darnell, Cory B
Subject: RE: Fort Fisher PJD Request

Hey Cory,

I don't think a site visit will be necessary for this one. I'll add it to my pile to process, but this email serves as confirmation that there are no waters on the site, which will require me to do an AJD.

Thanks,
Rachel

-----Original Message-----
From: Darnell, Cory B [mailto:Cory.Darnell@terracon.com]
Sent: Tuesday, August 27, 2019 9:05 AM
To: Capito, Rachel A CIV USARMY CESAW (US) <Rachel.A.Capito@usace.army.mil>
Cc: Craig, Emma C <Emma.Craig@terracon.com>
Subject: [Non-DoD Source] RE: Fort Fisher PJD Request

Rachel-

Can you let us know when you're available to make a determination on this site?

Thanks,

Cory Darnell, PWS
Terracon Consultants, Inc.
D [984] 202-4065 I cory.darnell@terracon.com

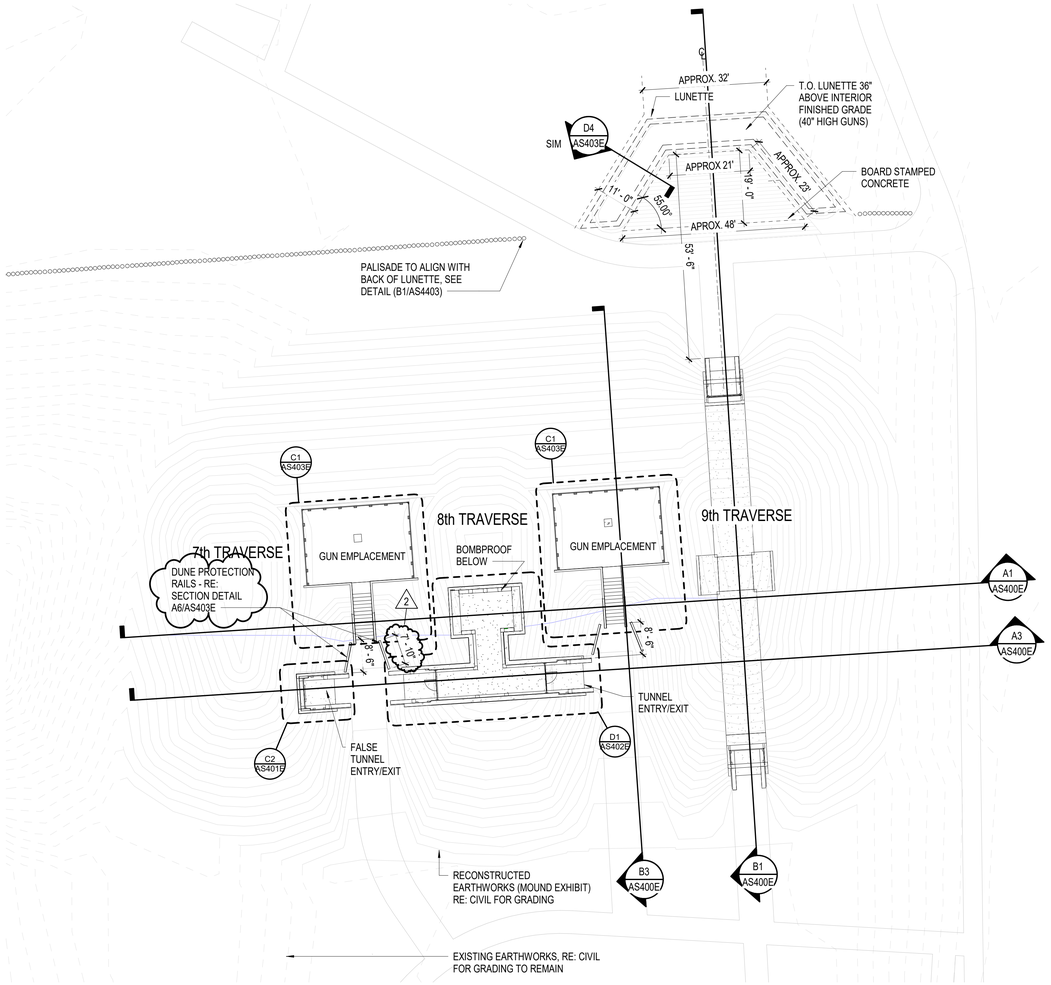
-----Original Message-----
From: Darnell, Cory B
Sent: Wednesday, July 24, 2019 2:22 PM
To: 'Capito, Rachel A CIV USARMY CESAW (US)' <Rachel.A.Capito@usace.army.mil>
Cc: Craig, Emma C <Emma.Craig@terracon.com>
Subject: RE: Fort Fisher PJD Request

Sounds good. We will use this for future submissions. Let us know when you're available to meet on site, if needed.

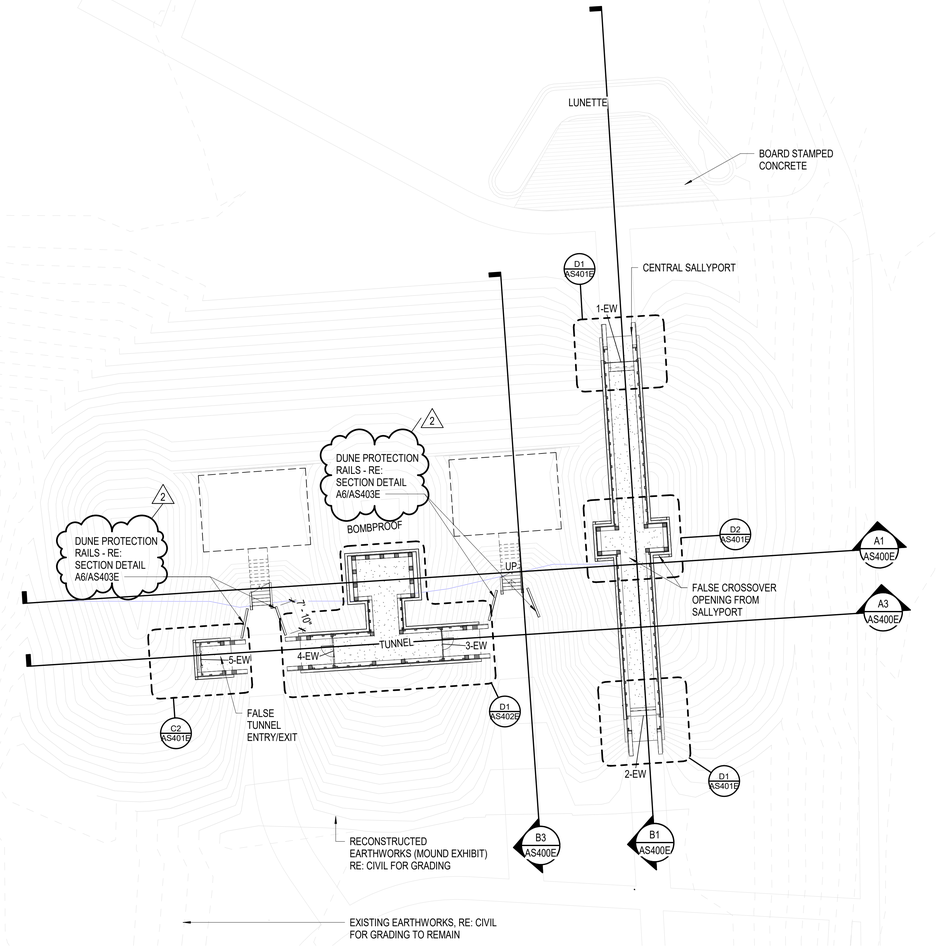
Thanks,

Cory Darnell, PWS
Terracon Consultants, Inc.
D [984] 202-4065 I cory.darnell@terracon.com

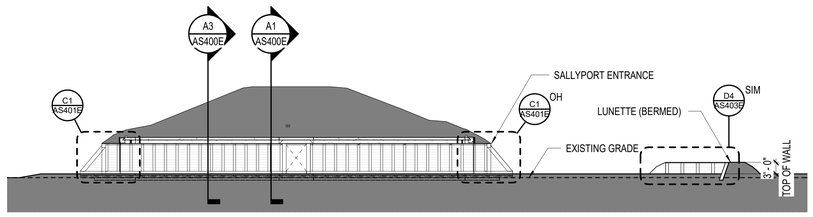
-----Original Message-----
From: Capito, Rachel A CIV USARMY CESAW (US) <Rachel.A.Capito@usace.army.mil>
Sent: Tuesday, July 23, 2019 12:11 PM



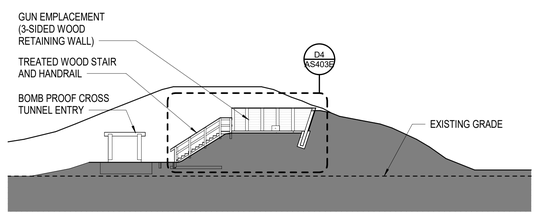
C1 MOUNDS EXHIBIT SITE PLAN
1/16" = 1'-0"



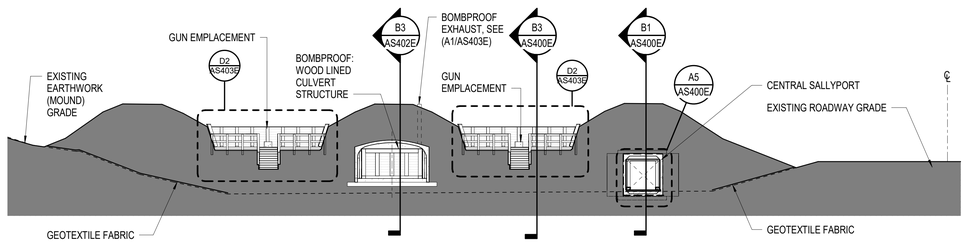
C3 MOUNDS EXHIBIT CUT PLAN
1/16" = 1'-0"



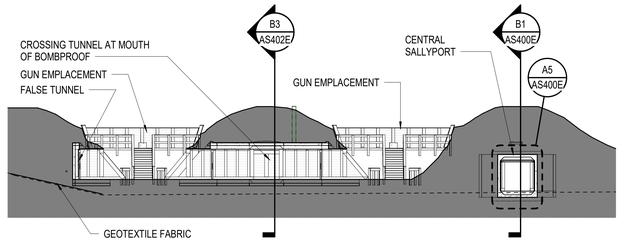
B1 SECTION THROUGH SALLYPORT AND LUNETTE
1/16" = 1'-0"



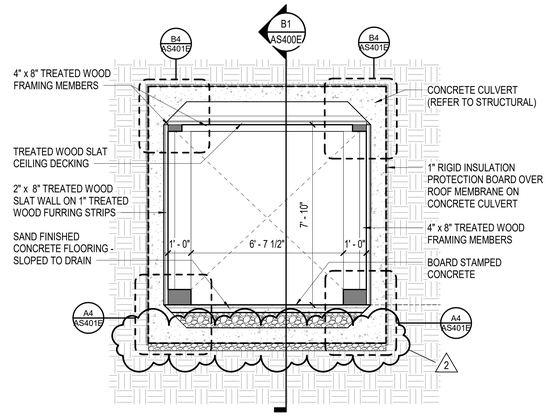
B3 SECTION THROUGH GUN EMPLACEMENT EXHIBIT
1/16" = 1'-0"



A1 SECTION THROUGH EARTHWORKS AT GUN EMPLACEMENTS
1/16" = 1'-0"



A3 SECTION THROUGH EARTHWORKS AT CROSSING TUNNEL
1/16" = 1'-0"



A5 SECTION THROUGH SALLYPORT
3/8" = 1'-0"

GRAPHIC SCALE(S)

3/8" = 1' - 0" 0 1' 2' 3' 4' 5' 10'

1/16" = 1' - 0" 0 5' 10' 20' 30' 60'

DESIGN: RMH
DRAWN: WMP
REVIEW: DLF

CN 7173-B

DEPARTMENT OF NATURAL AND CULTURAL RESOURCES

EARTHWORKS AND FORTIFICATION EXHIBIT AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S
KURE BEACH, NC 28449

SCO#: 16-16311-02B
CODE: 41614
ITEM: 4C01

DESIGNER

CLARKNEXSEN
333 FAYETTEVILLE STREET, SUITE 1000
RALEIGH, NORTH CAROLINA 27601
919·828·1876

CLARK NEXSEN LICENSE NUMBER: C-1028
PROFESSIONAL SEAL

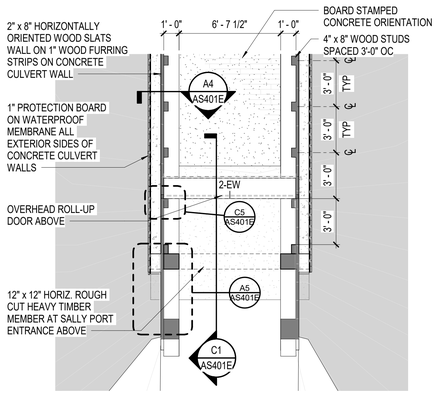
SUBMITTAL
APRIL 29, 2022
BID SET

REVISIONS

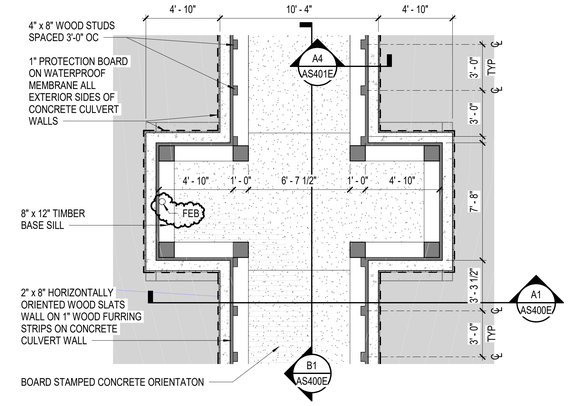
2	06/17/22	ADDENDUM 2

SHEET
FORTIFICATION EARTHWORKS RECONSTRUCTION EXHIBIT PLANS AND SECTIONS

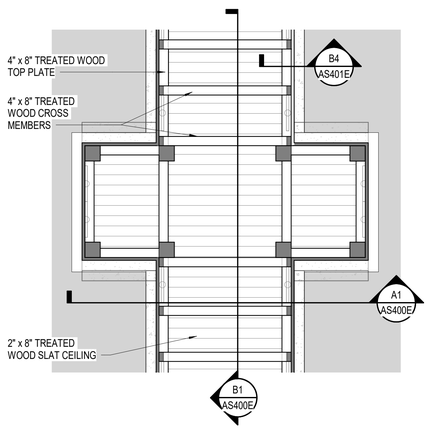
AS400E



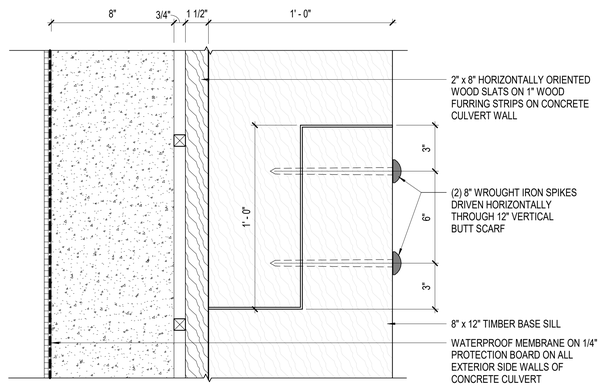
D1 SALLYPORT ENTRANCE PLAN
1/4" = 1'-0"



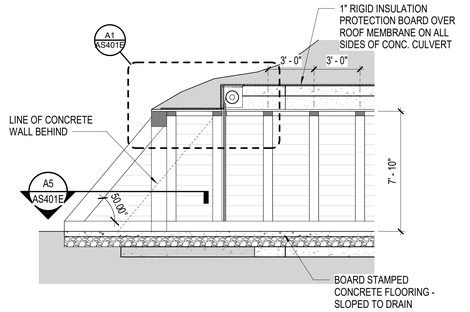
D2 SALLYPORT FALSE CROSSOVER PLAN
1/4" = 1'-0"



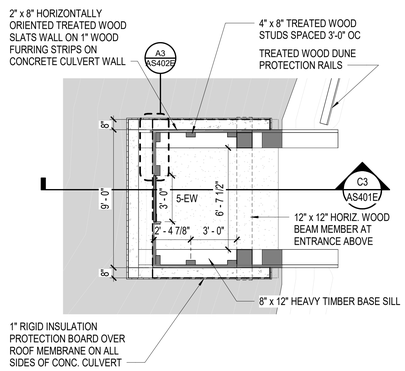
D3 SALLY PORT CROSSOVER CEILING PLAN
1/4" = 1'-0"



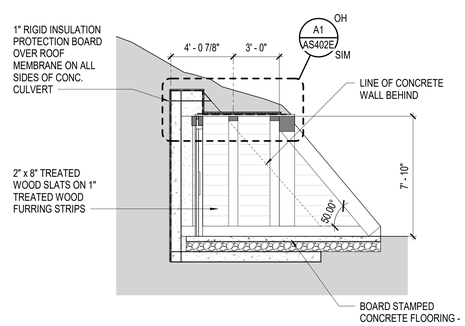
D5 PLAN DETAIL AT VERT. BUTT JOINT IN SALLY PORT
3" = 1'-0"



C1 SECTION AT SALLYPORT ENTRANCE
1/4" = 1'-0"

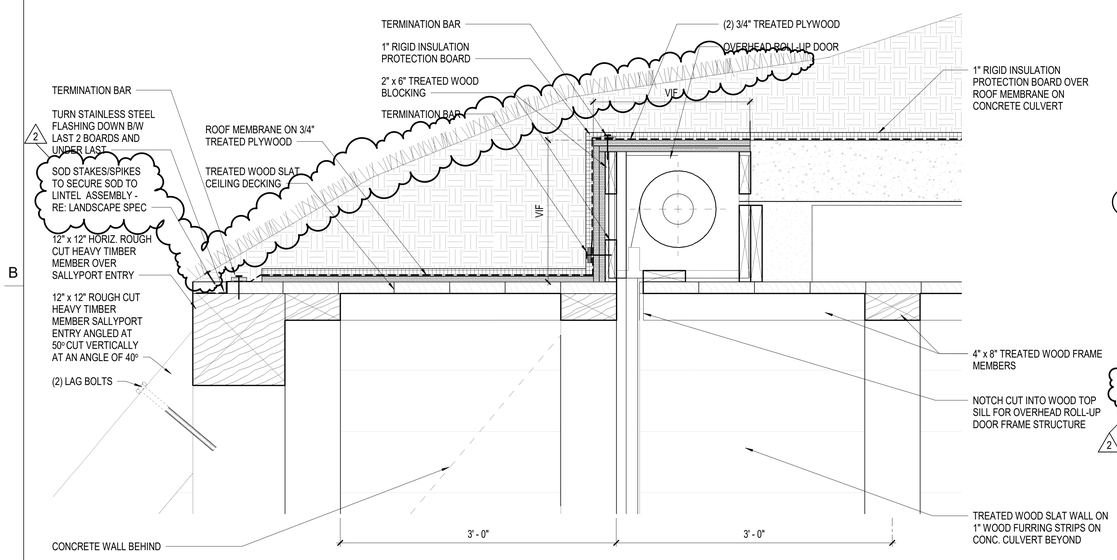


C2 FALSE TUNNEL ENTRY PLAN
1/4" = 1'-0"

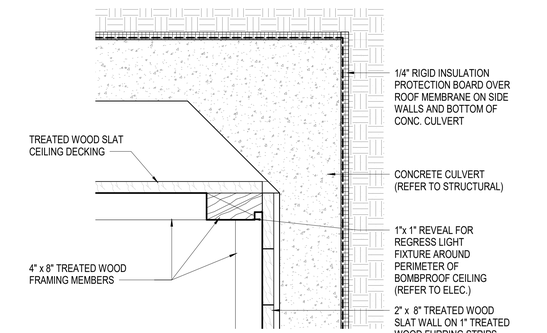


C3 SECTION AT FALSE TUNNEL
1/4" = 1'-0"

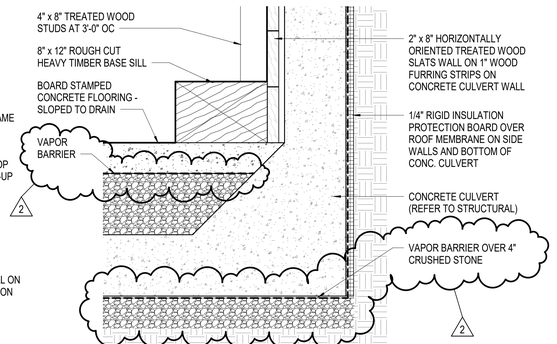
C5 PLAN DETAIL AT ROLL-UP DOOR
3" = 1'-0"



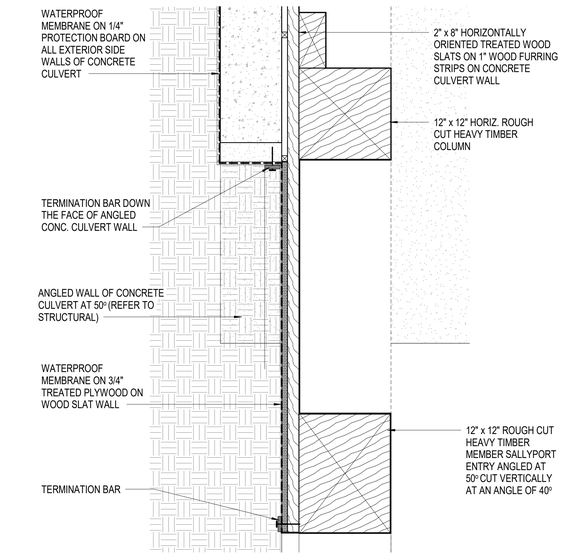
A1 DETAIL AT SALLYPORT ROLLUP DOOR
1 1/2" = 1'-0"



B4 SECTION DETAIL AT CULVERT
1 1/2" = 1'-0"



A4 SECTION DETAL AT CULVERT BASE
1 1/2" = 1'-0"



A5 PLAN DETAIL AT CULVERT WALL
1 1/2" = 1'-0"

GRAPHIC SCALE(S)

3" = 1' - 0"
1 1/2" = 1' - 0"
1/4" = 1' - 0"

DEPARTMENT OF NATURAL AND CULTURAL RESOURCES

EARTHWORKS AND FORTIFICATION EXHIBIT AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S
KURE BEACH, NC 28449

SCO#: 16-16311-02B
CODE: 41614
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DESIGNER
CLARKNEXSEN
333 FAYETTEVILLE STREET, SUITE 1000
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CLARK NEXSEN LICENSE NUMBER: C-1028
PROFESSIONAL SEAL

SUBMITTAL
APRIL 29, 2022
BID SET

REVISIONS

2	06/17/22	ADDENDUM 2

SHEET
FORTIFICATION EARTHWORKS RECONSTRUCTION EXHIBIT ENLARGED PLANS AND SECTION DETAILS

AS401E

DESIGN: RMH
DRAWN: WMP
REVIEW: DLF

CN 7173-B

6/17/2022 9:50:09 AM
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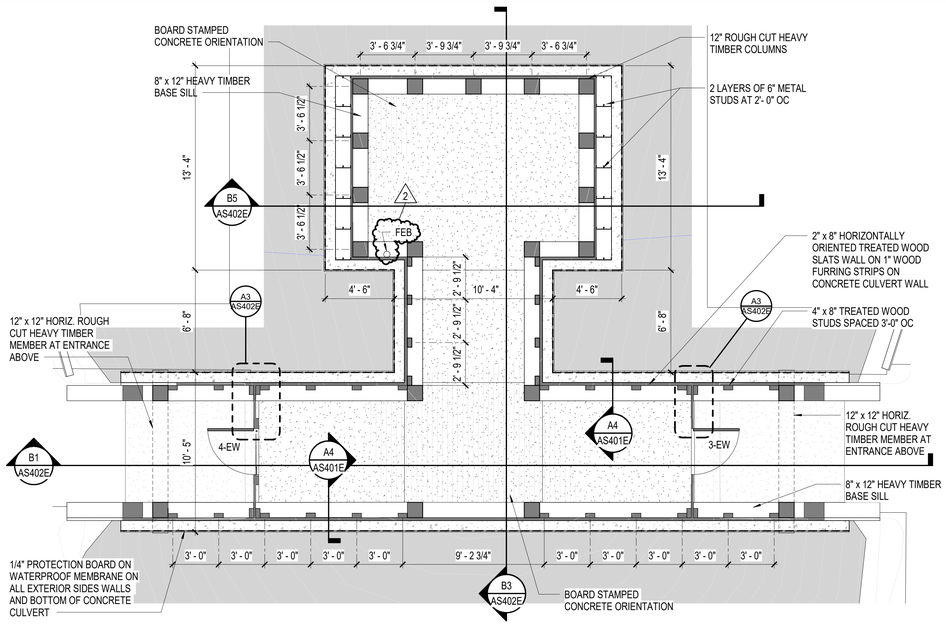
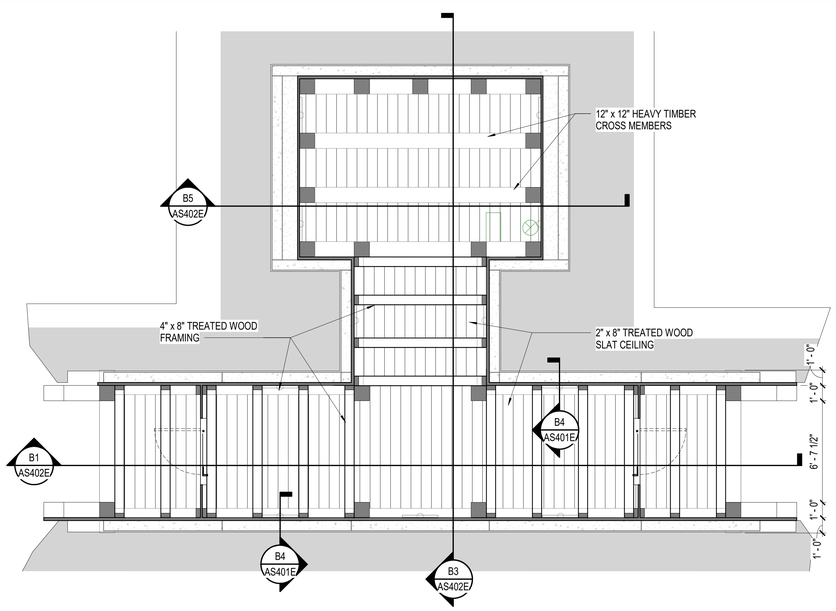
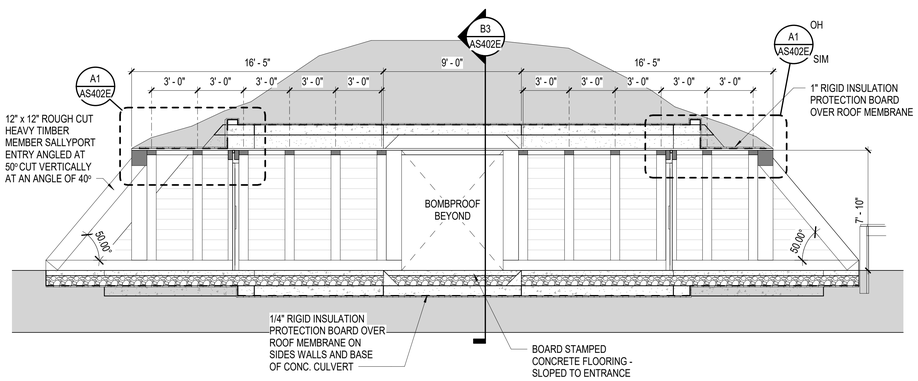


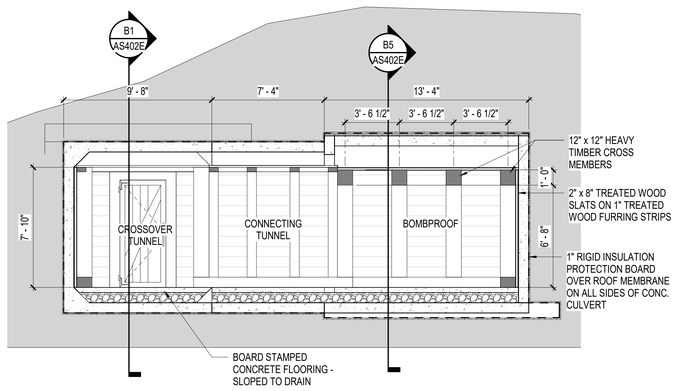
D1 EARTHWORKS - ENLARGED BOMBSHELTER
1/4" = 1'-0"



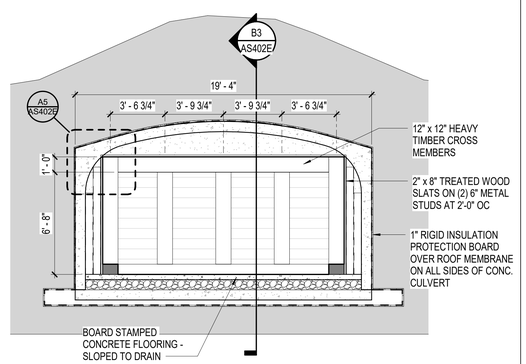
D3 BOMBPROOF CEILING PLAN
1/4" = 1'-0"



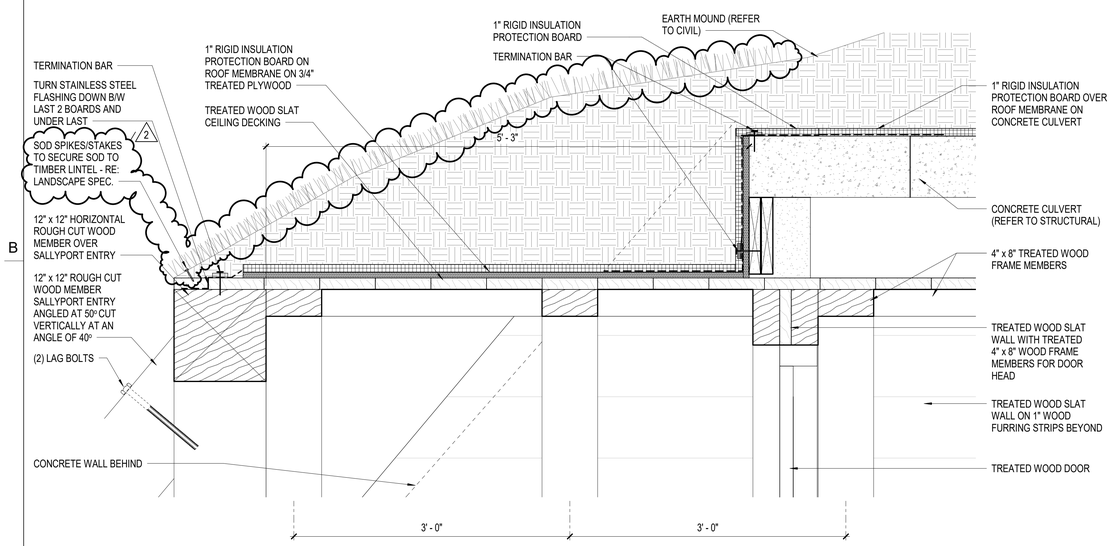
B1 SECTION AT BOMBPROOF CROSSOVER TUNNEL
1/4" = 1'-0"



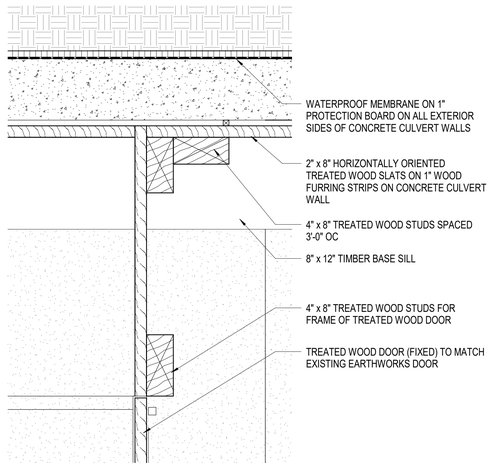
B3 SECTION THROUGH BOMBPROOF EXHIBIT
1/4" = 1'-0"



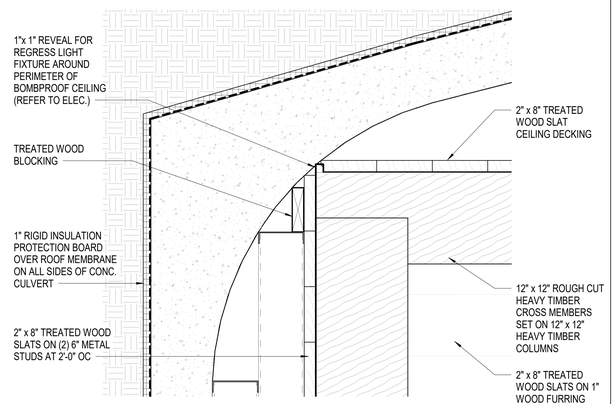
B5 SECTION AT BOMBPROOF
1/4" = 1'-0"



A1 SECTION DETAIL AT BOMBPROOF ENTRY
1 1/2" = 1'-0"



A3 PLAN DETAIL AT CROSSOVER DOOR
1 1/2" = 1'-0"



A5 SECTION DETAIL AT BOMBPROOF
1 1/2" = 1'-0"

GRAPHIC SCALE(S)

1 1/2" = 1' - 0" 0 3" 6" 9" 1' 2'

1/4" = 1' - 0" 0 1' 5' 10' 15'

DEPARTMENT OF NATURAL AND CULTURAL RESOURCES

EARTHWORKS AND FORTIFICATION EXHIBIT AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S
KURE BEACH, NC 28449

SCO#: 16-16311-02B
CODE: 41614
ITEM: 4C01

DESIGNER

CLARKNEXSEN

333 FAYETTEVILLE STREET, SUITE 1000
RALEIGH, NORTH CAROLINA 27601
919·828·1876

CLARK NEXSEN LICENSE NUMBER: C-1028
PROFESSIONAL SEAL

SUBMITTAL

APRIL 29, 2022

BID SET

REVISIONS

2	06/17/22	ADDENDUM 2

SHEET

FORTIFICATION EARTHWORKS RECONSTRUCTION EXHIBIT ENLARGED PLANS AND SECTION DETAILS

AS402E

DESIGN: RMH
DRAWN: WMP
REVIEW: DLF

CN 7173-B

6/17/2022 10:02:01 AM
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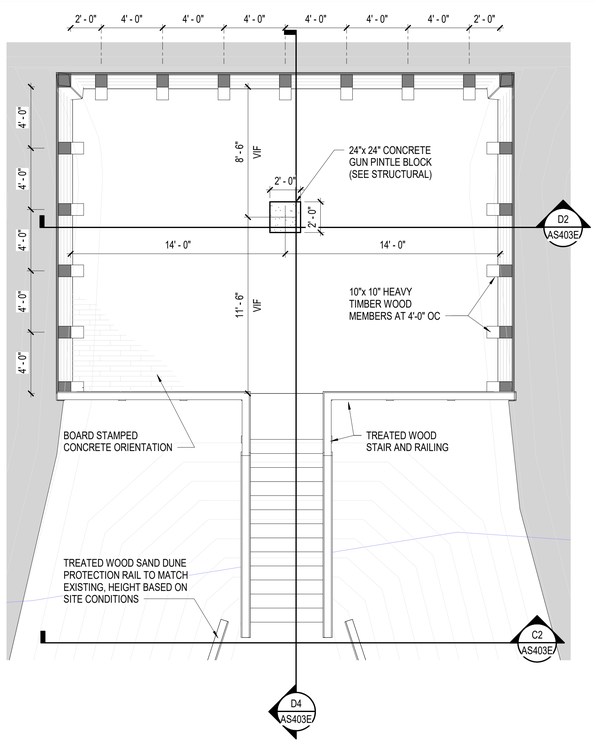
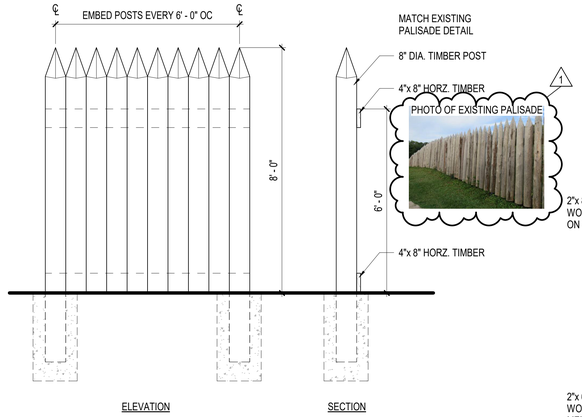
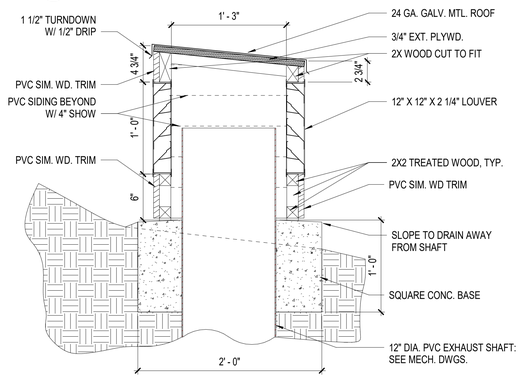


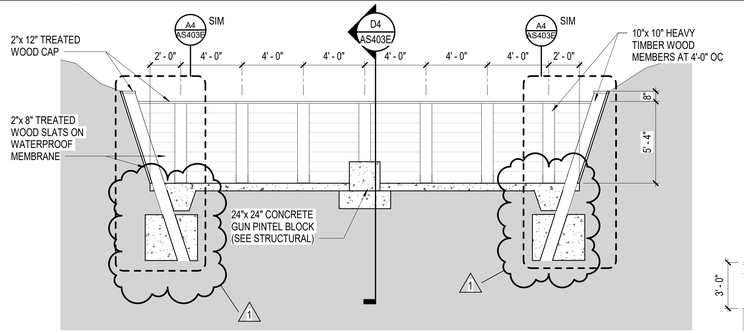
C1 GUN EMPLACEMENT
1/4" = 1'-0"



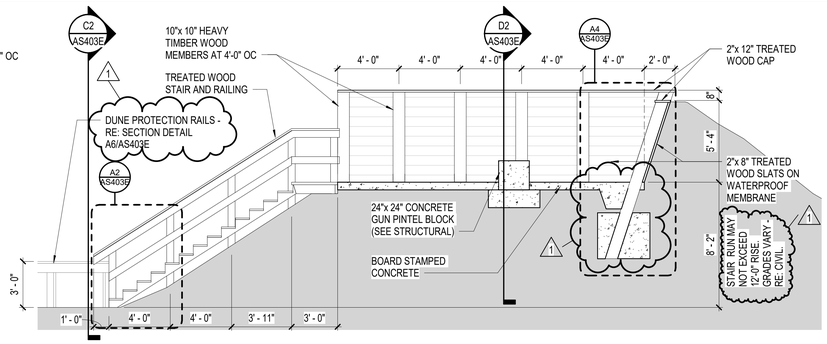
B1 PALISADE DETAIL
1/2" = 1'-0"



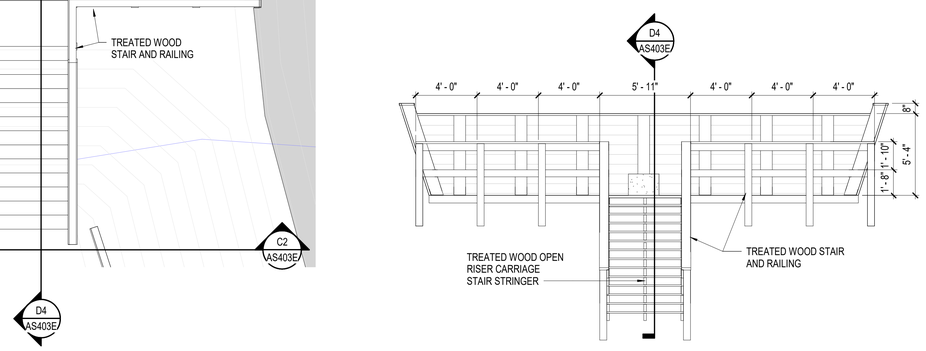
A1 BOMBPROOF EXHAUST SHAFT CAP
1 1/2" = 1'-0"



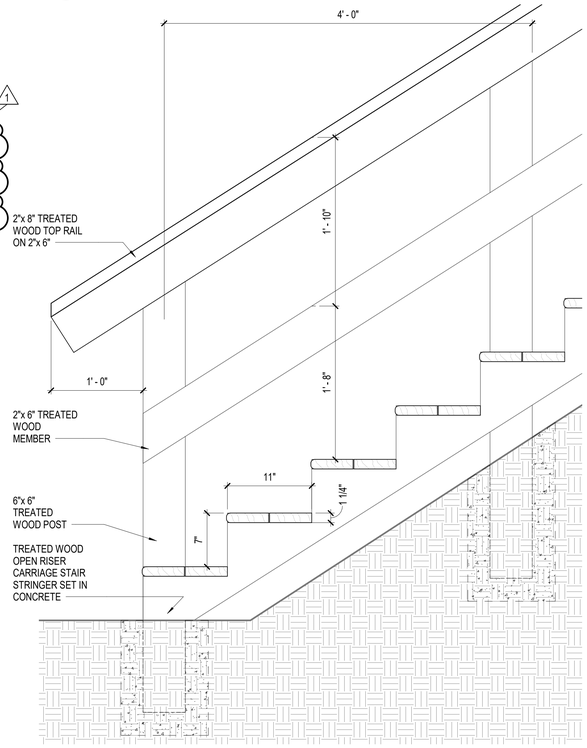
D2 SECTION AT GUN EMPLACEMENT
1/4" = 1'-0"



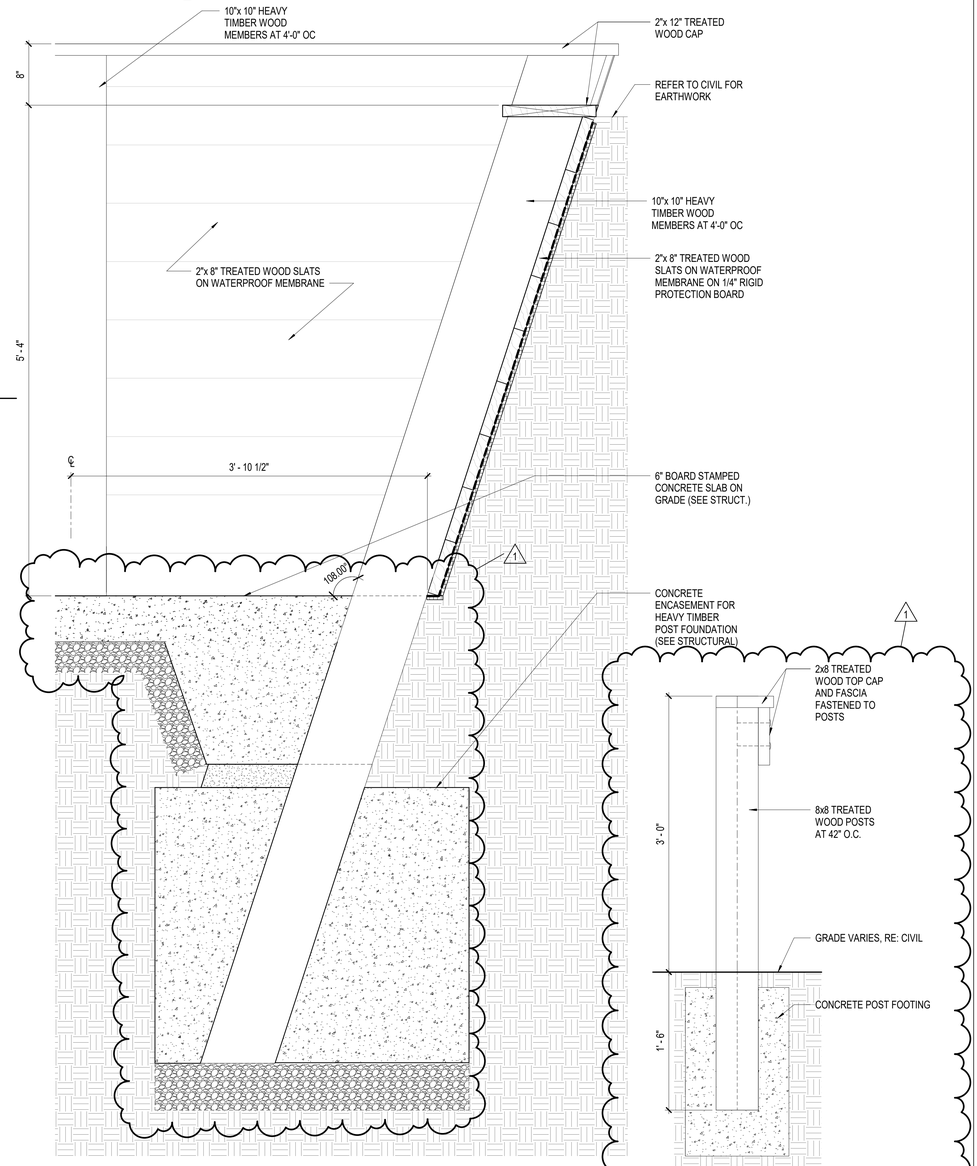
D4 SECTION AT GUN EMPLACEMENT
1/4" = 1'-0"



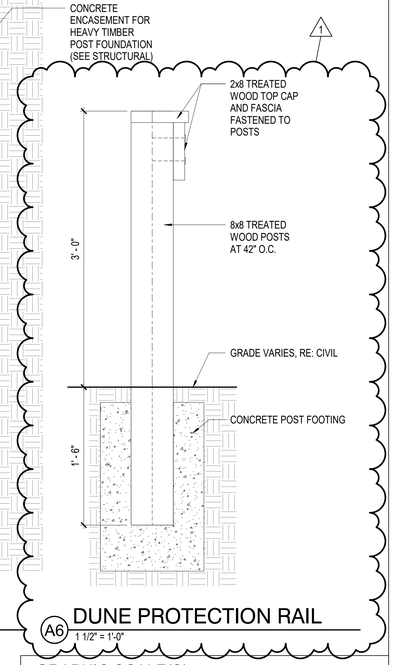
C2 ELEVATION AT GUN EMPLACEMENT STAIR
1/4" = 1'-0"



A2 DETAIL AT GUN EMPLACEMENT STAIR
1 1/2" = 1'-0"



A4 SECTION AT GUN EMPLACEMENT RETAINING WALL
1 1/2" = 1'-0"



A6 DUNE PROTECTION RAIL
1 1/2" = 1'-0"

GRAPHIC SCALE(S)

1 1/2" = 1' - 0" 0 3" 6" 9" 1' 2'

1/2" = 1' - 0" 0 6" 1' 2' 3' 4' 5'

1/4" = 1' - 0" 0 1' 5' 10' 15'

DEPARTMENT OF NATURAL AND CULTURAL RESOURCES

EARTHWORKS AND FORTIFICATION EXHIBIT AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S
KURE BEACH, NC 28449

SCO#: 16-16311-02B
CODE: 41614
ITEM: 4C01

DESIGNER

CLARKNEXSEN
333 FAYETTEVILLE STREET, SUITE 1000
RALEIGH, NORTH CAROLINA 27601
919-828-1876

CLARK NEXSEN LICENSE NUMBER: C-1028
PROFESSIONAL SEAL

SUBMITTAL
APRIL 29, 2022
BID SET

REVISIONS

1	06/10/22	ADDENDUM 1

SHEET
FORTIFICATION EARTHWORKS RECONSTRUCTION EXHIBIT SECTIONS AND DETAILS

AS403E

DESIGN: RMH
DRAWN: WMP
REVIEW: DLF

CN 7173-B

6/17/2022 10:05:10 AM
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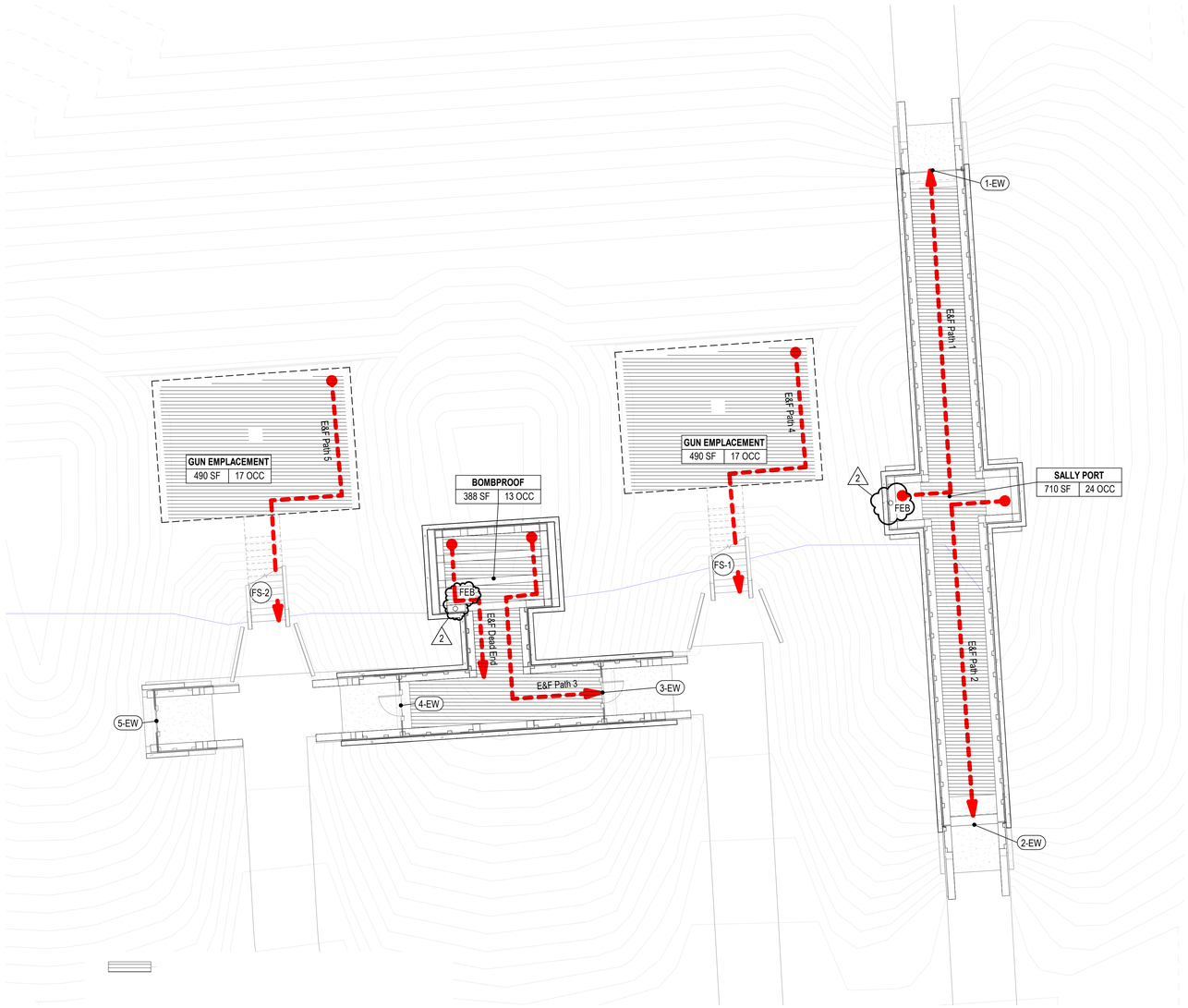

B1 FIRST FLOOR LIFE SAFETY PLAN

1/8" = 1'-0"

LIFE SAFETY - OCCUPANT CALCULATION - EARTHWORKS & FORTIFICATIONS

Name	OCCUPANCY	SF PER PERSON	OCCUPANCY SF TYPE	AREA	*NUMBER OF OCCUPANTS
BOMBPROOF	ASSEMBLY EXHIBIT GALLERY AND MUSEUM	30	NET	388 SF	13
WITHIN EARTHWORKS (considered as a single structure)	ND MUSEUM	30	NET	710 SF	24
				1,098 SF	37
GUN EMPLACEMENT	ASSEMBLY EXHIBIT GALLERY AND MUSEUM	30	NET	490 SF	17
GUN EMPLACEMENT	ASSEMBLY EXHIBIT GALLERY AND MUSEUM	30	NET	490 SF	17
FORTIFICATION GUN EMPLACEMENTS (exterior exhibits considered for Life Safety but not as a component of the building)				980 SF	34
EARTHWORKS & FORTIFICATIONS TOTALS:				2,078 SF	71

*NUMBER OF OCCUPANTS IS ROUNDED UP

LIFE SAFETY - EARTHWORKS & FORTIFICATIONS

DOOR NO.	CLEAR EGRESS WIDTH PROVIDED	EGRESS WIDTH FACTOR	OCCUPANT LOAD MAX PROVIDED	OCCUPANT LOAD REQUIRED	DELAYED EGRESS (SECONDS)	ELECTROMAGNETIC LOCK	HOLD OPEN DEVICE	PANIC HARDWARE	COMMENTS
1-EW	79"	0.2	395	12	NO	NO	NO	NO	OVERHEAD DOOR OPEN ONLY DURING PARK HOURS
2-EW	79"	0.2	395	12	NO	NO	NO	NO	OVERHEAD DOOR OPEN ONLY DURING PARK HOURS
3-EW	34"	0.2	170	7	NO	NO	NO	NO	
4-EW	34"	0.2	170	7	NO	NO	NO	NO	
5-EW	34"	0.2	170	0	NO	NO	NO	NO	DOOR TO FALSE TUNNEL
FIRST FLOOR TOTALS:				38					

LIFE SAFETY - FORTIFICATION STAIRS

STAIR MARK	CLEAR STAIR WIDTH PROVIDED	EGRESS WIDTH FACTOR	OCCUPANT LOAD MAX PROVIDED	OCCUPANT LOAD REQUIRED	COMMENTS
FS-1	57"	0.3	190	17	
FS-2	57"	0.3	190	17	
GRAND TOTAL: 2				34	

GENERAL NOTES

1. COORDINATE ALL FIRE EXTINGUISHERS LOCATIONS SHOWN ON PLANS W/ LOCAL FIRE OFFICIAL'S REQUIREMENTS.
2. CONTRACTOR TO PROVIDE & INSTALL ALL BLOCKING IN WALLS AS REQUIRED FOR MOUNTING FIRE EXTINGUISHERS.
3. CONTRACTOR TO COORDINATE INSTALLATION REQUIREMENTS OF EXIT SIGNS, ALL ASSOCIATED HARDWARE, JUNCTION BOXES, WIRING & REQUIRED EXIT DEVICES W/ ELECTRICAL DRAWINGS & LOCAL INSPECTOR.
4. RATED WALLS AND PARTITIONS REQUIRED TO HAVE PROTECTED OPENINGS SHALL BE PERMANENTLY STENCILED EVERY 10'-0" ABOVE THE CEILING OR CONCEALED SPACE.

   EXAMPLE:
   - 1-HOUR RATED BARRIER - PROTECT ALL OPENINGS

EGRESS PATH

PATH ID	DISTANCE
E&F Dead End	22' - 6"
E&F Path 1	52' - 6"
E&F Path 2	51' - 6"
E&F Path 3	39' - 0"
E&F Path 4	43' - 6"
E&F Path 5	43' - 0"

LIFE SAFETY LEGEND

- PATH ID — EGRESS TRAVEL PATH AND DISTANCE
- 101A — DOOR TAG. REFER TO LIFE SAFETY EGRESS DOOR SCHEDULE.
- A1 — STAIR TAG. REFER TO LIFE SAFETY EGRESS STAIR SCHEDULE
- FEC — FIRE EXTINGUISHER CABINET
- FEB — FIRE EXTINGUISHER BRACKET
- SPACE NAME / 9,876 SF | 385 OCC — SPACE NAME; OCCUPANCY LOAD (PEOPLE); SPACE AREA
- ILLUMINATED EXIT SIGN

GRAPHIC SCALE(S)

1/8" = 1' - 0" 0 5' 10' 15' 30'

DEPARTMENT OF NATURAL AND CULTURAL RESOURCES

EARTHWORKS AND FORTIFICATION EXHIBIT AT THE FORT FISHER STATE HISTORIC SITE

1610 FORT FISHER BLVD S
KURE BEACH, NC 28449

SCO#: 16-16311-02B
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CLARK NEXSEN LICENSE NUMBER: C-1028

PROFESSIONAL SEAL

SUBMITTAL
APRIL 29, 2022
BID SET

REVISIONS

2	06/17/22	ADDENDUM 2

SHEET
EARTHWORKS & FORTIFICATIONS LIFE SAFETY PLAN

GI011E

DESIGN: DLF
DRAWN: DLF
REVIEW: DLF

CN 7173-B

VOLUME 2: PHASE 1 TABLE OF CONTENTS

DIVISION 31 - EARTHWORK

DIVISION 32 - EXTERIOR IMPROVEMENTS

END OF TABLE OF CONTENTS

SECTION 055000 - METAL FABRICATIONS

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. *Steel framing and supports for overhead doors.*
2. *Steel framing and supports for applications where framing and supports are not specified in other Sections.*

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. 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.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. *Paint products.*
2. *Grout.*

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. *Steel framing and supports for overhead doors.*
2. *Steel framing and supports for applications where framing and supports are not specified in other Sections.*

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

C. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.

2.4 MISCELLANEOUS MATERIALS

A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. *Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.*
2. *Obtain fusion without undercut or overlap.*
3. *Remove welding flux immediately.*
4. *At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.*

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize exterior miscellaneous steel trim.

2.7 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.8 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with unless zinc-rich primer is primers specified in Section 099600 "High-Performance Coatings" are indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

3.2 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

***END OF SECTION** 055000*

SECTION 061063 - EXTERIOR ROUGH CARPENTRY

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 Recreations of Historic Civil War Fortifications including:

1. Wood retaining walls.
2. Wood interior finish of underground structures below:

    a. Sally port
    b. Bombproof

3. Exterior wood steps and railings.

1.3 DEFINITIONS

A. Boards: Lumber of less than 2 inches nominal in thickness and 2 inches nominal or greater in width.

B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

C. Timber: Lumber of 5 inches nominal or greater in least dimension.

D. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NLGA: National Lumber Grades Authority.
3. RIS: Redwood Inspection Service.
4. SPIB: The Southern Pine Inspection Bureau.
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.4 ACTION SUBMITTALS

A. Product Data: For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Certificates of Inspection: Issued by lumber grading agency for exposed wood products not marked with grade stamp.

C. Evaluation Reports: For preservative-treated wood products, from ICC-ES.

1.6 QUALITY ASSURANCE

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 LUMBER, GENERAL

A. Comply with DOC PS 20 and with grading rules of lumber grading agencies certified by ALSC's Board of Review as applicable. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by ALSC's Board of Review.

1. Factory mark each item with grade stamp of grading agency.
2. For items that are exposed to view in the completed Work, omit grade stamp and provide certificates of grade compliance issued by grading agency.
3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
4. Provide dressed lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content:

1. Boards: 19 percent.
2. Dimension Lumber: 19 percent.
3. Timber. 19 percent.

2.2 LUMBER

A. Dimension Lumber: No. 2 grade and the following species:

1. Mixed southern pine; SPIB.

B. Boards: Any of the following species and grades:

1. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Standard or No. 3 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
2. Mixed southern pine; No. 2 grade; SPIB.

2.3 POSTS

A. Timber Posts: Southern pine; No. 2; SPIB.

B. Round Wood Poles: Clean-peeled wood poles complying with ASTM D3200, with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.

1. Species: Southern Pine or Cypress.

2.4 PRESERVATIVE TREATMENT

A. Pressure treat timber with waterborne preservative according to AWPA U1; Use Category UC4a.

1. Treatment with CCA shall include post-treatment fixation process.

B. Preservative Chemicals: Acceptable to authorities having jurisdiction.

C. Use process for boards and dimension lumber that includes water-repellent treatment.

D. After treatment, redry to 19 percent maximum moisture content.

E. Mark treated wood with treatment quality mark of an inspection agency approved by ALSC's Board of Review.

1. For items indicated to receive a stained or natural finish, omit marking and provide certificates of treatment compliance issued by inspection agency.

F. Application: Treat all wood unless otherwise indicated.

2.5 FASTENERS

A. General: Provide fasteners of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.

1. Use stainless steel unless otherwise indicated.
2. For pressure-preservative-treated wood, use stainless steel fasteners.

B. Nails: ASTM F1667.

C. Power-Driven Fasteners: ICC-ES AC70.

D. Wood Screws and Lag Screws: ASME B18.2.1, ASME B18.6.1, or ICC-ES AC233.

E. Stainless Steel Bolts: ASTM F593, Alloy Group 1 or 2; with ASTM F594, Alloy Group 1 or 2 hex nuts and, where indicated, flat washers.

F. Postinstalled Anchors: Stainless steel, chemical or torque-controlled expansion anchors with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing according to ASTM E488, conducted by a qualified independent testing and inspecting agency.

1. Stainless steel bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2.

2.6 METAL ACCESSORIES

A. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, G90 coating designation.

B. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 316.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit work to other construction; scribe and cope as needed for accurate fit.

B. Framing Standard: Comply with AF&PA WCD1 unless otherwise indicated.

C. Install metal framing anchors to comply with manufacturer's written instructions.

D. Do not splice structural members between supports unless otherwise indicated.

E. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

F. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of members or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

G. Apply copper naphthenate field treatment to comply with AWPA M4, to cut surfaces of preservative-treated lumber.

H. Securely attach exterior rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. ICC-ES AC70 for power-driven fasteners.
2. "Fastening Schedule" in ICC's International Building Code.

I. Use common wire nails unless otherwise indicated. Select fasteners of size that do not fully penetrate members where opposite side is exposed to view. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads unless otherwise indicated.

END OF SECTION 061063

SECTION 061300 - HEAVY TIMBER CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Framing using timbers *and round wood poles*.

1.2 DEFINITIONS

A. Timbers: Lumber of 5 inches nominal or greater in least dimension.

B. *Poles: Round wood members, called either "poles" or "posts" in the referenced standards.*

C. Inspection agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NHLA: National Hardwood Lumber Association.
3. NLGA: National Lumber Grades Authority.
4. SPIB: Southern Pine Inspection Bureau (The).

1.3 ACTION SUBMITTALS

1.4 INFORMATIONAL SUBMITTALS

A. Certificates of Inspection: Issued by lumber-grading agency for exposed timber not marked with grade stamp.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Schedule delivery of materials to avoid extended on-site storage and to avoid delaying the Work.

B. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings.

PART 2 - PRODUCTS

2.1 TIMBER

A. Comply with DOC PS 20 and with grading rules of lumber-grading agencies certified by ALSC's Board of Review as applicable.

1. Factory mark each item of timber with grade stamp of grading agency.
2. For exposed timber indicated to receive a stained or natural finish, apply grade stamps to surfaces that are not exposed to view, or omit grade stamps and provide certificates of grade compliance issued by grading agency.

B. Timber Species and Grade: Balsam fir, Douglas fir-larch, Douglas fir-larch (North), eastern hemlock tamarack (North), hem-fir, southern pine, western hemlock, or western hemlock (North); No. 2, NeLMA, NLGA, SPIB, WCLIB, or WWPA.

C. Structural Properties: Provide any species and grade that, for moisture content provided, complies with required structural properties.

1. Allowable Stress Ratings for 12-Inch Nominal Depth: As indicated on Drawings.

D. Dressing: Provide timber that is rough sawn (Rgh) unless otherwise indicated.

2.2 ROUND WOOD POLES

A. Round Wood Poles: Clean-peeled wood poles complying with ASTM D3200; with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.

B. Species: Same species as timbers.

C. Size: Various sizes Min. 6” dia. To max. 10” dia.

2.3 TIMBER CONNECTORS

A. Provide bolts, 3/4 inch unless otherwise indicated, complying with ASTM A307, Grade A; provide nuts complying with ASTM A563; and, where indicated, provide flat washers.

B. Materials: Unless otherwise indicated, fabricate from the following materials:

1. Structural-steel shapes, plates, and flat bars complying with ASTM A36/.
2. Round steel bars complying with ASTM A575, Grade M 1020.
3. Hot-rolled steel sheet complying with ASTM A1011, Structural Steel, Type SS, Grade 33.

C. Finish steel assemblies and fasteners with rust-inhibitive primer, 2-mil dry film thickness.

D. Hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A123 or ASTM A153.

2.4 MISCELLANEOUS MATERIALS

A. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.

B. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Erect heavy timber framing true and plumb. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.

B. Fitting: Fit members by cutting and restoring exposed surfaces to match specified surfacing.

1. Predrill for fasteners using timber connectors as templates.
2. Finish exposed surfaces to remove planing or surfacing marks, and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.
3. Coat crosscuts with end sealer.

C. Install timber connectors as indicated.

1. Install bolts with orientation as indicated or, if not indicated, as directed by Architect.

D. Construct palisade using poles and timber framing using the existing palisade structure as a model.

1. Set posts in concrete (min. 4'-0" depth) at foot intervals of 6 feet with horizontal timbers at top and bottom of palisade "fencing" as indicated in Detail A1 Sheet AS403E.
2. Sharpen top of pole fencing members as existing.

3.2 ADJUSTING

A. Repair damaged surfaces and finishes after completing erection. Replace damaged heavy timber framing if repairs are not approved by Architect.

END OF SECTION 061300

SECTION 075419 - POLYVINYL-CHLORIDE (PVC) ROOFING

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. Adhered polyvinyl chloride (PVC) roofing system on concrete deck including:

a. Extruded polystyrene insulation.
b. Adhesives
c. Misc. accessories

1.3 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Roofing Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Construction Manager, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.

8. *Review temporary protection requirements for roofing system during and after installation.*
9. *Review roof observation and repair procedures after roofing installation.*

1.5 ACTION SUBMITTALS

A. *Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:*

1. *Base flashings and membrane terminations.*
2. *Flashing details at penetrations.*
3. *Orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.*
4. *Insulation fastening patterns for corner, perimeter, and field-of-roof locations.*
5. *Tie-in with waterproofing membrane.*

B. *Samples for Verification: For the following products:*

1. *Roof membrane and flashing, of color required.*

1.6 INFORMATIONAL SUBMITTALS

A. *Qualification Data: For Installer and manufacturer.*

B. *Manufacturer Certificates:*

1. *Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.*

a. *Submit evidence of compliance with performance requirements.*

2. *Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.*

C. *Product Test Reports: For roof membrane and insulation, tests performed by independent qualified testing agency indicating compliance with specified requirements.*

D. *Evaluation Reports: For components of roofing system, from ICC-ES.*

E. *Field Test Reports:*

1. *Concrete internal relative humidity test reports.*

F. *Field quality-control reports.*

G. *Sample Warranties: For manufacturer's special warranties.*

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is listed in SPRI's Directory of Roof Assemblies for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. *Special warranty includes roof membrane, base flashings, roof insulation, fasteners, and other components of roofing system.*
2. *Warranty Period: 20 years from date of Final Acceptance.*

B. *Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, roof insulation, fasteners, and walkway products, for the following warranty period:*

1. *Warranty Period: Five years from date of Final Acceptance.*

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. *General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings shall remain watertight.*

1. *Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.*
2. *Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D3746, ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.*

B. *Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.*

2.2 POLYVINYL CHLORIDE (PVC) ROOFING

A. *PVC Sheet: Adhered, flexible reinforced PVC sheet with backing designed for use under a plaza deck.*

1. *Basis-of-Design Product: Subject to compliance with requirements, provide Sarnafil G476-15, White EPA Energy Star Membrane or comparable product by the same manufacturer as Systems 1 and 2 above:*
2. *Thickness: 60 mils.*
3. *Exposed Face Color: Manufacturer's standard.*

B. *Source Limitations: Obtain components for roofing system from roof membrane manufacturer or manufacturers approved by roof membrane manufacturer.*

2.3 AUXILIARY ROOFING MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.

1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.

B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as PVC sheet. All sheet metal flashings (such as scuppers and penetration flashings) shall be PVC coated to allow welding to roofing as required.

C. Bonding Adhesive: Manufacturer's standard, water based.

D. Water-Based, Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard water-based, cold-applied adhesive formulated for compatibility and use with fabric-backed membrane roofing.

2.4 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured or approved by PVC roof membrane manufacturer.

B. Extruded-Polystyrene Board Insulation: ASTM C578, minimum density, 25-psi minimum compressive strength, square edged.

1. Thermal Resistance: R-value of 5.0 per inch.
2. Size: 48 by 48 inches.
3. Thickness:

a. Base Layer: 1-1/2 inches.
b. Upper Layer: as required for minimum R25 thermal resistance.

2.5 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.

B. Cover Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum board or ASTM C1278/C1278M fiber-reinforced gypsum board.

1. Thickness: 1/2 inch.
2. Surface Finish: Factory primed.

2.6 DRAINAGE COMPOSITE

A. Manufacturer's standard drainage composite material of either:

1. *Polypropylene drainage core of fused entangled filaments or with geotextile fabric bonded to each side.*
2. *Geometrically patterned core drainage mat with a protection fabric laminated to the underside and a laminated filter fabric on the upper side.*

PART 3 - EXECUTION

3.1 EXAMINATION

A. *Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.*

1. *Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.*
2. *Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than 75 percent, or as recommended by roofing system manufacturer, when tested according to ASTM F2170.*

    a. *Test Frequency: One test probe per each 1000 sq. ft.of roof deck, with no fewer than three test probes.*
    b. *Submit test reports within 24 hours of performing tests.*

3. *Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.*
4. *Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.*

B. *Proceed with installation only after unsatisfactory conditions have been corrected.*

3.2 PREPARATION

A. *Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation according to roofing system manufacturer's written instructions. Remove sharp projections.*

3.3 INSTALLATION OF ROOFING, GENERAL

A. *Install roofing system according to roofing system manufacturer's written instructions.*

B. *Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.*

3.4 INSTALLATION OF ADHERED ROOF MEMBRANE

A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.

B. Unroll roof membrane and allow to relax before installing.

C. Start installation of roofing in presence of roofing system manufacturer's technical personnel as required for warranty certification and Owner's testing and inspection agency.

D. Accurately align roof membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

E. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.

F. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, at perimeter of roofing and as the manufacturer's system design requires to meet roofing uplift loading.

G. Apply roof membrane with side laps shingled with slope of roof deck where possible.

H. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.
2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

I. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

1. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

3.5 INSTALLATION OF BASE FLASHING

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.6 INSTALLATION OF INSULATION

A. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.

B. Installation Over Concrete Decks:

1. Install drainage mat over roofing membrane per manufacturer's instructions prior to installing insulation.

2. Install base layer of insulation with joints staggered not less than 24 inches in adjacent rows.

a. Make joints between adjacent insulation boards not more than 1/4 inch in width.
b. Fill gaps exceeding 1/4 inch with insulation.
c. Loosely lay base layer of insulation units over substrate.

3. Install upper layers of insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.

a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
c. Make joints between adjacent insulation boards not more than 1/4 inch in width.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, sheet flashings, protection, and drainage components, and to furnish reports to Architect.

B. Owner will engage a qualified testing agency to perform the following tests:

1. Infrared Thermography: Testing agency shall survey entire roof area using infrared color thermography according to ASTM C1153.

a. Perform tests before overlying construction is placed.
b. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection tests.
c. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

d. Testing agency shall prepare survey report of initial scan indicating locations of entrapped moisture, if any.

2. Testing agency shall prepare survey report indicating locations of initial discontinuities, if any.

C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.

D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.8 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

END OF SECTION 075419

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

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. Non-load-bearing steel framing systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

1.5 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Horizontal Deflection: For non-composite wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft. Use a horizontal loading of 10 lbf/sq. ft. in the Gallery and other locations indicated to support exhibits.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C754 for conditions indicated.

1. *Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.*
2. *Protective Coating: ASTM A653/A653M, G40, hot-dip galvanized unless otherwise indicated.*

B. *Studs and Tracks: ASTM C645.*

1. *Steel Studs and Tracks:*

a. *Manufacturers: Subject to compliance with requirements, provide products by one of the following:*

1) *CEMCO; California Expanded Metal Products Co.*
2) *ClarkDietrich.*
3) *MarinoWARE.*

b. *Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection.*
c. *Depth: As indicated on Drawings.*

C. *Slip-Type Head Joints: Where indicated, provide one of the following:*

1. *Single Long-Leg Track System: ASTM C645 top track with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.*
2. *Double-Track System: ASTM C645 top outer tracks, inside track with 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.*
3. *Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.*

D. *Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.*

1. *Minimum Base-Steel Thickness: 0.0329 inch.*

E. *Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch- wide flanges.*

1. *Depth: 1-1/2 inches.*
2. *Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.*

F. *Hat-Shaped, Rigid Furring Channels: ASTM C645.*

1. *Minimum Base-Steel Thickness: 0.0296 inch.*
2. *Depth: 7/8 inch.*

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide the following:

1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Installation Standard: ASTM C754.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

3.3 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.

2. Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

E. Direct Furring:

1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 099114 - EXTERIOR PAINTING (MPI STANDARDS)

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. Surface preparation and application of paint systems on the following exterior substrates:

a. Concrete.
b. Steel and iron.
c. Galvanized metal.
d. Wood.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for shop priming of metal substrates.
2. Section 055000 "Metal Fabrications" for shop priming metal fabrications.

1.3 DEFINITIONS

A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.

B. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

C. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.

D. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.

E. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.

F. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include preparation requirements and application instructions.
2. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
3. Indicate VOC content.

B. Samples: For each type of topcoat product.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in the Exterior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Benjamin Moore & Co.
2. PPG Paints.
3. Sherwin-Williams Company (The).

B. Source Limitations: Obtain paint from single source from single manufacturer.

2.2 PAINT PRODUCTS

A. MPI Standards: Provide products complying with MPI standards indicated and listed in its "MPI Approved Products List."

B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. Colors: As indicated in a color schedule.

1. 30 percent of surface area will be painted with deep tones.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Wood: 15 percent.

C. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:

1. SSPC-SP 2.

F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

H. Wood Substrates:

1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.
2. Sand surfaces that will be exposed to view and remove sanding dust.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 INSTALLATION

A. Apply paints in accordance with manufacturer's written instructions and recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in the Exterior Painting Schedule may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.

B. Tint undercoats same color as topcoat but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed to view:

a. Equipment, including panelboards and switch gear.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, Contractor shall pay for testing and apply additional

coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
3. Allow empty paint cans to dry before disposal.
4. Collect waste paint by type and deliver to recycling or collection facility.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:

1. Latex System MPI EXT 3.1A:

a. Prime Coat: Primer, alkali resistant, water based, MPI #3.
b. Intermediate Coat: Latex, exterior, matching topcoat.
c. Low-Sheen Topcoat: Latex, exterior, low sheen (MPI Gloss Level 3-4), MPI #15.

B. Steel and Iron Substrates:

1. Water-Based Light Industrial Coating System MPI EXT 5.1N:

a. Shop Prime Coat: Shop primer specified in Section where substrate is specified.
b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
c. Semigloss Topcoat: Light industrial coating, exterior, water based, semigloss (MPI Gloss Level 5), MPI #163.

C. Galvanized-Metal Substrates:

1. Latex System MPI EXT 5.3H:

a. Water-Based Prime Coat: Primer, galvanized, water based, MPI #134.
b. Intermediate Coat: Latex, exterior, matching topcoat.
c. Semigloss Topcoat: Latex, exterior, semigloss (MPI Gloss Level 5), MPI #11.

D. Wood Substrates:

1. Latex over Latex Primer System MPI EXT 6.3L:

a. Prime Coat: Primer, latex for exterior wood, MPI #6.
b. Intermediate Coat: Latex, exterior, matching topcoat.
c. Semigloss Topcoat: Latex, exterior, semigloss (MPI Gloss Level 5), MPI #11.

END OF SECTION 099114