

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT				1. CONTRACT ID CODE J		PAGE 1 OF 5 PAGES	
2. AMENDMENT/MODIFICATION NUMBER 0004		3. EFFECTIVE DATE See Item 16		4. REQUISITION/PURCHASE REQUISITION NUMBER		5. PROJECT NUMBER (If applicable) 475034	
6. ISSUED BY W071 ENDIST PORTLAND KO CONTRACTING DIVISION, 333 SW FIRST AVE PORTLAND, OR 97204-3495 UNITED STATES CHRISTOPHER BURROUGHS, EMAIL: CHRISTOPHER.D.BURROUGHS@USACE. ARMY.MIL TELEPHONE: 503-808-4910		CODE W9127N		7. ADMINISTERED BY (If other than Item 6) SCD: PAS:		CODE	
8. NAME AND ADDRESS OF CONTRACTOR (Number, street, county, State and ZIP Code)				(X)		9A. AMENDMENT OF SOLICITATION NUMBER W9127N26BA024	
				(X)		9B. DATED (SEE ITEM 11) 19 AUG 2026	
				()		10A. MODIFICATION OF CONTRACT/ORDER NUMBER	
				()		10B. DATED (SEE ITEM 13)	
CODE		FACILITY CODE					

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☒ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended. ☒ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:
 (a) By completing items 8 and 15, and returning 1 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted;
 or (c) By separate letter or electronic communication which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER.
 If by virtue of this amendment you desire to change an offer already submitted, such change may be made by letter or electronic communication, provided each letter or electronic communication makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)

SEE SECTION G - CONTRACT ADMINISTRATION DATA

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NUMBER AS DESCRIBED IN ITEM 14.

CHECK ONE	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NUMBER IN ITEM 10A.
☐	
☐	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation data, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
☐	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
☐	D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor ☐ is not ☐ is required to sign this document and return _____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

See Schedule

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)		16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print) Justin Figueredo	
15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA FIGUEREDO.JUSTIN.F. 1292876188 Digitally signed by FIGUEREDO.JUSTIN.F.1292876188 Date: 2026.09.18 06:54:59 -07'00'	16C. DATE SIGNED 18SEP26
(Signature of person authorized to sign)		(Signature of Contracting Officer)	

Previous edition unusable

SECTION SF 30 BLOCK 14 CONTINUATION PAGE

SUMMARY OF CHANGES

Block 14 (Description of Amendment/Modification): DESCRIPTION OF AMENDMENT

This amendment effects changes to the Block 14 (Description of Amendment/Modification):

Solicitation Specifications, Section 31 68 13.00 99 - GROUND ANCHORS, Part 1 GENERAL, Paragraph 1.5.2 Qualifications are changed as detailed in the SUMMARY OF CHANGES.

Solicitation Specifications, Section 31 73 20.00 99 - JET GROUTING, Part 1 GENERAL, Paragraph 1.7.1 Qualifications are changed as detailed in the SUMMARY OF CHANGES.

Solicitation Specifications, Section 00 73 00 - Supplementary Conditions, Paragraph L. - COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK (APR 1984), the Period of Performance is amended as detailed in the SUMMARY OF CHANGES.

This will allow for work to occur during the 2029 and 2030 In Water Work Window years. Environmental permits remain unchanged by this amendment. Marine Mammal protections as listed in the specification, and as governed by the IHA, included with the Attachments, remain in effect for the permitted years. No in water work, that is governed by IHA, will be allowed beyond the IHA permit years allowed.

SUMMARY OF CHANGES

CHANGE IN SOLICITATION SPECIFICATIONS:

Solicitation Specifications, Section 31 68 13.00 99 - GROUND ANCHORS, Part 1 GENERAL, Paragraph 1.5.2 Qualifications, delete the paragraph in its entirety and replace with the following full text:

1.5.2 Qualifications

Due to the specialized nature of the ground anchor portion of the work, the ground anchor Contractor must be pre-qualified prior to the performance of ground anchor or ground anchor related work. Contractors must meet the experience criteria listed below. The Contracting Officer will approve or reject the Contractor's qualifications within 15 calendar days after receipt of a complete qualifications submission. Additional time required due to incomplete or unacceptable submittals will not be cause for time extension or impact or delay claims. All costs associated with incomplete or unacceptable submittals must be borne by the Contractor.

Solicitation Specifications, Section 31 73 20.00 99 - JET GROUTING, Part 1 GENERAL, Paragraph 1.7.1 Qualifications, delete the paragraph in its entirety and replace with the following full text:

1.7.1 Qualifications

Due to the specialized nature of the jet grouting portion of the work, the Jet Grouting Contractor must be pre-qualified prior to the performance of jet grouting or jet grouting related work. Contractors must meet the experience criteria listed below. The Contracting Officer will approve or reject the Contractor's qualifications within 15 calendar days after receipt of a complete qualifications submission. Additional time required due to incomplete or unacceptable submittals will not be cause for time extension or impact or delay claims. All costs associated with incomplete or unacceptable submittals must be borne by the Contractor.

Solicitation Specifications, Section 00 73 00 - Supplementary Conditions, Paragraph L - COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK ALTERNATE I (APR 1984), delete the paragraph in its entirety and replace with the following full text:

L. COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK ALTERNATE I (APR 1984)

The Contractor shall be required to (a) commence work under this contract within 10 calendar days after the date the Contractor receives the notice to proceed, (b) prosecute the work diligently, and (c) complete the entire work ready for use not later than 1,295 calendar days after receipt of Notice to Proceed. The time stated for completion shall include final cleanup of the premises.

Section 00 73 00 - Supplementary Conditions

The delivery information for the following CLIN(s) / SLIN(s) / ELIN(s) were modified:

0001

INFORMATION	FROM	TO
Delivery	930 Calendar Days, From Date of Notice to Proceed Receipt to completion of performance	1295 Calendar Days, From Date of Notice to Proceed Receipt to completion of performance

0002

INFORMATION	FROM	TO

Delivery	930 Calendar Days, From Date of Notice to Proceed Receipt to completion of performance	1295 Calendar Days, From Date of Notice to Proceed Receipt to completion of performance
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0003

INFORMATION	FROM	TO
Delivery	930 Calendar Days, From Date of Notice to Proceed Receipt to completion of performance	1295 Calendar Days, From Date of Notice to Proceed Receipt to completion of performance

0004

INFORMATION	FROM	TO
Delivery	930 Calendar Days, From Date of Notice to Proceed Receipt to completion of performance	1295 Calendar Days, From Date of Notice to Proceed Receipt to completion of performance

0005

INFORMATION	FROM	TO
Delivery	930 Calendar Days, From Date of Notice to Proceed Receipt to completion of performance	1295 Calendar Days, From Date of Notice to Proceed Receipt to completion of performance

0006

INFORMATION	FROM	TO
Delivery	930 Calendar Days, From Date of Notice to Proceed Receipt to completion of performance	1295 Calendar Days, From Date of Notice to Proceed Receipt to completion of performance

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SECTION 31 68 13.00 99

GROUND ANCHORS

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

1.1.1 Scope of Work

a. Furnish all labor, materials, tools, supervision, transportation, installation equipment, and incidentals necessary to complete the work specified herein and shown on the Contract drawings. The work must include but not be limited to mobilization, surveying, drilling, inserting, grouting, stressing, load testing, and lock-off of ground anchors at the appropriate locations.

b. Unless otherwise directed, the Contractor must select the ground anchor type, drilling method, grouting method, grouting pressures, and, subject to the minimum values in the contract documents, determine the bond length, free-stressing (unbonded) length, and anchor diameter. The Contractor must be responsible for installing ground anchors that will develop the load-carrying capacity indicated on the Contract Drawings in accordance with the testing subsection of this Specification.

c. The anchor tendon must be protected from corrosion as shown on the Contract drawings and in accordance with the requirements of this Specification.

1.2 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO M 252 (2009; R 2017) Standard Specification for
Corrugated Polyethylene Drainage Pipe

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M (2024) Standard Specification for Pipe,
Steel, Black and Hot-Dipped, Zinc-Coated,
Welded and Seamless

ASTM A192/A192M (2002; R 2012) Standard Specification for
Seamless Carbon Steel Boiler Tubes for
High-Pressure Service

ASTM A500/A500M (2023) Standard Specification for
Cold-Formed Welded and Seamless Carbon
Steel Structural Tubing in Rounds and
Shapes

ASTM A709/A709M	(2021) Standard Specification for Structural Steel for Bridges
ASTM A775/A775M	(2022) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM C109/C109M	(2023) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM D1248	(2016) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D4101	(2017) Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials

POST-TENSIONING INSTITUTE (PTI)

PTI DC35.1	(2014) Recommendations for Prestressed Rock and Soil Anchors
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1.3 DEFINITIONS

The following definitions are in addition to those given in PTI DC35.1, Section 2.0:

1.3.1 Admixture

Substance added to the grout to either control bleed or shrinkage, improve flowability, reduce water content, or retard setting time.

1.3.2 Alignment Load (AL)

A nominal minimal load applied to an anchor during testing to keep the testing equipment correctly positioned.

1.3.3 Anchor

A system, used to transfer tensile loads to the ground (soil or rock), which includes the prestressing steel, anchorage, corrosion protection, sheathings, spacers, centralizers, and grout.

1.3.4 Anchor Grout

See Primary Grout.

1.3.5 Anchor Head

A system, used to transfer tensile loads to the ground (soil or rock), which includes the prestressing steel, anchorage, corrosion protection,

sheathings, spacers, centralizers, and grout.

1.3.6 Anchor Nut

The threaded device that transfers the prestressing force in a bar to a bearing plate.

1.3.7 Anchorage

The combined system of anchor head, bearing plate, trumpet, and corrosion protection that is capable of transmitting the prestressing force from the prestressing steel to the surface of the ground or the supported structure.

1.3.8 Anchorage Cover

A cover to protect the anchorage from corrosion and physical damage.

1.3.9 Apparent Free Tendon Length

The length of tendon which is apparently not bonded to the surrounding grout or ground, as calculated from the elastic load extension data during testing.

1.3.10 Bearing Plate

A steel plate under the anchor head that distributes the prestressing force to the anchored structure.

1.3.11 Bond Length

The length of the tendon that is bonded to the primary grout and capable of transmitting the applied tensile load to the surrounding soil or rock.

1.3.12 Bond Breaker

A sleeve placed over the anchor tendon in the free stressing length to ensure unobstructed elongation of the tendon during stressing.

1.3.13 Centralizer

A device to support and position the tendon in the drill hole so that a minimum grout cover is provided.

1.3.14 Coarse-Grained Soils

Soils with more than 50 percent, by weight of material larger than the No. 200 sieve size.

1.3.15 Cohesive Soils

Soils that exhibit plasticity. Atterberg limits are commonly used to determine plasticity and better define a soil as cohesive or non-cohesive.

1.3.16 Consolidation Grout

Portland cement grout that is injected into the hole prior to inserting the tendon to either reduce the permeability of the rock surrounding the hole or improve the ground conditions.

1.3.17 Construction Quality Assurance (CQA) Inspector

The person or firm responsible for construction quality assurance (CQA) testing, monitoring, and other duties related to assuring the quality of construction and adherence to the Contract drawings and specifications.

1.3.18 Contract Drawings

The approved plans, profiles, typical cross sections, working drawings, and supplemental drawings which show the location, dimensions, and details of the work to be done.

1.3.19 Corrosion Inhibiting Compound

Material used to protect against corrosion and lubricate the prestressing steel.

1.3.20 Creep Movement

The movement that occurs during the creep test of an anchor under a constant load.

1.3.21 Creep Test

A test to determine the movement of the ground anchor at a constant load.

1.3.22 Factored Design Load (FDL)

Anticipated final maximum factored load in the anchor after allowance for time- dependent losses or gains. The factored design load includes appropriate load factors to ensure that the overall structure has adequate capacity for its intended use.

1.3.23 Elastic Movement

The recoverable movement measured during an anchor test.

1.3.24 Encapsulation

A corrugated or deformed tube protecting the prestressing steel against corrosion in the tendon bond length.

1.3.25 Fine Grained Soils

Soils with at least 50 percent, by weight of material smaller than the No. 200 sieve size.

1.3.26 Free Stressing (Unbonded) Length

The designed length of the tendon that is not bonded to the surrounding ground or grout during stressing.

1.3.27 Fully Bonded Anchor

Anchor in which the free stressing length without bondbreaker is grouted after stressing and so bonded to the surrounding structure or ground.

1.3.28 Lift-Off

The load (lift-off load) in the tendon which can be checked at any specified time with the use of a hydraulic jack, by lifting the anchor head off the bearing plate.

1.3.29 Lock-Off Load

The prestressing force in an anchor immediately after transferring the load from the jack to the stressing anchorage.

1.3.30 Non-Cohesive Soils

Material that is generally nonplastic.

1.3.31 Performance Test

Incremental cyclic test loading of a prestressed anchor in which the total movement of the anchor is recorded at each increment.

1.3.32 Primary Grout

Portland cement grout that is injected into the anchor hole prior to or after the installation of the anchor tendon to provide for the force transfer to the surrounding ground along the bond length of the tendon. Primary grout is also known as anchor grout.

1.3.33 Proof Test

Incremental loading of a prestressed anchor recording the total movement of the anchor at each increment.

1.3.34 Pulling Head

Temporary anchoring device behind the hydraulic jack during stressing.

1.3.35 Relaxation

The decrease of stress or load with time while the tendon is held under constant strain.

1.3.36 Residual Movement

The non-elastic (i.e., non-recoverable) movement of an anchor measured during load testing.

1.3.37 Restressable Anchor Head

An anchor head that permits the anchor load, throughout the life of the structure, to be measured by lift-off checking and adjusted by shimming, unshimming or thread- turning.

1.3.38 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits. Basalt, as referred to in these documents, is a fine-grained intrusive, igneous rock with columnar jointing such as basalt and diabase.

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1.3.39 Safety Factor

The ratio of the ultimate capacity to the working load used for the design of any component or interface.

1.3.40 Sheath

A smooth or corrugated pipe or tube protecting the prestressing steel in the free stressing length against corrosion.

1.3.41 Shop Drawings

All drawings, diagrams, illustrations, schedules, performance charts, brochures, and other data which are prepared for or by the Contractor or any subcontractor, manufacturer, supplier, or distributor and which illustrate the equipment, material, or any other matter relating to the work.

1.3.42 Spacer

A device to separate elements of a multiple-element tendon to ensure full bond development of each prestressing steel element.

1.3.43 Stressing Anchorage

See Anchorage.

1.3.44 Subcontractor

The Subcontractor is a person or firm who has a direct or indirect Contract relationship with the Contractor to perform any of the work.

1.3.45 Supplier

Any person or firm who supplies materials or equipment for the work, including fabricated to a special design, and may also be a Subcontractor.

1.3.46 Tendon

The complete anchor assembly (excluding grout) consisting of prestressing steel, corrosion protection, sheathings, and coating when required, as well as spacers and centralizers.

1.3.47 Test Load (TL)

The maximum load to which the anchor is subjected during testing.

1.3.48 Unbonded Anchor

Anchor in which the free stressing length remains permanently unbonded.

1.3.49 Working Load

Equivalent term for Design Load.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When

used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's Qualifications; G

SD-02 Shop Drawings

Working Drawings; G

SD-03 Product Data

Calibration Data; G

SD-06 Test Reports

Mill Test Reports; G

SD-07 Certificates

Certificates Of Compliance; G

SD-11 Closeout Submittals

Grouting Records; G

Ground Anchor Test Results; G

As-Built Drawings; G

1.5 QUALITY ASSURANCE

1.5.1 Construction Quality Assurance

The Construction Quality Assurance (CQA) Inspector will monitor all aspects of anchored wall construction. The CQA Inspector will perform material conformance testing as required. The Contractor must be aware of the activities required by the CQA Inspector and must account for these activities in the construction schedule. Correct all deficiencies and nonconformities identified by the CQA Inspector at no additional cost to the Owner.

1.5.2 Qualifications

~~Due to the specialized nature of the ground anchor portion of the work, the ground anchor Contractor must be pre-qualified before bidding on this work. Contractors must meet the experience criteria listed below. The Engineer will approve or reject the Contractor's qualifications within 15 calendar days after receipt of a complete qualifications submission. Additional time required due to incomplete or unacceptable submittals will not be cause for time extension or impact or delay claims. All costs associated with incomplete or unacceptable submittals must be borne by the Contractor.~~
Due to the specialized nature of the ground anchor portion of the work, the ground anchor Contractor must be pre-qualified prior to the performance of ground anchor or ground anchor related work. Contractors must meet the experience criteria listed below. The Contracting Officer will approve or reject the Contractor's qualifications within 15 calendar

days after receipt of a complete qualifications submission. Additional time required due to incomplete or unacceptable submittals will not be cause for time extension or impact or delay claims. All costs associated with incomplete or unacceptable submittals must be borne by the Contractor.

1.5.2.1 Project Experience

The ground anchor Contractor performing the work described in this Specification must have installed permanent ground anchors for a minimum of three years.

1.5.2.2 Personnel Experience

Assign an engineer to supervise the work with at least three years of experience in the design and construction of permanent anchored structures. The Contractor may not use consultants or manufacturer's representatives in order to meet the requirements of this section. Drill operators and on-site supervisors must have a minimum of one year experience installing permanent ground anchors with the Contractor's organization.

1.5.2.3 Ground Anchor Contractor Qualifications

The following must be submitted to the Owner's Representative by the ground anchor Contractor four weeks prior to the start of the work:

a. A list containing at least five projects completed within the last five years. For each project, include with this submittal, at a minimum:

- (1) name of client contact, address, and telephone number;
- (2) location of project;
- (3) Contract value; and
- (4) scheduled completion date and actual completion date for the project.

b. Resumes of the Contractor's staff. Only those individuals designated as meeting the qualification requirements must be used for the project. The Contractor cannot substitute for any of these individuals without written approval of the Owner or Owner's Engineer (Engineer).

1.5.3 Certificates of Compliance

Certificates of Compliance for the following materials, if used. The certificate must state that the material or assemblies to be provided will fully comply with the requirements of the contract.

- a. Prestressing steel, strand or bar
- b. Portland cement
- c. Prestressing hardware
- d. Bearing plates

- e. Corrosion protection system

1.5.4 Mill Test Reports

Mill test reports for the prestressing steel and bearing plate steel.

1.5.5 Calibration Data

Calibration data for each test jack, load cell, primary pressure gauge and reference pressure gauge to be used.

1.6 WORKING DRAWINGS

Prepare and submit to the Engineer for review and approval Working Drawings and a design submission describing the ground anchor system or systems intended for use. The Working Drawings and design submission must be submitted 30 working days prior to the commencement of the ground anchor work. The Working Drawings and design submission must include the following:

1.6.1 Ground Anchor Schedule

A ground anchor schedule including the following:

- a. Ground anchor number
- b. Ground anchor design load
- c. Type and size of tendon
- d. Minimum total anchor length
- e. Minimum bond length
- f. Minimum tendon bond length
- g. Minimum unbonded length

1.6.2 Ground Anchor Details

Ground anchor tendon and the corrosion protection system including the following:

- a. Ground anchor number
- b. Ground anchor design load
- c. Type and size of tendon
- d. Minimum total anchor length
- e. Minimum bond length
- f. Minimum tendon bond length
- g. Minimum unbonded length

1.7 PROJECT CLOSEOUT

Submit to the Engineer within 20 calendar days after completion of the ground anchor work a report containing the following:

- a. Prestressing steel manufacturer's mill test reports for the tendons incorporated in the installation.
- b. **Grouting records** indicating the cement type, quantity injected, and the grout pressures.
- c. **Ground anchor test results** and graphs.
- d. **As-built drawings** showing the location and orientation of each ground anchor, anchor capacity, tendon type, total anchor length, bond length, unbonded length, and tendon bond length as installed.

1.8 SITE CONDITIONS

A foundation investigation has been conducted at the site by the Government and is summarized in Geotechnical Data Report: Bonneville BN1 Old NL Bridge Geotechnical Explorations (Attachment A15). Prepared by Shannon and Wilson, dated January 2021. Data from the investigation is presented in the foundation data sheet drawings. While foundation information is representative of subsurface conditions at respective locations, local variations in the characteristics of the subsurface materials may be anticipated. Local variations which may be encountered include, but are not limited to, classification and thickness of rock strata, fractures, and other discontinuities in the rock structure, and variation in the soil classifications. Such variations will not be considered differing materially within the purview of the contract clauses, paragraph differing site conditions. The Contractor is responsible for verifying the location of all utilities that may be affected by construction or the installation of the anchors.

PART 2 PRODUCTS

- a. The Contractor must not deliver materials to the site until the Engineer has approved the submittals outlined in Paragraph SUBMITTALS.
- b. The designated storage location or locations must be protected by the Contractor from theft, vandalism, passage of vehicles, and other potential sources of damage to materials delivered to the site.
- c. Protect the materials from the elements by appropriate means. Prestressing steel strands and bars must be stored and handled in accordance with the manufacturer's recommendations and in such a manner that no damage to the component parts occurs. All steel components must be protected from the elements at all times. Cement and additives for grout must be stored under cover and protected against moisture.

2.1 ADMIXTURES

Admixtures which control bleed, improve flowability, reduce water content, and retard set may be used in the grout subject to the approval of the Engineer. Admixtures, if used, must be compatible with the prestressing steels and mixed in accordance with the manufacturer's recommendations. Expansive admixtures may only be added to the grout used for filling

sealed encapsulations, trumpets, and anchorage covers. Accelerators must not be permitted.

2.2 ANCHORAGE DEVICES

Stressing anchorages must be a combination of either a steel bearing plate with wedge plate and wedges, or a steel bearing plate with a threaded anchor nut. The steel bearing and wedge plate may also be combined into a single element. Anchorage devices must be capable of developing 95 percent of the specified minimum ultimate tensile strength (SMTS) of the prestressing steel tendon. The anchorage devices must conform to the static strength requirements of Section 3.1.6 (1) and Section 3.1.8 (1) and (2) of the PTI "Guide Specification for Post-Tensioning Materials."

2.2.1 Bearing Plate

The bearing plate must be fabricated from steel conforming to [ASTM A709/A709M](#) Grade 50 or 50W specifications.

2.2.2 Anchorage Covers

Anchorage covers must be fabricated from steel or plastic with a minimum thickness of [0.1 inch](#). The joint between the cover and the bearing plate must be watertight.

2.3 BONDBREAKER

The bondbreaker must be fabricated from a smooth plastic tube or pipe having the following properties:

- a. resistant to chemical attack from aggressive environments, grout, or corrosion inhibiting compound;
- b. resistant to aging by ultra-violet light;
- c. fabricated from material nondetrimental to the tendon;
- d. capable of withstanding abrasion, impact, and bending during handling and installation;
- e. enable the tendon to elongate during testing and stressing; and
- f. allow the tendon to remain unbonded after lock-off.

2.4 CEMENT GROUT

Type I, II, III, or V Portland cement conforming to AASHTO M85 must be used for grout. The grout must be a pumpable neat mixture of cement and water and must be stable (bleed less than 2 percent), fluid, and provide a minimum 28 day compressive strength of at least [4,000 psi](#) measured in accordance with [ASTM C109/C109M](#) at time of stressing.

2.5 CENTRALIZERS

- a. Centralizers must be fabricated from plastic, steel or material which is nondetrimental to the prestressing steel. Wood must not be used. The centralizer must be able to support the tendon in the drill hole and position the tendon so a minimum of [0.5 inch](#) of grout cover is provided and must permit grout to freely flow around the tendon and

up the drill hole.

b. Centralizers are not required on pressure injected anchors installed in coarse grained soils when the grouting pressure exceeds **150 psi**, nor on hollow stem-augered anchors when they are grouted through the auger with grout having a slump of **9 inches** or less.

2.6 CORROSION INHIBITING COMPOUND

The corrosion inhibiting compound placed in either the free length or the trumpet area must be an organic compound (i.e., grease or wax) with appropriate polar moisture displacing, corrosion inhibiting additives and self-healing properties. The compound must permanently stay viscous and be chemically stable and nonreactive with the prestressing steel, the sheathing material, and the anchor grout.

2.7 GROUT TUBES

Grout tubes must have an adequate inside diameter to enable the grout to be pumped to the bottom of the drill hole. Grout tubes must be strong enough to withstand a minimum grouting pressure of **150 psi**. Postgrout tubes must be strong enough to withstand postgrouting pressures.

2.8 HEAT SHRINKABLE SLEEVES

Heat shrinkable sleeves must be fabricated from a radiation crosslinked polyolefin tube internally coated with an adhesive sealant. Prior to shrinking, the tube must have a nominal wall thickness of 0.6 mm. The adhesive sealant inside the heat shrinkable tube must have a nominal thickness of 0.5 mm.

2.9 PRESTRESSING STEEL

Ground anchor tendons must consist of epoxy coated reinforcing steel bars conforming to **ASTM A775/A775M** and be fabricated from single elements.

2.10 SHEATH

A sheath must be used as part of the corrosion protection system for the unbonded length portion of the tendon. The sheath must be fabricated from one of the following:

- a. A polyethylene tube pulled or pushed over the prestressing steel. The polyethylene must be Type II, III or IV as defined by **ASTM D1248** (or approved equal). The tubing must have a minimum wall thickness of 1.5 mm.
- b. A hot-melt extruded polypropylene tube. The polypropylene must be cell classification B55542-11 as defined by **ASTM D4101** (or approved equal). The tubing must have a minimum wall thickness of 1.5 mm.
- c. A hot-melt extruded polyethylene tube. The polyethylene must be high density Type III as defined by **ASTM D1248** (or approved equal). The tubing must have a minimum wall thickness of 1.5 mm.
- d. Steel tubing conforming to **ASTM A500/A500M**. The tubing must have a minimum wall thickness of 5 mm.
- e. Steel pipe conforming to **ASTM A53/A53M**. The pipe must have a

minimum wall thickness of 5 mm.

f. Plastic pipe or tube of PVC conforming to [ASTM D1784](#) Class 13464-B. The pipe or tube must be Schedule 40 at a minimum.

g. A corrugated tube conforming to the requirement of the tendon bond length encapsulation.

2.11 SPACERS

Spacers must be used to separate elements of a multi-element tendon and must permit grout to freely flow around the tendon and up the drill hole. Spacers must be fabricated from plastic, steel or material which is nondetrimental to the prestressing steel. Wood must not be used. A combination centralizer-spacer may be used.

2.12 TENDON BOND LENGTH ENCAPSULATIONS

When the Contract drawings require the tendon bond length to be encapsulated to provide additional corrosion protection, the encapsulation must be fabricated from one of the following:

a. High density corrugated polyethylene tubing conforming to the requirements of [AASHTO M 252](#) and having a minimum wall thickness of 1.5 mm except pregrouted tendons which may have a minimum wall thickness of 1.0 mm.

b. Deformed steel tubing or pipes conforming to [ASTM A192/A192M](#) or [ASTM A500/A500M](#) with a minimum wall thickness of 5 mm.

c. Corrugated, polyvinyl chloride tubes manufactured from rigid PVC compounds conforming to [ASTM D1784](#), Class 13464-B.

d. Fusion-bonded epoxy conforming to the requirements of [ASTM A775/A775M](#).

2.13 WATER

Water for mixing grout must be potable, clean, and free of injurious quantities of substances known to be harmful to Portland cement or prestressing steel.

PART 3 EXECUTION

3.1 PERFORMANCE CRITERIA

a. The tendon must be sized so the design load does not exceed 60 percent of the specified minimum tensile strength (SMTS) of the prestressing steel. The lock-off load for the tendon must be chosen based on anticipated time or activity dependent load changes, but must not exceed 70 percent of the SMTS of the prestressing steel. The prestressing steel must be sized so the maximum test load does not exceed 80 percent of the SMTS of the prestressing steel.

b. The Contractor must be responsible for determining the bond length necessary to develop the design load indicated on the Contract Drawings or the approved Working Drawings. The minimum bond length must be [15 feet](#) for strand tendons in rock and [10 feet](#) for bar tendons in rock. The minimum bond length must [15 feet](#) for strand and bar

tendons in soil. The minimum tendon bond length must be 10 feet.

c. The free stressing length (unbonded length) for rock and soil anchors must not be less than 10 feet for bar tendons and 10 feet for strand tendons.

3.2 CORROSION PROTECTION

Corrosion protection requirements must be determined by the Owner and must be shown on the Contract drawings. The corrosion protection systems must be designed and constructed to provide reliable ground anchors for temporary and permanent structures.

3.2.1 Anchorage Protection

All stressing anchorages permanently exposed to the atmosphere must be grout-filled cover, except, for restressable anchorages, a corrosion inhibiting compound must be used. Stressing anchorages encased in concrete at least 2 inches thick do not require a cover.

3.2.2 Unbonded Length Protection

a. Corrosion protection of the unbonded length must be provided by a combination of sheaths, sheath filled with a corrosion inhibiting compound or grout, or a heat shrinkable tube internally coated with a mastic compound, depending on the tendon class. The corrosion inhibiting compound must completely coat the tendon elements and fill the void between them and the sheath. Provisions must be made to retain the compound within the sheath.

b. The corrosion protective sheath surrounding the unbonded length must not come into contact with the stressing anchorage during testing. Any excessive protection length must be trimmed off.

c. For pregrouted encapsulations and all Class I tendons, a separate bondbreaker or common sheath must be provided for supplemental corrosion protection or to prevent the tendon from bonding to the grout surrounding the unbonded length.

3.3 UNBONDED LENGTH/BOND LENGTH TRANSITION

The transition between the corrosion protection for the bonded and unbonded lengths must be designed and fabricated to ensure continuous protection from corrosive attack.

3.4 TENDON BOND LENGTH PROTECTION FOR GROUT PROTECTED TENDONS (CLASS II)

Cement grout can be used to protect the tendon bond length in non-aggressive ground when the installation methods ensure that the grout will remain fully around the tendon. The grout must overlap the sheathing of the unbonded length by at least 1 inch. Centralizers or grouting techniques must ensure a minimum of 0.5 inch of grout cover over the tendon bond length.

3.5 TENDON BOND LENGTH PROTECTION FOR ENCAPSULATED TENDONS (CLASS I)

A grout-filled, corrugated plastic encapsulation or a grout-filled, deformed steel tube must be used. The prestressing steel can be grouted inside the encapsulation prior to inserting the tendon into the drill hole

or after the tendon has been placed. Centralizers or grouting techniques must ensure a minimum of 0.5 inch of grout cover over the encapsulation.

3.6 EPOXY (CLASS I)

Fusion-bonded epoxy may be used to provide a layer of protection for the steel tendon in addition to the cement grout.

3.7 TENDON STORAGE AND HANDLING

a. Tendons must be handled and stored in such a manner as to avoid damage or corrosion. Damage to the prestressing steel, the corrosion protection, or the epoxy coating as a result of abrasions, cuts, nicks, welds and weld splatter will be cause for rejection by the Engineer. The prestressing steel must be protected if welding is to be performed in the vicinity. Grounding of welding leads to the prestressing steel is forbidden. Prestressing steel must be protected from dirt, rust, or deleterious substances. A light coating of rust on the steel is acceptable. If heavy corrosion or pitting is noted, the Engineer must reject the affected tendons.

b. Use care in handling and storing the tendons at the site. Prior to inserting a tendon in the drill hole, the Contractor and the CQA Inspector must examine the tendon for damage to the encapsulation and the sheathing. If, in the opinion of the CQA Inspector, the encapsulation is damaged, repair the encapsulation in accordance with the tendon supplier's recommendations. If, in the opinion of the CQA Inspector, the smooth sheathing has been damaged, repair it with ultra high molecular weight polyethylene tape. The tape should be spiral wound around the tendon to completely seal the damaged area. The pitch of the spiral must ensure a double thickness at all points

c. Banding for fabricated tendons must be padded to avoid damage to the tendon corrosion protection. Upon delivery, the fabricated anchors or the prestressing steel for fabrication of the tendons on site and all hardware must be stored and handled in such a manner to avoid mechanical damage, corrosion, and contamination with dirt or deleterious substances. Lifting of the pre-grouted tendons must not cause excessive bending, which can debond the prestressing steel from the surrounding grout. Prestressing steel must not be exposed to excessive heat (i.e., more than 230 degrees C).

3.8 ANCHOR FABRICATION

Anchors must be either shop or field fabricated from materials conforming to Part 2 of this specification and as shown in the approved Working Drawings. Prestressing steel must be cut with an abrasive saw or, with the approval of the prestressing steel supplier, an oxyacetylene torch. All of the tendon bond length, especially for strand, must be free of dirt, manufacturers' lubricants, corrosion-inhibitive coatings, or other deleterious substances that may significantly affect the grout-to-tendon bond or the service life of the tendon. Pregrouting of encapsulated tendons must be done on an inclined, rigid frame or bed by injecting the grout from the low end of the tendon.

3.9 DRILLING

a. Drilling methods must be left to the discretion of the Contractor, whenever possible. The Contractor must be responsible for using a

drilling method to establish a stable hole of adequate dimensions, within the tolerances specified. Drilling methods may involve, amongst others, rock coring, rotary, percussion, rotary/percussive or auger drilling; or percussive or vibratory driven casing.

b. Holes for anchors must be drilled at the locations and to the length, inclination and diameter shown on the Contract Drawings or the approved Working Drawings. The drill bit or casing crown must not be more than **0.1 inch** smaller than the specified hole diameter. At the ground surface the drill hole must be located within **6 inches** of the location shown on the Contract Drawings or the approved Working Drawings. The drill hole must be located so the longitudinal axis of the drill hole and the longitudinal axis of the tendon are parallel. In particular, the ground anchor hole must not be drilled in a location that requires the tendon to be bent in order to enable the bearing plate to be connected to the supported structure. At the point of entry the ground anchor must be installed within plus/minus 3 degrees of vertical.

3.10 TENDON INSERTION

a. Tendons must be placed in accordance with the Contract Drawings and details and the recommendations of the tendon manufacturer or specialist anchor contractor. The tendon must be inserted into the drill hole to the desired depth without difficulty. When the tendon cannot be completely inserted, the Contractor must remove the tendon from the drill hole and clean or redrill the hole to permit insertion. Partially inserted tendons must not be driven or forced into the hole.

b. Each anchor tendon must be inspected by field personnel during installation into the drill hole or casing. Damage to the corrosion protection system must be repaired, or the tendon replaced if not repairable. Loose spacers or centralizers must be reconnected to prevent shifting during insertion. Damaged fusion-bonded epoxy coatings must be repaired in accordance with the manufacturer's recommendations. If the patch is not allowed to cure prior to inserting the tendon in the drill hole, the patched area must be protected by tape or other suitable means.

c. The rate of placement of the tendon into the hole must be controlled such that the sheathing, coating, and grout tubes are not damaged during installation of the tendon. Anchor tendons must not be subjected to sharp bends. The bottom end of the tendon may be fitted with a cap or bullnose to aid its insertion into the hole, casing, or sheathing.

3.11 GROUTING

a. Use a neat cement grout or a sand-cement grout. The cement must not contain lumps or other indications of hydration. Admixtures, if used, must be mixed in accordance with the manufacturer's recommendations. The grouting equipment must produce a grout free of lumps and undispersed cement. A positive displacement grout pump must be used. The pump must be equipped with a pressure gauge to monitor grout pressures. The pressure gauge must be capable of measuring pressures of at least **150 psi** or twice the actual grout pressures used by the Contractor, whichever is greater. The grouting equipment must be sized to enable the grout to be pumped in one continuous

operation. The mixer should be capable of continuously agitating the grout. The grout must be injected from the lowest point of the drill hole. The grout may be pumped through grout tubes, casing, hollow-stem-augers, or drill rods. The grout can be placed before or after insertion of the tendon. The quantity of the grout and the grout pressures must be recorded. The grout pressures and grout takes must be controlled to prevent excessive heave or fracturing.

b. After the tendon is installed, the drill hole may be filled in one continuous grouting operation except that pressure grouting must not be used in the free length zone. If grout protected tendons are used for ground anchors anchored in rock, then pressure grouting techniques must be utilized. Pressure grouting requires that the drill hole be sealed and that the grout be injected until a minimum 50 psi grout pressure (measured at the top of the drill hole) can be maintained on the grout for at least five minutes. The grout tube may remain in the hole on completion of grouting if the tube is filled with grout. After grouting, the tendon must not be loaded for a minimum of three days.

3.12 ANCHORAGE INSTALLATION

The anchor bearing plate and the anchor head or nut must be installed perpendicular to the tendon, within plus/minus three degrees and centered on the bearing plate, without bending or kinking of the prestressing steel elements. Wedge holes and wedges must be free of rust, grout, and dirt. The stressing tail must be cleaned and protected from damage until final testing and lock-off. After the anchor has been accepted by the Engineer, the stress tail must be cut to its final length according to the tendon manufacturer's recommendations. The corrosion protection surrounding the unbonded length of the tendon must not contact the bearing plate or the anchor head during testing and stressing. If the protection is too long, the Contractor must trim the corrosion protection to prevent contact.

3.13 STRESSING, LOAD TESTING, AND ACCEPTANCE

Each ground anchor must be tested. No load greater than 10 percent of the design load can be applied to the ground anchor prior to testing. The maximum test load must be no less than the factored design load and must not exceed 80 percent of the specified minimum ultimate tensile strength (SMTS) of the prestressing steel of the tendon. The test load must be simultaneously applied to the entire tendon. Stressing of single elements of multi-element tendons must not be permitted.

3.13.1 Stressing Equipment

The stressing equipment, the sequence of stressing and the procedure to be used for each stressing operation must be determined at the planning stage of the project. The equipment must be used strictly in accordance with the manufacturer's operating instructions. Stressing equipment must preferably be capable of stressing the whole tendon in one stroke to the specified Test Load and the equipment must be capable of stressing the tendon to the maximum specified Test Load within 75 percent of the rated capacity. The pump must be capable of applying each load increment in less than 60 seconds. The equipment must permit the tendon to be stressed in increments so that the load in the tendon can be raised or lowered in accordance with the test specifications, and allow the anchor to be lift-off tested to confirm the lock-off load. Stressing equipment must be recently calibrated within an accuracy of plus or minus 2 percent prior to

use. The calibration certificate and graph must be available on site at all times. The calibration must be traceable to the National Institute of Standards and Technology (NIST).

3.13.2 Testing Equipment

The testing equipment must consist of:

- a. A dial gauge or vernier scale capable of measuring to the nearest **0.001 inch** must be used to measure the ground anchor movement. The movement-measuring device must have a minimum travel equal to the theoretical elastic elongation of the total anchor length at the maximum test load and it must have adequate travel so the ground anchor movement can be measured without resetting the device at an interim point.
- b. A hydraulic jack and pump must be used to apply the test load. The jack and a calibrated primary pressure gauge must be used to measure the applied load. The jack and primary pressure gauge must be calibrated by an independent firm as a unit. The calibration must have been performed within 45 working days of the date when the calibration submittals are provided to the Engineer. Testing cannot commence until the Engineer has approved the calibration. The primary pressure gauge must be graduated in **100 psi** increments or less. The ram travel must be at least **6 inches** and preferably not be less than the theoretical elongation of the tendon at the maximum test load. If elongations greater than **6 inches** are required, restroking can be allowed.
- c. A calibrated reference pressure gauge must also be kept at the site to periodically check the production (i.e., primary pressure) gauge. The reference gauge must be calibrated with the test jack and primary pressure gauge. The reference pressure gauge must be stored indoors and not subjected to rough treatment.
- d. Provide an electrical resistance load cell and readout to be used when performing an extended creep test.
- e. The stressing equipment must be placed over the ground anchor tendon in such a manner that the jack, bearing plates, load cells and stressing anchorage are axially aligned with the tendon and the tendon is centered within the equipment.

3.13.3 Load Testing Setup

Dial gauges must bear on the pulling head of the jack and their stems must be coaxial with the tendon direction. The gauges must be supported on an independent, fixed frame, such as a tripod, which will not move as a result of stressing or other construction activities during the operation. Prior to setting the dial gauges, the Alignment Load (AL) must be accurately placed on the tendon. The magnitude of AL depends on the type and length of the tendon. Regripping of strands, which would cause overlapping wedge bites, or wedge bites on the tendon below the anchor head, must be avoided. Stressing and testing of multiple element tendons with single element jacks is not permitted. Stressing must not begin before the grout has reached adequate strength.

3.13.4 Performance Tests

a. One performance test must be performed on a sacrificial ground anchor that is not located at a permanent ground anchor location and in accordance with the procedures described below. Sacrificial ground anchor for performance testing must be located within the excavation limits for Bent 2 and within prepared rock foundation surface. Sacrificial ground anchor for performance testing must be located a minimum distance of **5 feet** from any permanent ground anchor location. All permanent ground anchors must be tested in accordance with the proof test procedures.

b. The performance test must be made by incrementally loading and unloading the ground anchor in accordance with the schedule provided. The load must be raised from one increment to another immediately after recording the ground anchor movement. The ground anchor movement must be measured and recorded to the nearest **0.001 inch** with respect to an independent fixed reference point at the alignment load and at each increment of load. The load must be monitored with the primary pressure gauge. The reference pressure gauge must be placed in series with the primary pressure gauge during each performance test. If the load determined by the reference pressure gauge and the load determined by the primary pressure gauge differ by more than 10 percent, the jack, primary pressure gauge and reference pressure gauge must be recalibrated at no expense to the Owner. At load increments other than the maximum test load, the load must be held just long enough to obtain the movement reading.

c. The maximum test load in a performance test must be held for 10 minutes. A load cell must be used to monitor small changes in load during constant load-hold periods.

d. The jack must be adjusted as necessary in order to maintain a constant load. The load-hold period must start as soon as the maximum test load is applied and the ground anchor movement, with respect to a fixed reference, must be measured and recorded at one minute, two, three, four, five, six and 10 minutes. If the ground anchor movement between one minute and 10 minutes exceeds one mm, the maximum test load must be held for an additional 50 minutes. If the load hold is extended, the ground anchor movement must be recorded at 15 minutes, 20, 30, 40, 50 and 60 minutes.

STEPS FOR THE PERFORMANCE TEST					
Step	Loading	Applied Load	Record and Plot Total Movement ₍₁₎	Record and Plot Residual Movement ₍₂₎	Calculate Elastic Movement ₍₃₎
1	Apply alignment load (AL)				
2	Cycle 1	0.2FDL		N/A	
		AL	N/A		

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STEPS FOR THE PERFORMANCE TEST					
3	Cycle 2	0.2FDL		N/A	
		0.4FDL		N/A	
		AL	N/A		
4	Cycle 3	0.2FDL		N/A	
		0.4FDL		N/A	
		0.6FDL		N/A	
		AL	N/A		
5	Cycle 4	0.2FDL		N/A	
		0.4FDL		N/A	
		0.6FDL		N/A	
		0.8FDL		N/A	
		AL			
6	Cycle 5	0.2FDL		N/A	
		0.4FDL		N/A	
		0.6FDL		N/A	
		0.8FDL		N/A	
		1.0FDL		N/A	
		AL	N/A		
7	Hold load for 10 minutes while recording movement at specified times. If the total movement measured during the load hold exceeds the specified maximum value then the load hold should be extended to a total of 60 minutes.				
8	Cycle 5 cont'd.	AL			
Notes: AL: Alignment Load FDL: Factored Design Load (1): Record and plot total movement for each Cycle at each applied load (0.2FDL, 0.4FDL, etc.). After final applied load during Cycle 5 (1.0FDL) zero total movement reading for creep test. (2): Record and plot residual movement for each Cycle after unloading to AL. (3): Elastic movement equal to total movement recorded at final applied load minus residual movement recorded at AL.					

3.13.5 Proof Tests

a. The proof test must be performed by incrementally loading the ground anchor in accordance with the following schedule. The load must be raised from one increment to another immediately after recording the ground anchor movement. The ground anchor movement must be measured and recorded to the nearest 0.001 inch with respect to an independent fixed reference point at the alignment load and at each increment of load. The load must be monitored with the primary pressure gauge. At load increments other than the maximum test load, the load must be held just long enough to obtain the movement reading.

PROOF TEST SCHEDULE	
Step	Load
1	AL
2	0.2FDL
3	0.4FDL
4	0.6FDL
5	0.8FDL
6	1.0FDL
7	Reduce to lock-off load
8	AL (optional)
9	Adjust to lock-off load

b. The maximum test load in a proof test must be held for 10 minutes. The jack must be adjusted as necessary in order to maintain a constant load. The load-hold period must start as soon as the maximum test load is applied and the ground anchor movement with respect to a fixed reference must be measured and recorded at one minute, two, three, four, five, six, and 10 minutes. If the ground anchor movement between one minute and 10 minutes exceeds one mm, the maximum test load must be held for an additional 50 minutes. If the load hold is extended, the ground anchor movements must be recorded at 15 minutes, 20, 30, 40, 50 and 60 minutes.

3.13.6 Ground Anchor Acceptance Criteria

a. A performance-tested or proof-tested ground anchor with a 10 minute load hold must be acceptable if the:

- (1) ground anchor resists the maximum test load with less than one mm of movement between one minute and 10 minutes; and
- (2) total elastic movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the unbonded length.

b. A performance-tested or proof-tested ground anchor with a 60 minute load hold must be acceptable if the:

(1) ground anchor resists the maximum test load with a creep rate that does not exceed 0.1 inch in the last log cycle of time; and

(2) total elastic movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the unbonded length.

c. The initial lift-off reading must be within plus or minus 5 percent of the designed lock-off Load. If this criterion is not met, then the tendon load must be adjusted accordingly and the initial lift-off reading repeated.

3.13.7 Procedures for Anchors Failing Acceptance Criteria

a. Anchors that do not satisfy the minimum apparent free length criteria must be either rejected and replaced at no additional cost to the Owner or locked off at not more than 50 percent of the maximum acceptable load attained. In this event, no further acceptance criteria are applied.

b. Regroutable anchors which satisfy the minimum apparent free length criteria but which fail the extended creep test at the test load may be postgrouted and subjected to an enhanced creep criterion. This enhanced criterion requires a creep movement of not more than one mm between one and 60 minutes at test load. Anchors which satisfy the enhanced creep criterion must be locked off at the design lock-off load. Anchors which cannot be postgrouted or regroutable anchors that do not satisfy the enhanced creep criterion must be either rejected or locked off at 50 percent of the maximum acceptable test load attained. In this event, no further acceptance criteria are applied. The maximum acceptable test load with respect to creep must correspond to that where acceptable creep movements are measured over the final log cycle of time.

3.13.8 Anchor Lock-Off

After testing has been completed, the load in the tendon must be such that after seating losses (i.e., wedge seating), the specified lock-off load has been applied to the anchor tendon. The magnitude of the lock-off load must be specified by the Engineer, and must not exceed 70 percent Fpu. The wedges must be seated at a minimum load of 50 percent Fpu. If the lock-off load is less than 50 percent Fpu, shims must be used under the wedge plate and the wedges seated at 50 percent Fpu. The shims must then be removed to reduce the load in the tendon to the desired lock-off load. Bar tendons may be locked off at any load less than 70 percent Fpu.

3.13.9 Anchor Lift-Off Test

After transferring the load to the anchorage, and prior to removing the jack, a lift-off test must be conducted to confirm the magnitude of the load in the anchor tendon. This load is determined by reapplying load to the tendon to lift off the wedge plate (or anchor nut) without unseating the wedges (or turning the anchor nut). This moment represents zero time for any long time monitoring.

-- End of Section --

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SECTION 31 73 20.00 99

JET GROUTING

PART 1 GENERAL

1.1 SCOPE

a. This Section specifies requirements for furnishing all labor, equipment, materials, and supplies necessary for soil stabilization by jet grouting and associated testing, monitoring, sampling, and recording as required to reduce potential for lateral spreading, and seismic slope instability.

b. The work consist of installation, monitoring, sampling and testing of jet grouting within the limits indicated on drawings.

c. In connection with the jet grouting program, as shown on drawings, the Contractor must provide all labor, materials and equipment to accomplish the following items of work:

- (1) Mobilization and Demobilization.
- (2) Test program.
- (3) Drilling.
- (4) Jet Grouting.
- (5) Quality Assurance/Quality Control and verification.
- (6) Spoil containment, collection, and disposal.

d. The Contractor is responsible for selection of jet-grouting parameters, equipment, and construction of the jet-grout columns to meet the design intent.

1.2 PROJECT OBJECTIVES

Construction of soil cement enclosed cells consisting of overlapping jet grout columns in multiple rows, with the following characteristics:

- a. Ground Improvement Limits: As shown on drawings.
- b. Minimum Jet-Grout Column Diameter: 4 feet.
- c. Minimum Overlap Thickness: 1/8 of the column diameter or 6 inches, whichever is greater.
- d. Minimum 28 day Unconfined Compressive Strength (UCS): 400 pounds per square inch (psi).
- e. Top Elevation of Jet-Grout Columns: As shown on drawings.
- f. Bottom Elevation of Jet-Grout Columns: The jet-grout columns must extend to the top of Pre-Slide Alluvium, where the top of the layer

will be determined by the Owner's Representative in the field. Top of Pre-Slide Alluvium estimated to be at elevation -45 feet.

1.3 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM C192/C192M	(2019) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM D422	(1963; R 2007; E 2014; E 2014) Particle-Size Analysis of Soils
ASTM D1140	(2017) Standard Test Methods for Determining the Amount of Material Finer than 75- μ m (No. 200) Sieve in Soils by Washing
ASTM D2166	(2000; R 2017) Standard Test Method for Unconfined Compressive Strength of Cohesive Soil
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.4 DEFINITIONS

1.4.1 Jet Grouting

An in situ injection technique employed with specialized equipment that includes grout pump(s), grout mixer, drill rig, drill rods, and injection monitor with horizontal radial nozzles delivering high velocity fluids to erode, mix, and stabilize in situ soils using an engineered grout slurry.

1.4.2 Single Fluid Jet Grouting

The jet-grouting technique where a single fluid, typically neat cement grout, is injected at high velocity through horizontal radial nozzle(s) to directly erode, and mix with, the in situ soil.

1.4.3 Double Fluid Jet Grouting

The jet-grouting technique where one fluid, typically neat cement grout, is injected at high velocity through horizontal radial nozzle(s) and is assisted by a second fluid, typically air, delivered through a coaxial nozzle(s), to directly erode and mix with the in situ soil.

1.4.4 Triple Fluid Jet Grouting

The jet-grouting technique where one fluid, typically water, is injected at high velocity through horizontal radial nozzle(s) and is assisted by a second fluid, typically air delivered through a coaxial nozzle(s), to erode the in situ soil, while a separate nozzle placed lower on the

monitor delivers a third fluid, typically neat cement grout, at lower velocity to simultaneously fill the soil zone eroded by the cutting fluids (air and water).

1.4.5 Monitor (adjusted for single, double, and triple systems)

A single, double, or triple fluid drill pipe attached to the end of a drilling string and designed to deliver one to three elements of the jet-grouting process, typically air, water, and grout. The monitor has one or more injection points (nozzles).

1.4.6 Jet-Grouting Supervisor

The individual on site who is in responsible charge for the jet-grouting work.

1.4.7 Binder

Chemically reactive material (i.e., lime, cement, gypsum, blast furnace slag, fly ash, or other hardening reagents) that can be used for mixing with in situ soils to strengthen the soils and form jet grout columns. Also referred to as stabilizer or reagent. Binder slurry is frequently referred to as grout or slurry.

1.4.8 Soil-Cement

Mixture of grout slurry and in situ soils formed by the jet-grouting process.

1.4.9 Soil-Cement Element

A column, or panel (planar shape), of soil-cement formed by jet grouting, used as a component of a soil-cement structure.

1.4.10 Jet-Grouting Parameters

Pressure of the fluid(s) within the jet-grouting string; flow rate of the fluid(s); grout composition; rotational speed of the jet grouting string; and rate of withdrawal or insertion of the jet grouting string.

1.4.11 Jet-Grouting String

Jointed rods with simple, double or triple inner conduit that conveys the jet-grouting fluid(s) to the monitor.

1.4.12 Prejetting, Precutting or Prewashing

The method in which the jet grouting of an element is facilitated by a preliminary disaggregation phase consisting of jetting with water and other fluids.

1.4.13 Fresh-in-Fresh Sequence

Method that involves jet-grouting elements successively without waiting for the grout to harden in the overlapping elements.

1.4.14 Primary-secondary Sequence

Method in which installation of an overlapping element cannot commence

before a specified hardening time or achievement of predetermined strength of the adjacent previously constructed elements(s).

1.4.15 Spoil Return

All materials including, but not limited to liquids, semi-solids, and solids, which are discharged above ground surface during, or as a result of jet grouting.

1.4.16 UCS

Unconfined Compressive Strength at 28 days.

1.5 AVAILABLE INFORMATION

Available information developed by the Owner or by the Owner's duly authorized representative (engineer) includes the following items:

Bonneville Lock and Dam Subsurface Investigation and Liquefaction Analysis: Subsurface Investigation Report. Prepared by INCA/Anderson Perry Joint Venture, dated April 2017 (Attachment A14).

1.6 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor Qualifications; G

Field Demonstration Test Program; G

Installation Details; G

Work Procedures Plan; G

Jet Grout Spoil Return Management Plan; G

Containment, Treatment, And Disposal Plan; G

Quality Assurance, Quality Control And Verification Procedures; G

SD-03 Product Data

Equipment Data; G

Field Data Collection Forms; G

Tabular And Graphical Data Presentations; G

SD-06 Test Reports

Bench-Scale Testing Report; G

SD-09 Manufacturer's Field Reports

Daily Reports

SD-11 Closeout Submittals

As-Built Field Measurement Data; G

1.7 QUALITY CONTROL

1.7.1 Qualifications

~~Due to the specialized nature of the jet grouting portion of the work, the Jet Grouting Contractor must be pre-qualified before bidding on this work. Contractors must meet the experience criteria listed below. The Engineer will approve or reject the Contractor's qualifications within 15 calendar days after receipt of a complete qualification's submission. Additional time required due to incomplete or unacceptable submittals will not be cause for time extension or impact or delay claims. All costs associated with incomplete or unacceptable submittals must be borne by the Contractor.~~

Due to the specialized nature of the jet grouting portion of the work, the Jet Grouting Contractor must be pre-qualified prior to the performance of jet grouting or jet grouting related work. Contractors must meet the experience criteria listed below. The Contracting Officer will approve or reject the Contractor's qualifications within 15 calendar days after receipt of a complete qualifications submission. Additional time required due to incomplete or unacceptable submittals will not be cause for time extension or impact or delay claims. All costs associated with incomplete or unacceptable submittals must be borne by the Contractor.

1.7.1.1 Project Experience

The Jet Grouting Contractor must have at least three years' jet grouting experience; and must have completed at least five jet-grouting projects with at least 15,000 cubic yards of total treatment volume in Jet Grouting construction with at least two projects where a minimum of 5,000 cubic yards of Jet Grouting columns in a gridded treatment pattern was completed (Contractor to provide the number of years/projects, project description(s), volume of Jet Grout treatment, and reference list for each of at least five representative projects).

1.7.1.2 Personnel Experience

The Jet Grouting Contractor's personnel assigned to this Project to design and manage the work (specifically this Project), must have at least five years' jet grouting experience over the last 10 years; and have completed at least five jet-grouting projects, with at least two projects having objectives and jet-grouting system (single, double or triple) similar to those of this Project and in the same type of soil.

1.7.1.3 Supervisor Experience

The Contractor's Jet Grouting Supervisor must have at least five years' on site experience managing jet grouting field operations of similar size and scope, and must have supervised at least two projects within the past three years employing the jet grouting technique proposed for this project. The supervisor must have experience and knowledge of all aspects of jet grouting as required for the project and must be present at the work site at all times during jet-grouting operations.

1.7.1.4 Jet Grouting Contractor Qualifications

The following must be submitted to the Owner's Representative by the Jet Grouting Contractor four weeks prior to the start of the work:

- a. A list of at least five previously completed projects for review by the Owner's Representative. The list must include a description of the project, project location, scope of work, total jet grouting performed in cubic yards, depths of jet grouting, size of jet grout columns, and contact person with phone number.
- b. A list of at least two previously completed projects of similar scope and purpose for review by the Owner's Representative. The list must include a description of the project, relative size, and contact person with phone number.
- c. Resumes of the management, supervisory, and key personnel, for approval by the Owner's representative, in accordance Paragraph QUALIFICATIONS.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Existing Conditions

- a. Prior to submitting a bid price for the jet grouting, conduct a site inspection to assess the site geometry, equipment access conditions, staging area location and conditions, location of existing structures, and above-ground utilities and facilities; and review available subsurface information (including all geotechnical engineering and data reports).
- b. The Contractor will be responsible for making arrangements to have below ground utilities field located.
- c. Field locate and verify the locations of all utilities prior to starting work. Maintain uninterrupted service for those utilities designated to remain in service throughout the work. Notify the Owner's Representative of any utility locations different from those shown on drawings that may require relocation of jet-grout columns or structure design modification. Subject to the Owner's Representative's approval, the Contractor will be compensated for additional costs of column relocation and structure design modifications resulting from utility locations different from those shown on drawings.

PART 2 PRODUCTS

2.1 EQUIPMENT

- a. Submit equipment data to the Owner's Representative four weeks prior to the start of the work. Equipment data submitted must include catalog cuts, details of grout mixers, pumps, drill rigs, and a plan view of the jet-grouting equipment arrangement, noting any equipment that has been modified or is of unique construction. Submit copies of field data collection forms, including a sample copy of daily field report as described in Paragraph DAILY REPORTS.
- b. All equipment used for drilling boreholes; lowering, raising and rotating jet monitors; mixing grout; supplying pressurized grout and

air-water to jet monitors; and jet monitors must have proven performance records for use in jet grouting work, as demonstrated by the information to be submitted under Paragraph DEFINITIONS.

c. Spare parts and equipment must be available on site to maintain jet grouting equipment in satisfactory operational condition at all times during execution of the jet grouting work.

2.1.1 Drilling Equipment

Use drilling equipment of a type and capacity suitable for drilling required hole diameters and depths, and lowering, raising, and rotating jet grout monitors to the depths and at the rates required to perform the work as shown on the Contract drawings and as specified herein. The drill rig must be equipped with automated controls to regulate and maintain consistent rod retraction rate, and rod RPM and have pressure gauges for all fluids injected.

2.1.2 Drill Bit and Drill String

Use drill bits and tooling appropriate for the given conditions so as to reach the design depths shown on drawings and specified.

2.1.3 Grout Mixing and Injection Equipment

Use grout mixers and holding tanks, water tanks, air compressors, and pumps of sufficient capacity to ensure adequate supply of grout, air, and water at required pressure to the jet grouting monitors during a full work shift to produce jet grout elements of the quality and dimensions necessary.

2.1.4 Jet Grouting Pump

Must be capable, with the nozzles proposed, of providing the required velocity and a delivery rate adequate for the execution of the work.

2.1.5 Compressor (for Double and Triple Jet Grouting)

Must be capable of producing the pressure and to deliver the flow rate values proposed by the Contractor depending on the parameters chosen.

2.1.6 Filling Grout Pump (for Triple Jet Grouting)

Must be capable of producing the pressure and to deliver the flow rate values proposed by the Contractor depending on the parameter chosen.

2.1.7 Jet Grout Tools

Use jet grouting monitors with appropriate nozzles with the capacity suitable for producing jet-grout elements in the soil types identified during Subsurface Explorations performed at the site, and of the size and depth shown on drawings and as specified herein. The drill hole diameter must be sufficiently large to be a clear path for continuous spoil return during all jetting operations.

2.1.8 Equipment Instrumentation

Provide instrumentation that allows continuous monitoring and automatic recording of data throughout the jet-grouting operations. As a minimum,

the following must be provided versus depth:

- a. Pressure gauges/devices at the drilling rig to automatically record pressures of cement grout, water, and air during the grouting process.
- b. Flow meter(s) to monitor and record the rate and total volume of grouting fluids through the grouting monitor at every element.
- c. Devices that automatically monitor and record the rate of monitor rotation and withdrawal.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

2.2.1 Bench-Scale Testing

Submit a [bench-scale testing report](#) of the results from bench-scale tests conducted a minimum of four weeks prior to the start of the work. The report must provide all data collected, including, at a minimum, descriptions of sampling techniques used, boring logs, classifications of all major soil strata to be mixed, site groundwater conditions, binder materials used, mixed design proportions, laboratory mixing techniques used, and curing curves for unconfined compressive strength versus time for each major soil type. Discussion of tests results must be provided, including proposed mix designs for use in the field. If the Contractor intends to deviate from the equipment defined in Paragraph EQUIPMENT, submit evidence of satisfactory use of the proposed material from past projects with similar soil conditions.

2.2.1.1 Bench-Scale Testing Criteria

Laboratory bench-scale testing must be used to identify initial mix designs for use in the test program. Bulk soil samples from the site, and representative of site soil condition must be obtained by the Contractor. A set of three different mix designs is required for each major soil stratum encountered to the expected termination depth of the jet grout elements. Record the location and depth of the soil collected for the bench-scale testing. For each bulk sample collected complete and provide results for minimum of two particle size analyses of soil in accordance with [ASTM D422](#), amount of material finer than No. 200 sieve in accordance with [ASTM D1140](#), and Atterberg limits tests in accordance with [ASTM D4318](#).

2.2.2 Test Program

- a. Prior to production work, a test program must be conducted by the Contractor in accordance with the accepted work plan. The test program must be used to optimize the various parameters, including type of jet grouting (single, double or triple), necessity of prejetting with water, grout mix composition, fluid(s) flows and pressures, rotational speed, retraction rate, grout, and number and size of nozzles; and confirm that resultant in situ soil-cement properties meet required design criteria.
- b. The test program and its results will be observed, reviewed and approved by the Engineer. The test program must be installed in areas near the planned production work at a location agreed upon between the Owner's Representative and Jet Grouting Contractor and in representative soils and depths anticipated to be found during production work.

c. Submit details of proposed [field demonstration test program](#) for jet grouting, as specified herein to the Owner's Representative four weeks prior to the start of the work. This must include location of test columns, layout of test pattern, jet-grouting parameters to be used and variables to be tested during test program, and details of proposed quality control/quality assurance testing to meet acceptance criteria specified in Paragraph ACCEPTANCE CRITERIA.

d. Following performance of the field demonstration test program and prior to beginning production jet-grouting operations, submit [installation details](#) regarding drilling and installation of test columns, jet grouting parameters, quality control/quality assurance test results, and recommended changes to jet grouting parameters based on test program, if any.

e. If the Contractor begins construction of production jet grout elements prior to obtaining QA/QC test results, the work will be considered to be at risk to the Contractor and any re-work or additional work required because of the nonconformance to acceptance criteria must be at the Contractor's sole expense.

2.2.2.1 Test Program Criteria

a. The test section must consist of a minimum of three jet-grouted columns. Install each test column along the border of the limits of ground improvement as shown in the drawings. One test column at both the southwest and southeast corners of the ground improvement limits and one test column along the southern boundary of the ground improvement limits near the center of the area of the limits. Test columns must extend to the top of the Pre-Slide Alluvium, where the top of the Pre-Slide Alluvium is determined by the Owner's Representative in the field.

b. Collect minimum of one wet grab sample per test column at location and depth determined by the Owner's Representative. Collect the sample by inserting a downhole in situ sampler within a fresh jet grout column to retrieve the wet grab sample of in-place soilcrete.

c. The Contractor must obtain full-depth continuous core samples from the test columns in accordance with the QC/QA requirements outlined in Paragraph QUALITY CONTROL/QUALITY ASSURANCE.

d. Three acceptable/representative core specimens from each test column selected by the Engineer must be sent to an independent Laboratory for the tests required to satisfy the criteria specified in Paragraph ACCEPTANCE CRITERIA.

e. The top of all test elements must be exposed by excavation and measured for geometric properties. A minimum of [6 feet](#) of the top of each test column must be exposed. The Contractor must provide access for the Engineer to inspect the columns. The columns must be backfilled after inspection is complete.

f. Subject to the results of the test program, the Contractor will present parameters selected to achieve the specified acceptance criteria for review of the Engineer. The Contractor, at their expense, may be required to repeat the construction of a test section if selected parameters fall outside test requirements. The test program must confirm that the resultant soil-cement properties met the

required design criteria prior to the Contractor proceeding with production work.

2.2.3 Jet Grouting Procedure

The following must be submitted to the Owner's Representative by the Contractor four weeks prior to the start of the work:

- a. Submit a general [Work Procedures Plan](#) outlining the spacing, location, depth and general sequence to achieve the specified criteria detailed in this specification. Grout hole locations must be dimensionally referenced to the Contract drawings and shown on layout plans of suitable scale to effectively indicate the details of the layout. The layout must provide a unique number for each planned jet grout column for the purpose of inspection and installation documentation.
- b. Submit a general [jet grout spoil return management plan](#) outlining waste containment methods during jet grouting and treatment and removal plans for jet grout spoil return. Jet grout spoil return management plan must include methods preventing migration of grout materials into Navigation Lock 1 and the Columbia River.
- c. Submit a general [containment, treatment, and disposal plan](#) outlining description and details of means and methods for containment, treatment, and disposal of ground improvement spoil material, cement grout, and water coming in contact with cement grout during the mixing process or as part of the containment process.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

Submit [quality assurance, quality control and verification procedures](#) to be used for the field test and production work. This must include details of the procedures to obtain soil-cement samples; and catalog cuts or shop fabrication drawings of the soil-cement sampling device and curing boxes. Submit proposed details and formats of all required [tabular and graphical data presentations](#) that will be submitted to the Engineer during the course of the work. This will include submittal of a copy of the reports used for data monitoring and recording, as described herein.

3.1.1 Quality Control/Quality Assurance

- a. All Jet Grouting must be performed in the presence of the Owner's QC/QA Representative. Owner's QC/QA Representative must be notified prior to initiating jet-grouting. Monitoring and logging of jet-grouting operations for both test areas and production work must be performed by the Contractor.
- b. The Contractor's equipment must be configured to record and continuously show all fluid flows and pressures, rotational speed, depth and rod retraction rates. The rod retraction rate and rod RPM must be set by the driller then automatically controlled by the drill rig during the entire jet-grouting process and recorded on the jet-grout installation log.
- c. All the data monitored and recorded, as described above, must be made available to the Engineer in a format previously agreed on prior

to the work. Supply the Engineer with the software used for this task. The software must be capable of processing the data recorded and graphic in a satisfactory manner. Proposal of the software to be used must be described in advance to the Engineer.

d. Grout mix proportions must be measured and documented by the Contractor per the submittal requirements in Paragraph SUBMITTALS. Appropriate records must be kept by the Contractor and submitted to the Engineer to verify that grout mixture(s) are as accepted.

e. Throughout the jet-grouting operations, perform continuous coring to full depth on five percent of production jet grout columns to obtain drill cores of the jet grout soil. The drill core will be evaluated for compliance with specific acceptance criteria defined in Paragraph ACCEPTANCE CRITERIA herein. The Contractor will be notified immediately if the soil-cement samples do not meet the acceptance criteria outlined herein.

- (1) Perform all coring operations in the presence of the Engineer. Notify the Engineer at least one business day in advance of beginning sampling operations.
- (2) Determine the time interval between element installation and coring except that the interval must be no longer than required to conduct 28 day strength testing.
- (3) The full-depth samples must be obtained along a vertical alignment located in the outer half of the column diameter.
- (4) Core samples must be retrieved using standard triple-tube or equivalent continuous coring techniques.
- (5) Samples must have a diameter of at least 3 inches, and each core run must be at least 3 feet in length.
- (6) The cores must be drilled at locations defined by the Engineer.
- (7) Photograph each core run.
- (8) Upon retrieval, provide the cores to the Engineer for logging and test specimen selection.
- (9) Following logging, the Engineer will select at least five specimens from each full-depth continuous core for strength testing. Each test specimen must have a length-to-diameter ratio of two or greater.
- (10) Immediately following logging and test specimen selection by the Engineer, seal the entire full-depth sample, including the designated test specimens, in plastic wrap to prevent drying and transport the sealed sample to the laboratory. The samples must be protected against drying and mechanical damage prior to and during transport.
- (11) The samples must be stored in a moist room in accordance with ASTM C192/C192M until the test date.
- (12) Samples must not be submerged in water during curing unless they are sealed in a water-tight plastic bag with as much air

removed as possible prior to sealing to void swelling.

(13) Retain portions of the samples that are not tested until completion and acceptance of all jet grouting work for possible future inspection and confirmation testing by the Engineer. If a large volume of samples cannot be reasonably stored on the job site, cores from columns deemed satisfactory may be disposed of prior to project completion if approved by the Engineer.

(14) All core holes must be filled with cement grout that will obtain a 28 day unconfined compressive strength equal to or greater than the 28 day unconfined compressive strength of the grouted material.

f. Wet Grab Samples: Collect minimum of one wet grab sample per day during production work at location and depth determined by the Owner's QC/QA Representative. Collect the sample by inserting a downhole in situ sampler within a fresh jet grout column to retrieve the wet grab sample of in-place soilcrete.

g. Strength Testing:

(1) Strength testing must be conducted by an independent testing laboratory retained by the Contractor and approved by the Engineer.

(2) Testing for unconfined compressive strength must be conducted in accordance with [ASTM D2166](#), except that loading will continue on all specimens until the cylinders break sufficiently to examine the interior of the specimen.

(3) The broken specimen must be photographed so that the Engineer may document any apparent segregation, lenses, and pockets in the specimen.

(4) For test program, unconfined compressive strength testing must be performed on specimens from wet grab samples three, seven, 28, and 56 days or more after mixing.

(5) For full production work, unconfined compressive strength testing must be performed on specimens from wet grab samples at seven days and 28 days after mixing.

(6) For specimens obtained by coring, unconfined compressive strength testing must be performed 28 days after mixing.

h. Uniformity Evaluation: Provide the continuous core samples to the Engineer for logging and assessing uniformity in accordance with the acceptance criteria outlined in Paragraph ACCEPTANCE CRITERIA.

i. Both the Contractor's testing and the Owner's testing (if performed) must demonstrate that the required strengths are met prior to accepting the work. Conduct additional coring and testing required to demonstrate the acceptability of the jet grouting product due to non-conformance at no additional cost to the Owner.

3.1.2 Daily Reports

Within one business day of a work shift, submit summary daily reports during test and production jet grouting that provide the information

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listed below. A sample of the report form proposed for use must be submitted to the Engineer for approval prior to the start of work.

- a. Project name.
- b. Jet-grout element number.
- c. Time and date (day, month, year) of beginning and completion of each grout element, including interruptions to the jetting process or material supply.
- d. Grout mix data, including mix proportions and unit weight density measurements.
- e. Injection pressure of all fluids used to construct each grout element.
- f. Flow rates of all fluids used to construct each grout element.
- g. Rates of rotation and withdrawal of jet rods for each grout element.
- h. Total grout quantity used for each element.
- i. Top and bottom elevations of the jet-grout element.
- j. Continuous flow of spoils return.
- k. Name of field superintendent in charge of the work for the Contractor.
- l. Notes and description of obstructions, interruptions of binder injections, or other difficulties during installation and their resolution.
- m. Other pertinent observations including but not limited to binder escapes, ground settlement or heave, collapses of the treatment zone, and any unusual behavior of any equipment during the jet-grouting process.
- n. For both wet grab samples and coring, provide collection date, time, plan location, elevation, and identification numbers of all samples, including unsuccessful attempts to retrieve samples.
- o. For coring operations, provide the coring method, equipment, and personnel; recovery percentage and percent treatment (percent of run length that is treated) for each core run; sample collection, handling, and storage details; and name of person responsible for logging and collecting cores and samples to be tested.
- p. Quantities of all binder materials delivered to the site plus a reconciliation showing the amount actually injected.
- q. Summary of any down time or other unproductive time including time, duration, and reason.
- r. Detailed results of all testing.
- s. Continuous recording of jet-grouting parameters must be provided for each production column to verify consistency with the approved

test program results.

3.1.3 Acceptance Criteria

a. Installation records from Paragraph QUALITY CONTROL/QUALITY ASSURANCE and daily reports from Paragraph DAILY REPORTS documenting that the approved parameters from the test program were accurately repeated for the production work.

b. The Engineer will make the sole determination as to whether the test results satisfy the following acceptance criteria.

3.1.3.1 Uniformity Acceptance Criteria

a. Full-depth continuous core samples retrieved by the Contractor from the jet-grout element will be used to evaluate uniformity.

b. Core recovery (expressed as a percentage) will be reported for each run and is equal to the total length of recovered core divided by the total core run length. Length of recovered core includes lengths of treated and untreated soil.

c. Percent treatment is calculated as the total length of recovered core minus the sum of the lengths of unmixed or poorly mixed soil regions or lumps that extend across the entire diameter of the core divided by the total core run length expressed as a percentage. Percent treatment must be at least 80 percent for every 5 feet core run. If 80 percent treatment cannot be confirmed by coring in coarse sandy or gravelly soil, optical televiewer logs can be used to confirm uniformity.

d. If the Contractor uses core runs shorter than 5 feet (e.g., 3 feet), then the recovery and percent treatment can be calculated taking into equal amounts of core run length on either side of the short core run length to make up a total 5 feet run length for calculation purposes. At least 80 percent of all jet-grout samples tested must have a minimum 28 day unconfined compressive strength of 400 psi.

e. The use of pH color indicator, such as phenolphthalein, will not be considered in determining percent treatment of test program or production cores.

3.1.3.2 Strength Acceptance Criteria

a. The specified unconfined compressive strength of the jet grout material as determined by ASTM D2166 at 28 days curing time is 400 psi.

b. 80 percent of unconfined compressive strength test results as determined by ASTM D2166 from each tested jet grout column must equal or exceed the specified strength. If a strength specimen falls below the specified strength due to an obviously unrepresentative lump of unmixed soil in the specimen, the Engineer has the option to select another specimen from the same core run and allow the Contractor's laboratory to test the replacement specimen and substitute the strength from the replacement specimen for the strength from the unrepresentative specimen that failed to satisfy the strength requirement. Only one such retest will be allowed per core run.

3.1.3.3 Geometric Acceptance Criteria

- a. Minimum Overlap Thickness: Adjacent grout columns must have a minimum overlap greater than 1/8 of the column diameter or 6 inches, whichever is greater.
- b. Verticality and Horizontal Tolerances: vertical alignment must be maintained within one percent of plumb. Centerline of the elements must not be more than 3 inches from the indicated plan location.
- c. The top of the jet grout element must extend upward to the designated elevation or higher.
- d. The bottom of the jet grout element must extend to the top of the Pre-Slide Alluvium layer, where the top of the layer must be determined by the Owner's Representative in the field.

3.1.4 Nonconformance

- a. The Contractor is responsible for correcting the location or alignment of misplaced elements that will adversely affect the project quality. The Contractor must correct misaligned elements that interfere with the Project in a manner acceptable to the Owner.
- b. If the strength and uniformity acceptance criteria are not achieved for production elements, the Contractor must submit a proposed plan for investigating and repairing failed sections for review and approval by the Engineer.
- c. To prove acceptability of the failed element, the Contractor may core elements on both sides of the failed element. If those two cores meet the criteria, then the element will be accepted. If the additional cores fail, then the Contractor can propose additional investigations and remedial measures, which the Engineer will review and has the option to accept or reject depending on whether the proposed remedial measures meet the design intent. Examples of such investigations and remedial measures include the following:
 - (1) In the case that the treated soil meets the uniformity criteria but fails to meet the strength criteria, the elements or zone could be assigned a lower strength level. The Contractor could propose installing additional elements to compensate the strength required by the design intent. If the treated soil fails to meet the uniformity criteria, the elements need to be replaced.
 - (2) If the treated soil that failed to pass cannot be isolated in a specific zone, the Contractor must provide remedial measures for all elements constructed during all rig shifts that occurred between passing elements.
 - (3) Remedial measures are subject to coring and application of the specification acceptance criteria.

3.2 CONSTRUCTION SEQUENCE

The sequence of installing the jet grout columns must start along the edge nearest Navigation Lock 1 and progress away from the channel. Install the entire row of columns along the Navigation Lock 1 edge prior to installing columns further from the channel.

3.3 PRODUCTION WORK

- a. Jet grout columns should be laid out so that they form enclosed cells by overlapping of columns creating multiple rows within the limits of ground improvement as shown on the drawings. All jet grout columns must be laid out and installed so that no part of any column is located within 4 feet of the theoretical edge of any drilled shaft to be installed for the foundations at Bent 1.
- b. Before beginning installation, the Contractor must provide sufficient survey control points to allow Owner's Representative to verify accurate locations of ground improvement elements and stake each end of ground improvement grid lines shown on drawings using a licensed surveyor. The Contractor must provide an adequate method for locating elements and to allow the Owner's Representative to verify the as-built location of the elements during construction. The Contractor will not be compensated for elements that are located outside of the tolerances specified in Paragraph QUALITY CONTROL/QUALITY ASSURANCE. The Owner will review the location of misaligned elements to determine if the elements interfere with the proposed construction. If the Owner determines that misaligned elements will interfere with construction, the Contractor must correct the alignment. The method of correction must be submitted by the Contractor to the Engineer for review and approval.
- c. If an obstruction is encountered that prevents drilling advancement, the Contractor must immediately notify the Owner's Representative and investigate the location and extent of the obstruction using methods approved by the Engineer. The Contractor must propose remedial measures to clear the obstruction for approval by the Engineer. The Contractor will be compensated for removal or clearing of obstructions with prior approval from the Owner. If the element cannot be installed at the design location due to obstructions, the element will be relocated as directed by the Engineer.
- d. Execute production jet grouting using the same jet-grout tooling, materials, and procedures as demonstrated from the satisfactory set of test elements.
- e. Install jet-grout elements, such that continuous spoil return up the borehole annulus is achieved during all work.
- f. Centerline of the elements must not be more than 3 inches from the indicated plan location.
- g. The sequence of the jet grouting, primary and secondary, fresh on fresh, pre-jetting with water is the responsibility of the Contractor and must be based on the results of the successful test program.
- h. Maintain a clean site and dispose of all spoil debris, water, and spilled material during jet-grouting operations.
- i. Equipment for mixing, holding, and pumping grout must be in a secure location and must be operated to minimize spillage of material. No material will be allowed to enter storm drains or other drainage courses.

j. Monitor nearby grade, structures and utilities during all jetting work.

k. If jet grouting is interrupted during the execution of a column, the re-start of the jetting must be undertaken so the nozzles are at least 6 inches below the previous stopping point.

l. Site access must be provided to Owner's Representatives for observation of the work.

m. Control of Spoils:

(1) Control and dispose of all waste materials produced as a result of the grouting operation in accordance with the project requirements. The spoils must be contained and processed within the limits of ground improvement as shown on drawings. The spoils must be contained onsite for at least six hours prior to loading and transport to an offsite disposal area to allow excess water to drain from the spoil material.

(2) Collect and treat bleed water originating from spoil material prior to discharging water in accordance with 1200-C and other applicable permits or disposing of water offsite.

3.4 CLOSEOUT ACTIVITIES

3.4.1 As-Built Field Measurement Data

After completion of the Project, submit as-built field measurement data indicating surveyed as-built plan locations of each jet grout element, including the element center (per site specific coordinates), the element dimension, the column verticality, and the top and bottom elevations of each element to the accuracy required by the Project specifications.

-- End of Section --