

PROJECT MANUAL

SKOWHEGAN RIVERFRONT PROMENADE

Also known as “Skowhegan Riverfront Walkway”

A project of the Skowhegan River Park (formerly Run of River Project)

SKOWHEGAN, ME

DECEMBER 5, 2025

PROJECT TEAM

Principle

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Studio W513
Boston, MA 02118
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REQUEST for PROPOSALS “SKOWHEGAN RIVERFRONT PROMENADE”

Public Notice Date: December 24, 2025

Main Street Skowhegan (MSS), 501(c)(3) requests proposals for the Skowhegan Riverfront Promenade, a project of the Skowhegan River Park (formerly known as the Run of River Project). The scope of work includes construction services for an accessible boardwalk along a portion of the gorge bank of the Kennebec River with landscaping, hardscaping, lighting, and other amenities as indicated in the Contract Documents.

The firm-fixed price contract will be awarded to the responsible offeror whose proposal is most advantageous considering price and evaluation factors in accordance with CFR 2.00 federal procurement rules and regulations. The project is fully funded by Community Project Funding (CPF) grant issued by the U.S. Department of Housing and Urban Development (HUD). The project is subject to all applicable CPF rules and regulations for FY22 CPF grantees and the bid is processed according to the 2CFR Part 200. Compliance with Davis Bacon and Related Acts (DBRA) is not a condition or requirement for CPF grants. Bids to exclude State of Maine Sales Tax. Exemption certificate will be issued by MSS.

Small businesses, minority businesses, women’s business enterprises, veteran-owned businesses and labor surplus area firms are welcomed and encouraged to respond to this request for proposals.

The project document package can be obtained online at

<https://mainstreetskowhegan.org/bids/>

EVALUATION FACTORS

Construction service proposals will be evaluated on price and per the weighted factors below and the most qualified offeror will be selected, subject to negotiation of fair and reasonable compensation.

- a. Project understanding - 25%
- b. Technical approach - 25%
- c. Experience of firm/ past performance - 40%
- d. Specialized expertise - 10%

CONTRACT AWARD

All proposals will be received electronically by kristina@mainstreetskowhegan.org until **Noon on January 30th, 2026**. The proposals will be evaluated, and the selected offeror will be notified within ten calendar days.

A recommended pre-proposal site visit will be held at **Noon on January 5th 2026**, rain or shine. Please meet at Skowhegan Outdoors Basecamp, 65 Water Street (Riverside). Procedures for submitting proposals, claiming an error, withdrawal of proposals and other pertinent information are contained in the *Instructions for Bidder’s Proposal* document available at the website above. All questions should be forwarded to Kristina Cannon at kristina@mainstreetskowhegan.org and copied to Ariane Rutt at ariane@principle.us. All emails will be documented for record and any changes in the project document package will be published by amendments available on the website above.

Due to funding limitations, Main Street Skowhegan reserves the right to choose certain tasks only and calculate the total bid cost from the qualified bidders.

December 5, 2025

Skowhegan, Maine

002100**INSTRUCTIONS FOR BIDDER'S PROPOSAL****I. RECEIPT AND OPENING OF BIDS**

- A. To be considered, the Bidder's Proposal (to be completed on the form attached hereto as **SECTION 004113**) must be complete, typewritten, in both words and figures and signed by the Bidder (the "Bid").
- B. An electronic copy of the Bid must be submitted with the name of the Bidder along with the Bidder's address and the name of the Project via email to Kristina Cannon at kristina@mainstreetskowhegan.org no later than **Noon on January 30th, 2026**.
- C. Any Bid received after the Bid Due Date will not be considered.
- D. Bids shall be valid for thirty (30) days after the Bid Due Date.
- E. Non-Responsive or Erroneous Bid:
 - 1. Owner may consider non-responsive any Bid not prepared and submitted in accordance with the provisions hereof and may waive informalities or reject any or all Bids.
 - 2. Bids may be withdrawn by written request received from the bidder prior to the time fixed for opening.
 - 3. A Bidder may submit a letter declaring a Bid error after Bid opening with documentation and/or justification why Owner should consider modifying or allowing the Bidder to withdraw the submitted Bid. Negligence on the part of the bidder in preparing the bid confers no right for the withdrawal of the bid after it has been opened, except in the case of a proven clerical error as permitted by applicable federal and state law.
- F. By submitting a Bid, Bidder agrees to carry out all of the provisions set forth in the Bid Documents, according to their full intent and meaning.
- G. No bid will be opened prior to the Bid Due Date. All bids will be opened publicly by Owner at 12:15pm on January 30th, 2026 at the offices of Main Street Skowhegan: 65 Water Street, Skowhegan, Maine, 04976. A public video link will be available for remote viewing at the bid website: <https://mainstreetskowhegan.org/bids/>

II. BID SECURITY

- A. Each Bid must be accompanied by a cashier's check, certified check or a bid bond, duly executed by the Bidder as principal and having as surety thereon a surety company approved by the

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Owner in the amount of five (5%) percent of the Base Bid (per CFR 200.326). Such checks or bid bonds will be returned to all, except the three (3) preferred Bidders within ten (10) days after the opening of the bids. The remaining checks or bid bonds will be returned promptly after the Owner and the accepted Bidder have executed the Contract. Upon a demand at any time thereafter, the remaining checks or bid bonds will be returned if no award has been made within thirty (30) days after the date of the opening of the Bids.

- B. The successful Bidder, upon failure or refusal to execute and deliver a contract and the required payment and performance bonds to the Owner within fifteen (15) days after Bidder has received notice of acceptance of its Bid, shall forfeit to the Owner, as liquidated damages for such failure or refusal, the security deposited with its Bid. Upon forfeiture, the Owner will disqualify said successful Bidder and award to the next responsible Bidder in accordance with Section XII of these Instructions to Bidders.
- C. Any attorney in fact who signs bid bonds or contract bonds must file with each bond a certified and effectively dated copy of such person's Power of Attorney.

III. QUALIFICATION OF BIDDERS

- A. Proposals shall be evaluated on the Proposal price as well as on the qualification of bidders as listed in the Request for Proposals and as noted below:
 - a. Project Understanding = 25%
 - b. Technical Approach = 25%
 - c. Experience of Firm / past performance = 40%
 - d. Specialized Expertise = 10%
- B. Written responses describing the evaluation factors above shall be completed on the form attached hereto as Section 004113. Written responses on separate letterhead are acceptable.
- C. Owner may make such investigation as it deems necessary to determine the ability of the Bidder to perform the Work, and the Bidder shall furnish to Owner all such information and data for this purpose as Owner may request. Owner to determine Bid winner per evaluation factor rubric. Owner reserves the right to reject any Bid if Owner determines that such Bidder is not properly qualified to carry out the obligation of the Contract and to complete the Work contemplated therein.

IV. BID DOCUMENTS

- A. The Plans are those drawings and specifications listed in Section IX.B herein. Plans will be available for examination and download after Noon on December 22nd, 2025, at the following website: <https://mainstreetskowhegan.org/bids/>

V. SITE VISIT AND WALK-THROUGH

- A. Bidders are encouraged to attend a pre-bid meeting and walk-through of the Site on **Noon on January 5th 2026** at Skowhegan Outdoors Basecamp, 65 Water Street (Riverside). All subcontractors are encouraged attend. Event will happen rain or shine.

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- B. Bidders and their subcontractors are encouraged to visit the Site to become familiar with the Project and the extent and character of the work involved, to verify all dimensions and to inform themselves fully of the existing conditions and the conditions under which the Work is to be performed.

VI. ADDITIONAL INFORMATION AND INTERPRETATIONS

- A. Additional information and document clarification will be issued in written addenda when and if required. All costs of work specified by addenda shall be included in the Bid.
- B. Verbal instructions or interpretations are not binding. Only a written interpretation or correction by addendum shall be binding and no Bidder shall rely upon interpretations or corrections given by any other method.
- C. Every request for an interpretation of Bid Documents must be in writing and submitted to the Architect or Engineer as applicable at the email address set forth on the Request for Proposals. Each Bidder shall examine the bidding documents carefully, and not later than **January 14, 2026**, shall make a written request for interpretations or corrections of any ambiguity, inconsistency, error or code violation therein which may be discovered. Any and all such interpretations and other supplemental instructions will be in the form of a written addendum to the Plans issued to all Bidders. Failure of any Bidder to receive such interpretation shall not relieve such Bidder from any obligation under the Bid as submitted. All addenda so issued shall become a part of the Contract Documents.
- D. Any and all addenda or RFI responses shall be posted to the RFP website no later than **5pm on January 21st, 2026**: <https://mainstreetskowhegan.org/bids/>
- E. Bidder shall acknowledge receipt of Addenda where noted in Item 2 of its Bid.

VII. OBLIGATION OF BIDDER

- A. At time of the opening of the Bids, each Bidder will be presumed to have inspected the Site and to have read and to be thoroughly familiar with the Plans and Bid Documents (including all Addenda). The failure or omission of any Bidder to visit the Site or examine any form, instrument or document shall in no way relieve any Bidder from any obligation in respect to its Bid.
- B. Each Bidder represents and warrants to Owner that it has examined and carefully studied the Bid Documents and acknowledges that it has observed no error, defect, deficiency, lack of clarity, inconsistency, conflict of any sort or omissions in any of the Plans, Specifications or other Bid Documents and that such Plans, Specifications or other Bid Documents are adequate to complete the Work for the price and in accordance with the time schedule set forth in its Bid.
- C. Each Bidder must inform itself fully of the conditions relating to the construction of the Project and the employment of labor thereon. Failure to do so will not relieve a successful Bidder of its obligations to furnish all the material and labor necessary to carry out the

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provisions of the Contract. Insofar as possible, the Bidder, in carrying out its work, must employ such methods or means as will not cause any interruption of or interference with the work of any other contractor.

- D. Each Bidder by submission of a Bid agrees to abide by the terms and conditions of these Bid Documents as well as hold its Base Bid open and available for acceptance for a minimum of thirty (30) days after Bid opening.

VIII. TAXES AND PERMITS

- A. Taxes: Owner represents that it is exempt from sales tax under Maine State law. Owner will provide the successful Bidder with a Project Tax Exemption Certificate for the Project.
- B. Permits: Bidder shall at its own expense, procure and maintain all licenses, permits (including occupancy permits), inspections necessary for the execution of the Work.
1. Approvals: the Project has received the required national and local approvals including the HUD certification of Part 58 Environmental Review (NEPA compliance) which is on file in the HEROS database administered by the Town of Skowhegan.

IX. BID DOCUMENTS

- A. The Bid Documents for this Project shall consist of the following:
1. Request for Proposal;
 2. Instruction for Bidder's Proposal;
 3. Bid Form;
 4. Written Addenda (if any);
 5. (Anticipated) Form of Agreement between Owner and Contractor AIA 101
 6. (Anticipated) General Conditions of the Contract AIA 201 and
 7. The Plans.
- B. The Plans consist of the following:
1. Drawings: See Attached List of Drawings
 2. Specifications: See Attached Specifications

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X. PAYMENT AND PERFORMANCE BONDS

- A. Bidder shall furnish evidence of Bidder's available bonding capacity as required by CFR 200.326
- B. Simultaneously with the delivery of the executed Contract, Bidder shall, furnish bonds covering the faithful performance of the Contract and payment of obligations arising thereunder. Bidder shall either furnish a copy of the bonds to Owner or shall permit a copy to be made.
 - 1. Performance Bond: A performance bond on the contractor's part for 100 percent of the contract price. A performance bond is a bond executed in connection with a contract to secure the fulfillment of all the contractor's requirements under a contract.
 - 2. Payment Bond: A payment bond on the contractor's part for 100 percent of the contract price. A payment bond is a bond executed in connection with a contract to assure payment as required by the law of all persons supplying labor and material in the execution of the work provided for under a contract
- C. Any attorney in fact who signs bid bonds or contract bonds must file with each bond a certified and effectively dated copy of such person's Power of Attorney.

XI. AWARD OF CONTRACT

- A. Any contract awarded for the Work shall be awarded on the basis of the qualified Bid, which is within the amount of the funds authorized for the Project and to be completed in a time agreeable to the Owner. The Owner reserves the right to reject any and all bids and re-bid the Project or to negotiate a contract with any Bidder.
- B. Upon receipt of a written Notice of Acceptance of Bid, the successful Bidder shall be required to execute a contract with the Owner for construction of the Work. Such Contract is anticipated in the form of **AIA Document A101-2017 (and corresponding General Conditions A201-2017)** and executed and delivered, along with any required payment and performance bonds, to Owner within fifteen (15) days of receipt of the Notice of Acceptance of Bid.
- C. Any contract awarded for the Work shall include as the contract documents all of the documents listed in **Section IX** of these Instructions for Bidder's Proposal and the executed Contract between the successful Bidder and Owner
- D. Upon execution of a Contract, the successful Bidder will be required to submit a certificate of insurance, properly endorsed, that complies with the insurance requirements of the Contract Documents. No employee or subcontractor of Bidder or any other person will be permitted to perform any work at the Project Location until Owner has received and approved the required certificate of insurance. Such certificate of insurance shall be delivered to the Owner's Representative who will be responsible for forwarding it to the appropriate individuals for review and approval.

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XII. OTHER REQUIREMENTS

- A. Alternates. In addition to the Base Bid, the Owner requests Alternate Proposals for ALTERNATE ONE which Owner may elect to accept.
- B. Material & Equipment: Owner Furnished, Owner Installed: Not Used.
- C. Material & Equipment: Owner Furnished, Contractor Installed: Not Used

XIII. NON-DISCRIMINATION AND EQUAL OPPORTUNITY

A. Equal Employment Opportunity/Non-discrimination. By submitting a Bid, Bidder warrants that in any contract for work or services performed in connection with the Project, Bidder (which term for purposes of this section only shall include the Bidder, any transferees, lessees, designees, successors and assigns thereof, including without limitation any entity related to the Bidder by one of the relationships described in Section 267(b) of the United States Internal Revenue Code of 1986, as amended), its employees, contractors, subcontractors, and material suppliers shall comply with all applicable federal, state and local laws, ordinances or regulations governing equal opportunity and nondiscrimination (the "Laws"). Moreover, the Bidder shall contractually require its contractors, subcontractors and material suppliers to comply with the Laws. Neither the Bidder nor any of its contractors or subcontractors shall contract with any party known to have been found in violation of the Laws.

Additionally, the contract with the successful bidder will require that the contractor use reasonable and good faith efforts to ensure that minority business enterprises and qualified ethnic minorities have a meaningful opportunity to participate in the work that is the subject of the contract. The successful bidder will routinely meet with and report its efforts in these areas to Owner. The successful bidder will work cooperatively with the Owner to document its good faith efforts and to address areas of concern, if any.

XIV. OTHER POLICIES

- A. Bidder shall comply with all applicable Owner policies including, but not limited to, the policies set forth in the General Conditions of the Contract.

December 5, 2025

Skowhegan, Maine

SECTION 004113
CONTRACTOR BID FORM – STIPULATED SUM

PROJECT TITLE: SKOWHEGAN RIVERFRONT PROMENADE ("WALKWAY")
PROJECT TOWN: SKOWHEGAN, MAINE
PROJECT LOCATION: INTERSECTION OF PATTEN COURT & THE PEDESTRIAN BRIDGE

To all Prospective Contractors:

This Form must be completed to be considered in the selection process. These responses correspond to the evaluation factors listed in the Request for Proposal.

ITEM 1: CONTACT INFORMATION

COMPANY NAME*	
ADDRESS	
PHONE NUMBER	
EMAIL ADDRESS	

ITEM 2: BID INFORMATION

1. The Bidder, having carefully examined the Skowhegan Riverfront Promenade Project Documents dated December 5th, 2025, prepared by VHB and team, as well as Specifications, Drawings, and any Addenda, the form of contract, and the premises and conditions relating to the work, proposes to furnish all labor, equipment and materials necessary for and reasonably incidental to the construction and completion of this project for the **Base Bid** amount of:

a. \$_____ .00

2. Addenda: Bidder acknowledges the following, if any, addenda as posted on the Bid website <https://mainstreetskowhegan.org/bids/>

a. Addenda Number (s): _____

3. Allowances on this project: Not Used

Contractor Bid Form – Stipulated Sum

December 5, 2025

Skowhegan, Maine

4. Alternate Bids on this project:

- a. Alternate One: \$_____.00
- b. Alternate Two: \$_____.00
- c. Any dollar amount line above that is left blank by the Bidder shall be read as a bid of \$0.00.

- 5. Bid security on this project. If the Base Bid amount exceeds \$125,000.00, the Bidder shall include with this bid form a satisfactory Bid Bond (section 00 43 13) or a certified or cashier's check for 5% of the bid amount with this completed bid form submitted to the Owner.

ITEM 3: QUALIFICATIONS

Responses to the items below may be presented on a separate letterhead.

- 1. Project Understanding: Provide a written statement describing the company's understanding of the project scope.
 - a. _____
- 2. Technical Approach: Provide a detailed statement of how the company proposes to accomplish the requested work.
 - a. _____
- 3. Experience: list two or more recent projects for work of similar character as needed in this project.
 - a. _____
 - b. _____
- 4. Specialized Expertise: include any other statement or document that would further qualify the company for this particular job site location.
 - a. _____

ITEM 4: AUTHORIZATION

The Bidder agrees, if the Owner offers to award the contract, to provide any and all bonds and certificates of insurance, as well as Schedule of Values, Project Schedule, and List of Subcontractors and Suppliers if required by the Owner, and to sign the designated Construction Contract within twelve calendar days after the date of notification of such acceptance, except if the twelfth day falls on a State of Maine government holiday or other closure day, or a Saturday, or a Sunday, in which case the aforementioned documents must be received before 12:00 noon on the first available business day following the holiday, other closure day, Saturday, or Sunday.

Contractor Bid Form – Stipulated Sum

December 5, 2025

Skowhegan, Maine

As a guarantee thereof, the Bidder submits, together with this bid, a bid bond or other acceptable instrument as required by the Bid Documents.

AUTHORIZED SIGNATURE*	
JOB TITLE	
DATE	

*If a corporation, complete the certificate of vote enclosed.

December 5, 2025

SKOWHEGAN RIVERFRONT WALKWAY
Skowhegan, Maine

SECTION 002110
CERTIFICATE OF VOTE

(Only General Bidders and filed Sub-Bidders who are Corporations)

At a duly authorized meeting of the Board of Directors of the

_____ held on _____, it

(Name of Corporation)

(Date)

was VOTED, THAT _____ of this company, be and hereby
is authorized to execute contracts and bonds in the name and on behalf of said company, and
affix its corporate seal hereto; and such execution of any contract or obligation in this
company's name on its behalf by such officer under seal of the company, shall be valid and
binding upon this company.

I hereby certify that I am the clerk of the above named corporation and that

_____ is the duly elected officer as above of said
company, and that the above vote has not been amended or rescinded and remains in full
force and effect as the date of this contract.

Date

(Clerk)

CORPORATE
SEAL

**THIS FORM MUST BE SIGNED & RETURNED
WITH YOUR GENERAL BID OFFER IF A CORPORATION.**

LIST OF DRAWINGS
SKOWHEGAN RIVERFRONT PROMENADE

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REPORT Rev1

22-2147

July 23, 2025

Explorations and Geotechnical Engineering Services

Proposed Riverfront Promenade
Off Patten Court Street
Skowhegan, Maine

Prepared For:

Main Street Skowhegan
Attention: Kristina Cannon
65 Water Street, Unit 1
Skowhegan, ME 04976

Prepared By:

S. W. Cole Engineering, Inc.
26 Coles Crossing Drive
Sidney, ME 04330
T: 207.626.0600

www.swcole.com | info@swcole.com

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22-2147

July 23, 2025

Main Street Skowhegan
Attention: Kristina Cannon
65 Water Street, Unit 1
Skowhegan, ME 04976

Subject: Explorations and Geotechnical Engineering Services – Rev1
Proposed Riverfront Promenade
Off Patten Court Street
Skowhegan, Maine

Dear Kristina:

In accordance with our Revised Proposal, dated June 19, 2024, we have performed subsurface explorations for the subject project. This report summarizes our findings and geotechnical recommendations, and its contents are subject to the limitations set forth in Appendix A.

1.0 INTRODUCTION

1.1 Scope and Purpose

The purpose of our services is to obtain subsurface information in order to provide geotechnical recommendations for foundations, earthwork, and pavement associated with proposed construction. Our scope of services included test boring explorations, laboratory testing, a geotechnical analysis of the subsurface findings, and preparation of this report.

1.2 Site and Proposed Construction

The site is located off Water Street and south of Patten Court and consists of an approximate 1,000-foot section of the Kennebec River's northern bank in Skowhegan, Maine. Based on the current concept plan, provided July 14, 2025, we understand improvement plans envision construction of a new 16-foot-wide promenade and elevated walkway from the Old Mill building (about 33 Water Street) to the Municipal Building (225

Water Street). We understand the promenade will be an on-grade cantilever structure constructed over the edge of the existing slope. We understand the cantilever structure will be supported on either a mass concrete spread footing foundation or drilled foundation system to counter over-turning. We understand an elevated section of walkway with viewing areas will be constructed to wrap around the southerly side of the existing building at 181 Water Street and extend over the edge of the existing steep exposed bedrock slope at 181 Water Street.

Proposed and existing site features are shown on the "Exploration Location Plan" attached in Appendix B.

2.0 EXPLORATION AND TESTING

2.1 Explorations

Fifteen test borings (B-101 through B-114, and B-108A) were made at the site from October 21 to October 24, 2024, by Seaboard Drilling, LLC. The exploration locations were selected and established in the field by S. W. Cole Engineering, Inc. (S.W.COLE) using a mapping-grade GPS. The approximate exploration locations are shown on the "Exploration Location Plan" attached in Appendix B. Logs of the explorations and a key to the notes and symbols used on the logs are attached in Appendix C.

2.2 Field Testing

The test borings were drilled using a combination of hollow stem auger, cased wash-boring, and rock coring techniques. The soils were sampled at 2-to-5-foot intervals using a split spoon sampler and Standard Penetration Testing (SPT) methods. Upon encountering refusal, borings B-106, B-107, B-108, B-108A, and B-110 were advanced into bedrock using NQ2 rock coring. SPT blow counts and Rock Quality Designation (RQD) for each rock core run are shown on the logs.

2.3 Laboratory Testing

Soil and rock core samples obtained from the explorations were returned to our laboratory for classification and testing. Laboratory testing included four unconfined rock compressive strength tests and four rock core unit weight tests. Rock compressive strength and rock core unit weight test results are shown on the logs in Appendix C.

3.0 SUBSURFACE CONDITIONS

3.1 Soils and Bedrock

Test borings B-101 through B-110 were made in the area of the proposed promenade and elevated walkway and borings B-111 through B-114 were made in the area of redeveloped paved areas. Below a surficial layer of pavement or topsoil, the explorations encountered a subsurface profile generally consisting of granular fill with scattered debris (brick, concrete, etc.) overlying glacial till mantling refusal surfaces (probable bedrock) at depths of 3.6 to 8.8 feet. Where cored, the bedrock generally had about a 1-to-1.5-foot-thick weathered surface before becoming more competent. The more competent bedrock generally consisted of dark gray metapelite.

Rock Quality Designations (RQDs) of the recovered rock core ranged from 0 to 54 percent indicating a very poor to fair rock quality. In general, the rock core obtained appeared to consist of a 7-to-10-foot zone of highly fractured rock before becoming more intact.

Not all the strata were encountered at each exploration; refer to the attached logs for more detailed subsurface information.

3.2 Groundwater

The soils encountered in the test borings were generally moist from the ground surface. Saturated soils were not encountered at the time of exploration. Groundwater may become perched on the relatively glacial till and shallow bedrock encountered in the test borings. Long term groundwater information is not available. It should be anticipated that groundwater levels will fluctuate, particularly in response to periods of snowmelt and precipitation, as well as changes in site use and the water level of the river.

4.0 EVALUATION AND RECOMMENDATIONS

4.1 General Findings

Based on the subsurface findings, the proposed construction appears feasible from a geotechnical standpoint. The principle geotechnical considerations include:

- The site is generally underlain by fill with scattered debris (brick) and relic topsoil overlying glacial till mantling relatively shallow bedrock at depths of about 3.6 to 8.8 feet within the proposed promenade area at the top of slope and exposed bedrock

on the slope down to the Kennebec River within the area of the elevated walkway. The bedrock appeared to have a 7-to-10-foot zone of highly fractured rock before becoming more intact.

- Based on the variability of the existing fill, we recommend the proposed cantilever promenade be founded on either mass concrete foundations bearing on competent bedrock or drilled micropiles or steel H-piles socketed into competent bedrock. We anticipate foundations for the proposed elevated walkway will consist of drilled micropiles or steel H-piles socketed into competent bedrock.
- We recommend mass concrete or drilled foundations be founded behind an influence line extending upward from the toe of the bedrock slope at 0.5H:1V. Bedrock bearing surfaces should be leveled to 10H:1V or flatter and cleared of weathered, loose or displaced rock. Bedrock bearing surfaces should be evaluated for stability on a case-by-case basis to determine if rock dowels are required or if footings are required to be pinned to the bedrock.
- Due to access constraints, construction or evaluation on the steep bedrock slope would likely have to be performed from a platform suspended from a crane or on falsework extending from the toe of the slope.
- Uncontrolled fills in the proposed paved areas can be problematic for support of pavements and utilities. We recommend densifying uncontrolled fills with at least 3 passes of a 10-ton vibratory roller compactor. Areas that become soft following densification must be removed and replaced prior to installing base/subbase aggregates. Wood and organics encountered at subgrade elevation would require removal and replacement prior to installing base/subbase aggregates.
- The existing fills should be sampled and characterized by a qualified environmental professional to assess requirements for proper handling, reuse, and disposal.
- Earthwork and grading activities should occur during drier, non-freezing weather of Spring, Summer, and Fall. Excavation of soil bearing surfaces should be completed with a smooth-edged bucket to lessen subgrade disturbance.

4.2 Seismic and Liquefaction

Based on the subsurface findings and guidance in the 2015 International Building Code (IBC), we interpret the site soils to correspond to a Seismic Site Class C.

Liquefiable soils typically consist of loose, fine sands and non-plastic silts below the groundwater table. Based on the subsurface findings, it is our opinion that the risk of liquefaction is low.

4.3 Stability Evaluation

Based on limited access of the existing steep bedrock slope, we performed a preliminary evaluation of the bedrock discontinuities based on the exposed bedrock along the southerly riverbank. The results of the preliminary evaluation suggest high-angle primary joint sets and bedrock foliation striking approximately parallel to the river and dipping to the northwest. Secondary high-angle joint sets strike approximately perpendicular to the river and generally dip to the northeast. A low-angle tertiary joint set also strikes across the trend of the river and dips to the south.

The orientations of the joint sets relative to the rock face indicate the potential for block sliding or block toppling mechanisms of failure. It is anticipated that surface and groundwater infiltration coupled with freeze-thaw cycles contribute to frost wedging and the progressive spalling of the rock face. Following bedrock mapping and stability evaluation of the bedrock at proposed foundation locations, reinforcement of the rock slope may be required. We anticipate drilled and grouted rock dowels would be utilized as a slope stabilization concept, if needed. The bond zone of the rock dowels should commence beyond a 1H to 1V influence line from the toe of the rock.

4.4 Site and Subgrade Preparation

We recommend site preparation begin with the construction of an erosion control system to protect adjacent drainage ways and areas outside the construction limits. Surficial organics, roots and topsoil should be completely removed from areas of proposed fill and construction.

Promenade Cantilever Foundations: As discussed, the site was previously developed, and unsuitable fills are present at the site. We recommend the existing fills, native soils, relic structures and foundations if encountered be completely removed to bedrock below proposed cantilever foundation locations. We recommend foundations be located behind an influence line extending upward from the toe of the bedrock slope at 0.5H:1V. Bedrock

bearing surfaces should be leveled to 10H:1V or flatter and cleared of weathered, loose or displaced rock. Bedrock bearing surfaces should be evaluated for stability on a case-by-case basis to determine if rock dowels are required or if footings are required to be pinned to the bedrock.

Elevated Walkway Foundations: We anticipate foundations for the proposed elevated walkway will consist of either drilled micropiles or steel H-piles socketed into competent bedrock. Due to access constraints, construction on the steep bedrock slope would likely have to be performed from a platform suspended from a crane or on falsework extending from the toe of the slope. We anticipate pile locations will need to be prepped to construct a relatively flat surface to facilitate use of drilled equipment.

Paved Areas: Uncontrolled fills encountered beneath proposed paved areas should be densified with at least 3 passes of a 10-ton vibratory roller compactor. Areas that become soft after densification should be removed and replaced with compacted Granular Borrow or Structural Fill prior to installing base/subbase aggregates. Wood and organics encountered at subgrade elevation should be removed and replaced with compacted Granular Borrow or Structural Fill prior to installing base/subbase aggregates.

4.5 Excavation and Dewatering

Excavations will generally encounter uncontrolled and undocumented fills, native silty glacial till, and bedrock. Earthwork and grading activities should occur during drier, non-freezing weather of Spring, Summer, and Fall. Final cuts to subgrade should be performed with a smooth-edged bucket to help reduce strength loss from soil disturbance.

Based on the proximity of the existing building to the proposed elevated walkway, we recommend vibrations from construction should be controlled below threshold limits of 0.5 in/sec for structures within 500 feet of the project site. More restrictive vibration limits may be warranted.

Sumping and pumping dewatering techniques should be adequate to control groundwater in excavations. Controlling the water levels to at least one foot below planned excavation depths will help stabilize subgrades during construction. Excavations must be properly shored or sloped in accordance with OSHA Regulations to prevent sloughing and caving of the sidewalls during construction.

Care must be taken to preclude undermining adjacent structures, utilities, and roadways. The design and planning of excavations, excavation support systems, and dewatering is the responsibility of the contractor.

4.6 Spread Footing Foundations

As discussed, we recommend the existing fills, native soils, relic structures and foundations if encountered be completely removed to bedrock below proposed cantilever foundation locations. We recommend foundations be located behind an influence line extending upward from the toe of the bedrock slope at 0.5H:1V. Bedrock bearing surfaces should be leveled to 10H:1V or flatter and cleared of loose or displaced rock. For foundations bearing on properly prepared bedrock subgrades, we recommend the following geotechnical parameters for design consideration:

Geotechnical Parameters for Spread Footings and Foundation Walls	
Design Frost Depth (100-year AFI)	5 feet
Net Allowable Bedrock Bearing Pressure	8.0 ksf
Base Friction Factor	0.4
Total Unit Weight of Backfill	125 pcf
Internal Friction Angle of Backfill	30°
Seismic Soil Site Class	C

We anticipate foundations will be sized to resist potential uplift and overturning loading using mass concrete.

4.7 Pile Foundations

We recommend the proposed promenade and elevated walkway be supported on drilled micropiles or steel H-piles socketed into bedrock. The bedrock encountered at the explorations generally had a 7-to-10-foot zone of highly fractured rock overlying more competent bedrock, therefore, rock sockets will need to extend below the fractured zone and at least 5 feet into competent bedrock. Deeper rock sockets may be required depending on the load requirements.

The base of the rock sockets should be leveled and cleaned of loose material. We recommend foundations be drilled using steel casing within the overburden soils and seated into the bedrock in order to maintain sidewall stability. Highly fractured bedrock which is unstable may have to be cased or concreted and re-drilled to competent bedrock.

Prior to installing the H-pile or steel reinforcement in the drilled socket, S.W.COLE should observe the base of each drilled foundation.

Considering the subsurface conditions encountered, we anticipate socket axial capacity will be controlled by the concrete compressive strength. We recommend an allowable end-bearing pressure of 20 ksf utilizing a factor of safety of 2.0 for steel H-piles socketed into bedrock. We recommend neglecting end bearing for drilled micropiles. For sockets deeper than 5 feet, additional axial compressive capacity can be mobilized from skin friction between the pier and rock socket. For a design concrete strength of 4,000 psi, a unit skin friction of 17 ksf is recommended for the portion of the pier socketed greater than five feet into bedrock. For a design concrete strength of 5,000 psi, a unit skin friction of 20 ksf is recommended for the portion of the socket greater than 5 feet into bedrock.

Uplift resistance can be developed from skin friction between the socketed H-pile or drilled micropile and bedrock, as well as the dead weight of the pile. S.W.COLE can assist with uplift capacities as deemed necessary by the structural engineer.

A rock-socketed H-pile or drilled micropile design submittal, stamped by a Professional Engineer licensed in Maine, should be provided for review by the project team prior to installation of foundations.

We recommend bedrock stability analysis be performed for the elevated walkway, once proposed pile locations and loads are available.

4.8 Fill, Backfill and Compaction

We recommend the following fill and backfill materials: recycled products must also be tested in accordance with applicable environmental regulations and approved by a qualified environmental consultant.

Granular Borrow: Fill to raise grades in building and paved areas, as well as to repair soft areas, should be sand or silty sand meeting the requirements of 2020 MaineDOT Standard Specification 703.19 Granular Borrow.

Structural Fill: Backfill for foundations, material below exterior entrances slabs, and backfill to repair soft areas, should be clean, non-frost susceptible sand and gravel meeting the gradation requirements for Structural Fill as given below:

Structural Fill	
Sieve Size	Percent Finer by Weight
4 inch	100
3 inch	90 to 100
¾ inch	25 to 90
No. 40	0 to 30
No. 200	0 to 6

Crushed Stone: Crushed Stone used for underdrain aggregate should be washed ¾-inch crushed stone meeting the requirements of 2020 MaineDOT Standard Specification 703.13 Crushed Stone ¾-Inch.

Reuse of Site Soils: The non-organic on-site soils are unsuitable for reuse beneath paved and hardscape areas but may be suitable for reuse as Common Borrow in landscape areas, provided they are at a compactable moisture content at the time of reuse.

Placement and Compaction: Fill should be placed in horizontal lifts and compacted such that the desired density is achieved throughout the lift thickness with 3 to 5 passes of the compaction equipment. Loose lift thicknesses for grading, fill and backfill activities should not exceed 12 inches. We recommend fill and backfill in building and paved areas be compacted to at least 95 percent of its maximum dry density as determined by ASTM D-1557. Crushed Stone should be compacted with 3 to 5 passes of a vibratory plate compactor having a static weight of at least 500 pounds.

4.9 Weather Considerations

Construction activity should be limited during wet and freezing weather and the site soils may require drying or thawing before construction activities may continue. The contractor should anticipate the need for water to temper fills in order to facilitate compaction during dry weather. If construction takes place during cold weather, subgrades, leveling pads and concrete must be protected during freezing conditions. Concrete and fill must not be placed on frozen soil; and once placed, the concrete and soil must be protected from freezing.

4.10 Paved Areas

We anticipate paved areas will be subjected primarily to passenger vehicle and light delivery truck traffic with occasional heavy delivery truck traffic. Considering the site soils, and proposed usage, we offer the following pavement section for consideration.

FLEXIBLE (HMA) PAVEMENT SECTION – 2020 MaineDOT Standard Specs	
Pavement Layer	Material Thickness
MaineDOT 9.5 mm Hot Mix Asphalt	1 ½ inches
MaineDOT 19.0 mm Hot Mix Asphalt	2 ½ inches
MaineDOT 703.06 Aggregate Base Type A	6 inches
MaineDOT 703.06 Aggregate Subbase Type D	12 inches

The base and subbase materials should be compacted to at least 95 percent of their maximum dry density as determined by ASTM D-1557. Hot mix asphalt pavement should be compacted to 92 to 97 percent of its theoretical maximum density as determined by ASTM D-2041. A tack coat should be used between successive lifts of bituminous pavement.

4.11 Design Review and Construction Testing

S.W.COLE should be retained to review the construction documents prior to bidding to determine that our earthwork, foundation, and pavement recommendations have been properly interpreted and implemented.

S.W.COLE should be retained to review pile design and wall design submittals.

A construction material testing and quality assurance program should be implemented during construction to observe compliance with the design concepts, plans, and specifications. S.W.COLE is available to observe earthwork activities, the preparation of foundation bearing surfaces and pavement subgrades, the installation of piles, as well as to provide testing services for soils, concrete, steel, and asphalt construction materials.

4.12 Recommendations for Additional Study

Bedrock bearing surfaces should be evaluated for stability on a case-by-case basis to determine if rock dowels are required or if footings are required to be pinned to the bedrock. Additionally, we recommend bedrock stability analysis be performed for the elevated walkway, once proposed pile locations and loads are available.

5.0 CLOSURE

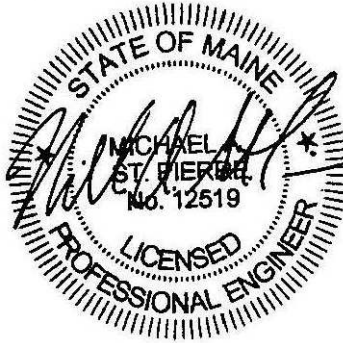
It has been a pleasure to be of assistance to you with this phase of your project. We look forward to working with you during the construction phase of the project.

Sincerely,

S. W. Cole Engineering, Inc.

Michael A. St. Pierre, P.E.
Principal Geotechnical Engineer

MAS-PRW:tjb-rec



APPENDIX A

Limitations

This report has been prepared for the exclusive use of Main Street Skowhegan for specific application to the proposed Riverfront Promenade of Patten Court in Skowhegan, Maine. S. W. Cole Engineering, Inc. (S.W.COLE) has endeavored to conduct our services in accordance with generally accepted soil and foundation engineering practices. No warranty, expressed or implied, is made.

The soil profiles described in the report are intended to convey general trends in subsurface conditions. The boundaries between strata are approximate and are based upon interpretation of exploration data and samples.

The analyses performed during this investigation and recommendations presented in this report are based in part upon the data obtained from subsurface explorations made at the site. Variations in subsurface conditions may occur between explorations and may not become evident until construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and to review the recommendations of this report.

Observations have been made during exploration work to assess site groundwater levels. Fluctuations in water levels will occur due to variations in rainfall, temperature, and other factors.

S.W.COLE's scope of services has not included the investigation, detection, or prevention of any Biological Pollutants at the project site or in any existing or proposed structure at the site. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and the byproducts of any such biological organisms.

Recommendations contained in this report are based substantially upon information provided by others regarding the proposed project. In the event that any changes are made in the design, nature, or location of the proposed project, S.W.COLE should review such changes as they relate to analyses associated with this report. Recommendations contained in this report shall not be considered valid unless the changes are reviewed by S.W.COLE.

APPENDIX B

Figures



LEGEND:

APPROXIMATE BORING LOCATION

NOTES:

1. EXPLORATION LOCATION PLAN WAS PREPARED FROM A 1"=30' SCALE PLAN OF THE SITE ENTITLED "BOUNDARY SURVEY," PREPARED BY SACKETT & BRAKE SURVEY, INC., DATED 2/27/2024.
2. THE BORING LOCATIONS WERE SELECTED BY PRINCIPLE AND SUBSEQUENTLY ESTABLISHED IN THE FIELD BY S. W. COLE ENGINEERING, INC. USING A MAPPING GRADE GNSS RECEIVER.
3. THIS PLAN SHOULD BE USED IN CONJUNCTION WITH THE ASSOCIATED S. W. COLE ENGINEERING, INC. GEOTECHNICAL REPORT.
4. THE PURPOSE OF THIS PLAN IS ONLY TO DEPICT THE LOCATION OF THE EXPLORATIONS IN RELATION TO THE EXISTING CONDITIONS AND PROPOSED CONSTRUCTION AND IS NOT TO BE USED FOR CONSTRUCTION.



MAIN STREET SKOWHEGAN
EXPLORATION LOCATION PLAN
PROPOSED RIVER WALK PARK
MAIN STREET
SKOWHEGAN, MAINE

Job No.: 22-2147
Date: 11/12/2024
Scale: 1" = 30'
Sheet: 1

APPENDIX C

Exploration Logs and Key

KEY TO NOTES & SYMBOLS

Test Boring and Test Pit Explorations

Stratification lines represent the approximate boundary between soil types and the transition may be gradual.

Key to Symbols Used:

w	-	water content, percent (dry weight basis)
q _u	-	unconfined compressive strength, kips/sq. ft. - laboratory test
S _v	-	field vane shear strength, kips/sq. ft.
L _v	-	lab vane shear strength, kips/sq. ft.
q _p	-	unconfined compressive strength, kips/sq. ft. – pocket penetrometer test
O	-	organic content, percent (dry weight basis)
W _L	-	liquid limit - Atterberg test
W _P	-	plastic limit - Atterberg test
WOH	-	advance by weight of hammer
WOM	-	advance by weight of man
WOR	-	advance by weight of rods
HYD	-	advance by force of hydraulic piston on drill
RQD	-	Rock Quality Designator - an index of the quality of a rock mass.
γ _T	-	total soil weight
γ _B	-	buoyant soil weight

Description of Proportions:

Trace:	0 to 5%
Some:	5 to 12%
"Y"	12 to 35%
And	35+%
With	Undifferentiated

Description of Stratified Soils

Parting:	0 to 1/16" thickness
Seam:	1/16" to 1/2" thickness
Layer:	1/2" to 12" thickness
Varved:	Alternating seams or layers
Occasional:	one or less per foot of thickness
Frequent:	more than one per foot of thickness

REFUSAL: Test Boring Explorations - Refusal depth indicates that depth at which, in the drill foreman's opinion, sufficient resistance to the advance of the casing, auger, probe rod or sampler was encountered to render further advance impossible or impracticable by the procedures and equipment being used.

REFUSAL: Test Pit Explorations - Refusal depth indicates that depth at which sufficient resistance to the advance of the backhoe bucket was encountered to render further advance impossible or impracticable by the procedures and equipment being used.

Although refusal may indicate the encountering of the bedrock surface, it may indicate the striking of large cobbles, boulders, very dense or cemented soil, or other buried natural or man-made objects or it may indicate the encountering of a harder zone after penetrating a considerable depth through a weathered or disintegrated zone of the bedrock.



BORING LOG

BORING NO.: B-101
SHEET: 1 of 1
PROJECT NO. 22-2147
DATE START: 10/23/2024
DATE FINISH: 10/23/2024

CLIENT: Main Street Skowhegan
PROJECT: Proposed Riverfront Promenade
LOCATION: Off Patten Court, Skowhegan, Maine

Drilling Information

LOCATION: See exploration location plan ELEVATION (FT): N/A TOTAL DEPTH (FT): 3.8 LOGGED BY: Aaron Smart
DRILLING CO.: Seaboard Drilling, LLC DRILLER: Ryan Hackett DRILLING METHOD: Hollow Stem Augers
RIG TYPE: Track Mounted Diedrich D-50 AUGER ID/OD: 4 1/4 in / 7 5/8 in SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic HAMMER WEIGHT (lbs): 140 / 300 CASING ID/OD: N/A /N/A CORE BARREL:
HAMMER CORRECTION FACTOR: HAMMER DROP (inch): 30 / 16
WATER LEVEL DEPTHS (ft): No free water observed.

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Thin Walled Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
Ø = Friction Angle (Estimated)
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
			1D		0.6-2.6	24/18	12-14- 11-21		0.4 Pavement Medium dense, brown, fine to medium SAND & GRAVEL, some silt (Fill)		
			2D		2.6-2.9	4/4	50/4"		Dense to very dense, brown, gravelly silty SAND (Fill)		

Auger Refusal at 3.8 feet
Possible Bedrock

Stratification lines represent approximate boundary between soil types; transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: B-101



BORING LOG

BORING NO.: **B-102**
SHEET: 1 of 1
PROJECT NO. 22-2147
DATE START: 10/23/2024
DATE FINISH: 10/23/2024

CLIENT: Main Street Skowhegan
PROJECT: Proposed Riverfront Promenade
LOCATION: Off Patten Court, Skowhegan, Maine

Drilling Information

LOCATION: See exploration location plan ELEVATION (FT): N/A TOTAL DEPTH (FT): 3.6 LOGGED BY: Aaron Smart
DRILLING CO.: Seaboard Drilling, LLC DRILLER: Ryan Hackett DRILLING METHOD: Hollow Stem Augers
RIG TYPE: Track Mounted Diedrich D-50 AUGER ID/OD: 4 1/4 in / 7 5/8 in SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic HAMMER WEIGHT (lbs): 140 / 300 CASING ID/OD: N/A /N/A CORE BARREL:
HAMMER CORRECTION FACTOR: HAMMER DROP (inch): 30 / 16
WATER LEVEL DEPTHS (ft): No free water observed.

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Thin Walled Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
Ø = Friction Angle (Estimated)
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
			1D		0-2	24/14	4-5-6-4		0.5' Topsoil		
			2D		2-3.6	19/18	17-11-26-50/1"		Medium dense, brown silty SAND, trace organics (roots) (Fill) Dense, light brown fine SAND, some silt, some gravel trace organics (roots) (Fill)		

Auger Refusal at 3.6 feet
Possible Bedrock

Stratification lines represent approximate boundary between soil types; transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: **B-102**



BORING LOG

BORING NO.: B-103
SHEET: 1 of 1
PROJECT NO. 22-2147
DATE START: 10/23/2024
DATE FINISH: 10/23/2024

CLIENT: Main Street Skowhegan
PROJECT: Proposed Riverfront Promenade
LOCATION: Off Patten Court, Skowhegan, Maine

Drilling Information

LOCATION: See exploration location plan ELEVATION (FT): N/A TOTAL DEPTH (FT): 3.6 LOGGED BY: Aaron Smart
DRILLING CO.: Seaboard Drilling, LLC DRILLER: Ryan Hackett DRILLING METHOD: Hollow Stem Augers
RIG TYPE: Track Mounted Diedrich D-50 AUGER ID/OD: 4 1/4 in / 7 5/8 in SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic HAMMER WEIGHT (lbs): 140 / 300 CASING ID/OD: N/A /N/A CORE BARREL:
HAMMER CORRECTION FACTOR: HAMMER DROP (inch): 30 / 16
WATER LEVEL DEPTHS (ft): No free water observed.

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Thin Walled Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
Ø = Friction Angle (Estimated)
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
			1D		0.5-2.5	24/12	16-16- 11-7		0.5' Pavement Medium dense, brown, gravelly SAND, some silt (Fill)		
			2D		2.5-3.3	10/10	8-50/4"		Dense to very dense, reddish brown Silty SAND, some gravel (Fill)		

Auger Refusal at 3.6 feet
Possible Bedrock

Stratification lines represent approximate boundary between soil types; transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: B-103



BORING LOG

BORING NO.: **B-104**
SHEET: 1 of 1
PROJECT NO. 22-2147
DATE START: 10/23/2024
DATE FINISH: 10/23/2024

CLIENT: Main Street Skowhegan
PROJECT: Proposed Riverfront Promenade
LOCATION: Off Patten Court, Skowhegan, Maine

Drilling Information

LOCATION: See exploration location plan ELEVATION (FT): N/A TOTAL DEPTH (FT): 8.4 LOGGED BY: Aaron Smart
DRILLING CO.: Seaboard Drilling, LLC DRILLER: Ryan Hackett DRILLING METHOD: Hollow Stem Augers
RIG TYPE: Track Mounted Diedrich D-50 AUGER ID/OD: 4 1/4 in / 7 5/8 in SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic HAMMER WEIGHT (lbs): 140 / 300 CASING ID/OD: N/A / N/A CORE BARREL:
HAMMER CORRECTION FACTOR: HAMMER DROP (inch): 30 / 16
WATER LEVEL DEPTHS (ft): No free water observed.

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Thin Walled Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
Ø = Friction Angle (Estimated)
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
			1D		0.4-2.4	24/16	10-12- 12-19		0.3 Pavement Medium dense, brown, gravelly SAND, some silt (Fill)		
			2D		2.4-4.4	24/12	18-11- 11-10		Medium dense, brown gravelly silty SAND (Fill)		
	5		3D		5-7	24/12	8-15- 15-12		Dense, grayish brown SAND and GRAVEL, some silt, trace brick fragments (Fill)		
			4D		7-8.4	17/12	10-8- 50/5"		Dense to very dense, brown gravelly silty SAND (Fill)		

Auger Refusal at 8.4 feet
Possible Bedrock

Stratification lines represent approximate boundary between soil types; transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: **B-104**



BORING LOG

BORING NO.: B-106
SHEET: 1 of 1
PROJECT NO. 22-2147
DATE START: 10/22/2024
DATE FINISH: 10/22/2024

CLIENT: Main Street Skowhegan
PROJECT: Proposed Riverfront Promenade
LOCATION: Off Patten Court, Skowhegan, Maine

Drilling Information

LOCATION: See exploration location plan ELEVATION (FT): N/A TOTAL DEPTH (FT): 15.0 LOGGED BY: Aaron Smart
DRILLING CO.: Seaboard Drilling, LLC DRILLER: Ryan Hackett DRILLING METHOD: Hollow Stem Augers
RIG TYPE: Track Mounted Diedrich D-50 AUGER ID/OD: 4 1/4 in / 7 5/8 in SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic HAMMER WEIGHT (lbs): 140 / 300 CASING ID/OD: N/A /N/A CORE BARREL:
HAMMER CORRECTION FACTOR: HAMMER DROP (inch): 30 / 16
WATER LEVEL DEPTHS (ft): No free water observed.

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Thin Walled Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
Ø = Friction Angle (Estimated)
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
			1D		0.4-2.4	24/14	7-9-8-8		0.4 Pavement Medium dense, gray-brown, gravelly SAND, some silt (Fill)		Augered to 10 ft
			2D		2.4-4.4	24/12	11-9-8-4		Medium dense, brown, silty SAND, trace brick fragments (Fill)		
5			3D		5-7	24/20	2-1-1-2		Very loose, light brown, silty SAND (Fill)		
			4D		7-8.8	22/8	3-10-25-50/4"		Dense, brown, gravelly silty SAND (Fill)		
			1R		10-15	60/60	18		8.8 Weathered Bedrock Advanced by auger to 10 feet		
10									10.0 Hard, fresh to slightly weathered, dark gray METAPELITE, fractures are very close, low to high angle, smooth to rough, occasional inflined seams of silty clay, thinly laminated with high angle foliations		
15											

Auger Refusal at 8.9 feet
Possible Bedrock

Stratification lines represent approximate boundary between soil types; transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: B-106

BORING / WELL 10-12-2022 22-2147.GPJ SWCE TEMPLATE.GDT 11/25/24



BORING LOG

BORING NO.: **B-107**
SHEET: 1 of 1
PROJECT NO. 22-2147
DATE START: 10/22/2024
DATE FINISH: 10/22/2024

CLIENT: Main Street Skowhegan
PROJECT: Proposed Riverfront Promenade
LOCATION: Off Patten Court, Skowhegan, Maine

Drilling Information

LOCATION: See exploration location plan ELEVATION (FT): N/A TOTAL DEPTH (FT): 20.8 LOGGED BY: Aaron Smart
DRILLING CO.: Seaboard Drilling, LLC DRILLER: Ryan Hackett DRILLING METHOD: Cased Boring
RIG TYPE: Track Mounted Diedrich D-50 AUGER ID/OD: N/A / N/A SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic HAMMER WEIGHT (lbs): 140 / 300 CASING ID/OD: 4 in / 4 1/2 in CORE BARREL: NQ2
HAMMER CORRECTION FACTOR: HAMMER DROP (inch): 30 / 16
WATER LEVEL DEPTHS (ft): No free water observed.

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Thin Walled Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
Ø = Friction Angle (Estimated)
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
			1D		0-2	24/18	??-??-??		0.5 Dark brown TOPSOIL Loose, brown, SAND, some silt (Fill)		
			2D		2-4	24/12	??-??-??		Medium dense, grayish brown fine SAND, some silt (Fill)		
	5		3D		4-5.3	16/16	3-3- 50/4"		Brown, silty fine SAND, some gravel, some organics (relic topsoil and roots), (Fill)		Augered to 6.8 ft
			1R		6.8- 11.8	60/60	17		6.8 Hard, fresh, dark gray METAPELITE, fractures are very close to close, low to high angle, smooth to rough, occasional infilled seams of silty clay, thinly laminated with high angle foliations		Several withdrawals to clear core barrel of silty clay cuttings
	10		2R		11.8- 16.8	60/60	8		Similar to R1		
	15		3R		16.8- 20.8	48/41	50	ID 16030A Qu=4490 psi Unit Wt.=165.7 pcf ID 16031A Qu=1900 psi Unit Wt.=173.4 pcf	Similar to R1 except joints are moderate close		
	20										

Bottom of Exploration at 20.8 feet

Stratification lines represent approximate boundary between soil types; transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: **B-107**

BORING / WELL 10-12-2022 22-2147.GPJ SWCE TEMPLATE.GDT 11/25/24



BORING LOG

BORING NO.: **B-108**
SHEET: 1 of 1
PROJECT NO. 22-2147
DATE START: 10/21/2024
DATE FINISH: 10/21/2024

CLIENT: Main Street Skowhegan
PROJECT: Proposed Riverfront Promenade
LOCATION: Off Patten Court, Skowhegan, Maine

Drilling Information

LOCATION: See exploration location plan ELEVATION (FT): N/A TOTAL DEPTH (FT): 13.1 LOGGED BY: Aaron Smart
DRILLING CO.: Seaboard Drilling, LLC DRILLER: Ryan Hackett DRILLING METHOD: Cased Boring
RIG TYPE: Track Mounted Diedrich D-50 AUGER ID/OD: N/A / N/A SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic HAMMER WEIGHT (lbs): 140 / 300 CASING ID/OD: 4 in / 4 1/2 in CORE BARREL: NQ2
HAMMER CORRECTION FACTOR: HAMMER DROP (inch): 30 / 16
WATER LEVEL DEPTHS (ft): No free water observed.

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Thin Walled Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
Ø = Friction Angle (Estimated)
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
			1D		0.4-2.4	24/20	3-3-5-7		0.4 Pavement Loose, brown, silty SAND, some gravel (Fill)		Augered to 4.8 ft Several withdrawals to clear core barrel of silty clay cuttings
			2D		2.4-3.8	17/16	8-17-50/5"		3.0 Dense, grayish brown, gravelly silty SAND (Fill) Dense to very dense, grayish brown, SAND, some silt, some gravel		
5			1R		4.8-9.8	60/60	33		4.8 Hard, fresh to slightly weathered, dark gray METAPELITE, fractures are very close, low to high angle, smooth to rough, occasional inflied seams of silty clay, thinly laminated with high angle foliations		
10			2R		9.8-13.1	39/28	23		Similar to 1R		

Bottom of Exploration at 13.1 feet

Stratification lines represent approximate boundary between soil types; transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: **B-108**



BORING LOG

BORING NO.: **B-108A**
SHEET: 1 of 1
PROJECT NO. 22-2147
DATE START: 10/24/2024
DATE FINISH: 10/24/2024

CLIENT: Main Street Skowhegan
PROJECT: Proposed Riverfront Promenade
LOCATION: Off Patten Court, Skowhegan, Maine

Drilling Information

LOCATION: See Exploration Location Plan ELEVATION (FT): N/A TOTAL DEPTH (FT): 23.5 LOGGED BY: Michael St. Pierre
DRILLING CO.: Seaboard Drilling, LLC DRILLER: Ryan Hackett DRILLING METHOD:
RIG TYPE: AUGER ID/OD: N/A / N/A SAMPLER:
HAMMER TYPE: N/A HAMMER WEIGHT (lbs): N/A CASING ID/OD: N/A / N/A CORE BARREL:
HAMMER CORRECTION FACTOR: HAMMER DROP (inch): N/A
WATER LEVEL DEPTHS (ft): No free water observed.

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Thin Walled Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
Ø = Friction Angle (Estimated)
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
									See boring B-108 for summary of strata from 0 to 13.1 feet.		
	5										
			1R		13.1-15.1	24/22	17		13.1 Hard, fresh to slightly weathered, dark gray METAPELITE, fractures are very close to close, low to high angle, smooth to rough, thinly laminated with high angle foliations Similar to 1R		
	15		2R		15.1-18.1	36/29	33				
			3R		18.1-20.4	28/28	0		Similar to 2R		
	20		4R		20.4-23.5	37/37	54	ID 16033A Qu=6350 psi Unit Wt.=168.4 pcf	Similar to 3R except fractures are close to moderately close		
Bottom of Exploration at 23.5 feet											

Stratification lines represent approximate boundary between soil types; transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: **B-108A**

BORING / WELL 10-12-2022 22-2147.GPJ SWCE TEMPLATE.GDT 11/25/24



BORING LOG

BORING NO.: **B-109**
SHEET: 1 of 1
PROJECT NO. 22-2147
DATE START: 10/21/2024
DATE FINISH: 10/21/2024

CLIENT: Main Street Skowhegan
PROJECT: Proposed Riverfront Promenade
LOCATION: Off Patten Court, Skowhegan, Maine

Drilling Information

LOCATION: See exploration location plan ELEVATION (FT): N/A TOTAL DEPTH (FT): 7.7 LOGGED BY: Aaron Smart
DRILLING CO.: Seaboard Drilling, LLC DRILLER: Ryan Hackett DRILLING METHOD: Hollow Stem Augers
RIG TYPE: Track Mounted Diedrich D-50 AUGER ID/OD: 4 1/4 in / 7 5/8 in SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic HAMMER WEIGHT (lbs): 140 / 300 CASING ID/OD: N/A /N/A CORE BARREL:
HAMMER CORRECTION FACTOR: HAMMER DROP (inch): 30 / 16
WATER LEVEL DEPTHS (ft): No free water observed.

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Thin Walled Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
Ø = Friction Angle (Estimated)
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
			1D		0.4-2.4	24/24	10-14- 20-15		0.4 Pavement Dense, brown, gravelly SAND, some silt (Fill)		
			2D		2.4-4.4	24/20	8-7-5-4		Medium dense, brown, Silty SAND, some gravel (Fill)		
	5		3D		5-6	12/12	12-50		Dense, brown, silty SAND, some gravel, trace organics (rootlets) (Fill)		

Auger Refusal at 7.7 feet
Possible Bedrock

Stratification lines represent approximate boundary between soil types; transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: **B-109**



BORING LOG

CLIENT: Main Street Skowhegan
PROJECT: Proposed Riverfront Promenade
LOCATION: Off Patten Court, Skowhegan, Maine

BORING NO.: B-110
SHEET: 1 of 1
PROJECT NO. 22-2147
DATE START: 10/21/2024
DATE FINISH: 10/21/2024

Drilling Information

LOCATION: See exploration location plan ELEVATION (FT): N/A TOTAL DEPTH (FT): 15.6 LOGGED BY: Aaron Smart
DRILLING CO.: Seaboard Drilling, LLC DRILLER: Ryan Hackett DRILLING METHOD: Cased Boring
RIG TYPE: Track Mounted Diedrich D-50 AUGER ID/OD: N/A / N/A SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic HAMMER WEIGHT (lbs): 140 / 300 CASING ID/OD: 4 in / 4 1/2 in CORE BARREL: NQ2
HAMMER CORRECTION FACTOR: HAMMER DROP (inch): 30 / 16
WATER LEVEL DEPTHS (ft): No free water observed.

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Thin Walled Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
Ø = Friction Angle (Estimated)
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
			1D		0-2	24/5	1-4-5-6		0.4 Topsoil		
			2D		2-4	24/18	4-3-3-5		Loose, brown, silty SAND, trace organics (roots) (Fill)		
	5		3D		5-7	24/12	4-3-2-1		Loose, brown, silty SAND, some gravel, trace brick fragments (Fill)		
			4D		7-8.3	15/12	12-30-50/3"		Dense to very dense, brown, silty SAND, trace brick fragments, trace organics (roots) (Fill)		
									8.3 Weathered Bedrock Advanced by auger		Augered to 9.8 ft
	10		1R		9.8-14.8	60/60	22		9.8 Hard, fresh to slightly weathered, dark gray METAPELITE, moderate low to high angle fracturing, fractures smooth to rough, occasional seams of silty clay, thinly laminated and high angle foliations		Several withdrawals to clear core barrel of silty clay cuttings
	15		2R		14.8-15.6	9/9	0		Similar to 1R		

Bottom of Exploration at 15.6 feet

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: B-110

BORING / WELL 10-12-2022 22-2147.GPJ SWCE TEMPLATE.GDT 11/25/24



BORING LOG

BORING NO.: **B-111**
SHEET: 1 of 1
PROJECT NO. 22-2147
DATE START: 10/22/2024
DATE FINISH: 10/22/2024

CLIENT: Main Street Skowhegan
PROJECT: Proposed Riverfront Promenade
LOCATION: Off Patten Court, Skowhegan, Maine

Drilling Information

LOCATION: See exploration location plan ELEVATION (FT): N/A TOTAL DEPTH (FT): 6.8 LOGGED BY: Aaron Smart
DRILLING CO.: Seaboard Drilling, LLC DRILLER: Ryan Hackett DRILLING METHOD: Cased Boring
RIG TYPE: Track Mounted Diedrich D-50 AUGER ID/OD: N/A / N/A SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic HAMMER WEIGHT (lbs): 140 / 300 CASING ID/OD: 4 in / 4 1/2 in CORE BARREL: NQ2
HAMMER CORRECTION FACTOR: HAMMER DROP (inch): 30 / 16
WATER LEVEL DEPTHS (ft): No free water observed.

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Thin Walled Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
Ø = Friction Angle (Estimated)
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
			1D		0.5-2.5	24/12	10-11- 13-8		0.4 Pavement Medium dense, brown Silty SAND, trace gravel (Fill)		
			2D		2.5-4.5	24/20	6-5-2-2		Loose, brown, silty SAND, some gravel, trace brick fragments (Fill)		
	5		3D		5-6.8	21/16	2-2-9- 50/3"		Medium dense, brown, silty SAND, some gravel, trace organics (rootlets) (Fill)		

Bottom of Exploration at 6.8 feet

Stratification lines represent approximate boundary between soil types; transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: **B-111**



BORING LOG

BORING NO.: **B-112**
SHEET: 1 of 1
PROJECT NO. 22-2147
DATE START: 10/21/2024
DATE FINISH: 10/21/2024

CLIENT: Main Street Skowhegan
PROJECT: Proposed Riverfront Promenade
LOCATION: Off Patten Court, Skowhegan, Maine

Drilling Information

LOCATION: See exploration location plan ELEVATION (FT): N/A TOTAL DEPTH (FT): 5.6 LOGGED BY: Aaron Smart
DRILLING CO.: Seaboard Drilling, LLC DRILLER: Ryan Hackett DRILLING METHOD: Hollow Stem Augers
RIG TYPE: Track Mounted Diedrich D-50 AUGER ID/OD: 4 1/4 in / 7 5/8 in SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic HAMMER WEIGHT (lbs): 140 / 300 CASING ID/OD: N/A / N/A CORE BARREL:
HAMMER CORRECTION FACTOR: HAMMER DROP (inch): 30 / 16
WATER LEVEL DEPTHS (ft): No free water observed.

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Thin Walled Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
Ø = Friction Angle (Estimated)
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
			1D		0.4-2.4	24/24	7-4-6-6		0.4 Pavement Loose, gray-brown, SAND, some gravel, some debris (brick fragments, ash, glass) (Fill)		
			2D		2.4-4.4	24/2	12-12- 8-5		Medium dense, brown, silty SAND, some gravel, trace brick fragments (Fill)		
	5		3D		5-5.6	7/6	47- 50/1"		Dense to very dense, brown, SAND and SILT, some gravel (Fill)		

Auger Refusal at 5.6 feet
Possible Bedrock

Stratification lines represent approximate boundary between soil types; transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: **B-112**



BORING LOG

BORING NO.: **B-113**
SHEET: 1 of 1
PROJECT NO. 22-2147
DATE START: 10/22/2024
DATE FINISH: 10/22/2024

CLIENT: Main Street Skowhegan
PROJECT: Proposed Riverfront Promenade
LOCATION: Off Patten Court, Skowhegan, Maine

Drilling Information

LOCATION: See exploration location plan ELEVATION (FT): N/A TOTAL DEPTH (FT): 6.5 LOGGED BY: Aaron Smart
DRILLING CO.: Seaboard Drilling, LLC DRILLER: Ryan Hackett DRILLING METHOD: Hollow Stem Augers
RIG TYPE: Track Mounted Diedrich D-50 AUGER ID/OD: 4 1/4 in / 7 5/8 in SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic HAMMER WEIGHT (lbs): 140 / 300 CASING ID/OD: N/A /N/A CORE BARREL:
HAMMER CORRECTION FACTOR: HAMMER DROP (inch): 30 / 16
WATER LEVEL DEPTHS (ft): No free water observed.

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS: Water Level
At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Thin Walled Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
Ø = Friction Angle (Estimated)
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
			1D		0.4-2.4	24/10	12-10- 9-5		0.4 Pavement Medium dense, brown, SAND, some silt, some gravel (Fill)		
			2D		2.4-4.4	24/6	6-5-4-9		Loose, gray-brown, silty gravelly SAND (Fill)		
	5		3D		5-6.5	18/15	9-26- 32		5.0 Very dense, light brown Silty SAND, some gravel (GLACIAL TILL)		

Bottom of Exploration at 6.5 feet

Stratification lines represent approximate boundary between soil types; transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: **B-113**



BORING LOG

BORING NO.: **B-114**
SHEET: 1 of 1
PROJECT NO. 22-2147
DATE START: 10/23/2024
DATE FINISH: 10/23/2024

CLIENT: Main Street Skowhegan
PROJECT: Proposed Riverfront Promenade
LOCATION: Off Patten Court, Skowhegan, Maine

Drilling Information

LOCATION: See exploration location plan ELEVATION (FT): N/A TOTAL DEPTH (FT): 6.4 LOGGED BY: Aaron Smart
DRILLING CO.: Seaboard Drilling, LLC DRILLER: Ryan Hackett DRILLING METHOD: Solid Stem Auger
RIG TYPE: Track Mounted Diedrich D-50 AUGER ID/OD: N/A / 4 1/2 in SAMPLER: N/A
HAMMER TYPE: N/A HAMMER WEIGHT (lbs): 140 / 300 CASING ID/OD: N/A /N/A CORE BARREL:
HAMMER CORRECTION FACTOR: HAMMER DROP (inch): 30 / 16
WATER LEVEL DEPTHS (ft): No free water observed.

GENERAL NOTES:

KEY TO NOTES AND SYMBOLS:
Water Level
At time of Drilling
At Completion of Drilling
After Drilling
D = Split Spoon Sample
U = Thin Walled Tube Sample
R = Rock Core Sample
V = Field Vane Shear
Pen. = Penetration Length
Rec. = Recovery Length
bpf = Blows per Foot
mpf = Minute per Foot
WOR = Weight of Rods
WOH = Weight of Hammer
RQD = Rock Quality Designation
PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.
q_u = Unconfined Compressive Strength, kips/sq.ft.
Ø = Friction Angle (Estimated)
N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION					Graphic Log	Sample Description & Classification	H ₂ O Depth	Remarks
			Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD				
	5								0.4 — Pavement Brown, silty gravelly SAND (Fill)		

Auger Refusal at 6.4 feet
Possible Bedrock

Stratification lines represent approximate boundary between soil types; transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING NO.: **B-114**

**Proposed Riverfront Promenade
Skowhegan, Maine**
Rock Core Photograph

Boring No.	Run	Depth (ft)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
B-106	1R	10.0 – 15.0	60	100%	11	18%	METAPELITE	1
B-107	1R	6.8 – 11.8	60	100%	10	17%	METAPELITE	2
B-107	2R	11.8 – 16.8	60	100%	5	8%	METAPELITE	3
B-107	3R	16.8 – 20.8	41	85%	24	50%	METAPELITE	



Notes: 1. "Box row" indicates the section of the box where the core run is contained: 1 = top, 4 = bottom.
2. Transition between core runs within box row is marked by wood separators.



**Proposed Riverfront Promenade
Skowhegan, Maine**
Rock Core Photograph

Boring No.	Run	Depth (ft)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
B-110	1R	9.8 – 14.8	60	100%	13	22%	METAPELITE	1
B-110	2R	14.8 – 15.6	9	100%	0	0%	METAPELITE	2
B-108	1R	4.8 – 9.8	60	73%	20	33%	METAPELITE	3
B-108	2R	9.8 – 13.1	28	72%	9	23%	METAPELITE	4



Notes: 1. "Box row" indicates the section of the box where the core run is contained: 1 = top, 4 = bottom.
2. Transition between core runs within box row is marked by wood separators.



**Proposed Riverfront Promenade
Skowhegan, Maine**
Rock Core Photograph

Boring No.	Run	Depth (ft)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
B-108A	1R	13.1 – 15.1	22	92%	4	17%	METAPELITE	1
B-108A	2R	15.1 – 18.1	29	81%	12	33%	METAPELITE	1
B-108A	3R	18.1 – 20.4	28	100%	0	0%	METAPELITE	2
B-108A	4R	20.4 – 23.5	37	100%	20	54%	METAPELITE	2/3



Notes: 1. "Box row" indicates the section of the box where the core run is contained: 1 = top, 4 = bottom.
2. Transition between core runs within box row is marked by wood separators.

Soil Management Plan

Skowhegan Riverfront Walkway – Phase 1

PREPARED FOR

Main Street Skowhegan
65 Water Street
Skowhegan, ME 04976
207.612.2571

PREPARED BY



600 Southborough Drive
Suite 100
South Portland, ME 04106
207.889.3150

November 4, 2025

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1

Purpose

Town of Skowhegan ("The Town") is advancing the Skowhegan River Park ("SRP") project, which includes improving visual connections to the Kennebec River. The first Phase of the Project, "Phase 1", includes the construction of a riverfront walkway / boardwalk. This Soil Management Plan ("SMP") addresses Phase 1 of the SRP Project. The "Site" is defined as the Phase 1 Project Area (see Figure 1).

Based on the urban nature of this Site and the historical industrial uses of the area, soils impacted by contaminants typically encountered in urban, developed, industrial settings are anticipated (heavy metals, polycyclic aromatic hydrocarbons, "PAHs") to be present in the project area. Should contaminated soils be encountered or otherwise disturbed, it is necessary to have established procedures in place to determine the nature and degree of the contamination and to safely handle, manage, and dispose of the contaminated soil. This plan describes the procedures that must be followed when contractors, employees, or other project stakeholders are engaged in excavation or other soil-disturbing activities at the site. Any persons engaged in excavation or other soil—disturbing activities at the site must follow the specific requirements set forth in this plan.

This plan was developed to address one of the obligations of the property owner in order to receive Community Project Funding ("CPF") Grant B-22-CP-ME-0420 from the Department of Housing and Urban Development ("HUD") and to comply with Maine Department of Environmental Protection ("MEDEP") regulations.

It is the responsibility of the property owner to ensure that this management plan is followed. If you have questions regarding the requirements of this plan, please contact VHB at 802-497-6100 or the staff in the MEDEP's Voluntary Response Action Program ("VRAP") at 207-215-8597.

2

Background

A. Brief Site History

The Site is located in downtown Skowhegan, on the north bank of the Kennebec River. It is situated along Patten Place, also known as River Street—both historical names for the alley behind the businesses on the south side of Water Street.

Based on historical Sanborn fire insurance maps, the site was developed as early as 1884, featuring a residence and a stone cutting business, and was situated next to the railroad and its bridge over the Kennebec River. The surrounding area included both residential and commercial properties. By 1892, section housing had been built adjacent to the railroad. Beginning in 1897, the site appears to have been primarily residential, with several homes constructed along Patten Place (also known as River Street). These residences were likely demolished in the 1980s and replaced with a paved asphalt parking and driveway area, along with vegetated land along the riverbank.

Multiple businesses have adjoined the Site, notably People's Laundry in 1909. In the surrounding vicinity of downtown Skowhegan, multiple businesses have operated including a blacksmith shop, automotive repair, gasoline service stations, drycleaners, print shops, mills, and other commercial businesses which likely utilized petroleum and hazardous materials.

B. Previous Site Investigations

As a part of an initial environmental desktop review conducted by VHB in 2025, the MEDEP online databases were reviewed to identify documented releases of petroleum and/or hazardous substances that may potentially impact environmental conditions within the Project Area. The databases reviewed include the Remediation Sites (Institutional Controls) Database, Technical Services Spill Projects, Hazardous Oil Spill System ("HOSS") Sites, Registered Petroleum Tanks Database, and Solid Waste - Closed Municipal Landfills. Four MEDEP listings were identified within a 500-foot radius of the proposed Project that have a potential to impact environmental conditions within the Project Area. Based on the MEDEP listings in the vicinity of the Project Area, as well as the history of commercial development on nearby properties, there is potential for environmental impacts within the Project Area. The surrounding area has included businesses such as a blacksmith shop, automotive repair facilities, gasoline service stations, drycleaners, print shops, mills, and other commercial enterprises. Many of these businesses likely utilized petroleum products and

other hazardous materials. As a result, contaminants released to the subsurface from these nearby properties could affect environmental conditions within the Project Area. This risk is similar to concerns commonly found in other urban settings. Contaminated environmental media (if encountered) would require proper management during construction. This SMP has been prepared to identify the proper procedures for on-site management and off-site disposal of potentially contaminated soil. Groundwater is not anticipated to be encountered during this Project due to the groundwater table exceeding final proposed excavation depths.

During a site visit conducted by VHB on July 31, 2025, it was observed that the area was paved with asphalt and vegetation was present along the riverbank. No structures or environmental concerns were identified within the site boundaries or in the immediate vicinity. A Phase II Site Investigation / Soil Pre-Characterization assessment has not been performed to date on the soils proposed to be disturbed. Therefore, this SMP assumes the soils will be impacted with typical urban contaminants, which may include heavy metals and PAHs above MEDEP Remedial Action Guidelines for Contaminated Sites ("RAGs"). While not currently suspected, there is also the potential for other contaminants such as petroleum and/or chlorinated volatile organic compounds ("VOCs") to be encountered. This Site Management Plan describes the procedures by which soils will be handled, including on-Site stockpiling and sampling to adequately profile the soil prior to off-Site disposal. Characterizing the soils ex-situ and comparing contaminant concentrations to the MEDEP RAGs will indicate whether soils will need to be disposed of at an appropriate landfill or can be re-used on or off-Site. Alternatively, soils may be pre-characterized in-situ; however, the soils may still need to be stockpiled on-Site in order for additional sampling to be conducted to satisfy landfill requirements.

3

Site Conditions and Criteria

A. Availability of this Document

A copy of this document must be provided to employees, contractors, subcontractors, and other persons who may contact or disturb soils being managed by this plan.

B. Activities Covered Under this Plan

Soil disturbance is covered under this plan and includes all earthwork activities such as excavation, grading, soil relocation, and soil transport and/or disposal and/or re-use off-Site.

C. Contaminants of Concern (COCs)

COCs typical of urban environments are anticipated, which include heavy metals and PAHs. While not currently suspected, there is also the potential for other contaminants such as petroleum and/or chlorinated VOCs to be encountered. If visibly oily, discolored, or otherwise impacted soils are encountered during earthwork, the EP should be notified and those soils should be screened with a PID, segregated from other soils, and stored within their own poly-encapsulated stockpile.

D. Areas of Concern (AOCs)

An AOC is the location where known or suspected release(s) to the environment may have occurred, that could adversely impact the environmental quality of that area. No specific area within the Phase 1 Project Area is identified as an AOC. The entire Project Area is considered an AOC under this SMP, based on the prior uses of the Project Area and surrounding downtown Skowhegan (as discussed in Section 2A, Brief Site History)

E. Guidelines Applied

The MEDEP's RAGs effective November 15, 2023, will be compared to the analyte results of representative soil samples that have yet to be collected in the Phase 1 Project Area.

F. Exposure Pathways and Scenarios Discussion

Currently, there are no exposure pathways for assumed COCs in soil as the Project Area is paved, and therefore there does not appear to be public contact with soils.

During construction, workers may be exposed to COCs in soil primarily via inhalation, direct contact, and ingestion. Controls and Personal Protective Equipment (“PPE”) may be employed to limit worker exposure. All contractors shall follow the procedures outlined in this SMP and the procedures outlined in their Health & Safety Plan.

Post-construction, no exposure pathways are identified as soils will be isolated under a boardwalk, and therefore there will be limited to no public contact with underlying soils.

G. Accessibility of Soil

The maximum proposed excavation depth for this Project is approximately 8 to 9 feet below ground surface. Accessible (upper 2-feet) and Potentially Accessible soils (between 2 and 15 feet) as defined in the RAGs will be disturbed during construction.

H. Engineering Controls

Imported fill and the finished surface (boardwalk) will limit public access to the underlying soils.

4

Maintenance of Soil Cover

The property owner maintains responsibility for the maintenance of the boardwalk, which is the finished surface defined as limiting the potential for public contact with underlying soils.

5

Soil Management / Disturbance Procedures

A. Notification to MEDEP VRAP Program

The MEDEP VRAP Program will be notified by the Environmental Professional (EP) hired by the project leader (Main Street Skowhegan) prior to the start of construction.

B. Environmental Professional Oversight

The project leader will retain an EP to monitor the implementation of the procedures prescribed by this SMP. The EP will prepare post-construction reporting.

C. Best Management Practices

The Best Management Practices for handling soils are presented in the following subsections.

D. Safety

The Contractor shall be responsible for oversight and direction of their employees to perform work in accordance with this SMP, the Contractor's Health and Safety Plan, and City requirements and guidance. The Contractor is also responsible for notifying workers of potential contamination risks in accordance with the Hazard Communication Standard, 29 CFR 1910.1200.

E. Contamination Identification

Ex-situ sampling of soil stockpiles is currently proposed. Sampling will be conducted in accordance with licensed landfill pre-approval guidelines, including the density of samples to be collected (typically based on volume and/or weight of soil) and the analyses to be performed in order to sufficiently characterize the contaminants and their concentrations in the stockpile.

Alternatively, soils may be pre-characterized in situ; however, additional sampling of the stockpile may be required to meet landfill acceptance criteria, if the in-situ samples are determined not to properly characterize the soils to be exported.

F. Soil Excavation

An estimated 450 cubic yards (CY) of soil will be excavated and stockpiled onsite. Based on the results of the soil stockpile characterization, this material will be transported offsite either to a landfill or to a suitable reuse location. The excavation of soil has the potential to generate dust that could be a potential health hazard to workers and/or the public. Therefore, during excavation activities, the Contractor shall visually evaluate the Project Area for fugitive dust and employ dust suppression techniques as needed to minimize visible dust and mitigate the risk. Additionally, the Contractor is responsible for proactively monitoring weather forecasts and preparing dust suppression measures accordingly to avoid the generation of fugitive dust.

The Contractor is responsible for managing accidental off-site tracking of soils via tires/equipment tracks and preparing mitigation measures accordingly, such as the installation of track-out mats and street sweeping if tracking occurs.

G. Management of Excavated Soil (Segregation of Clean and Contaminated Soil)

For the purposes of this SMP, all soils are considered contaminated until representative analytical data of the stockpiled soils, demonstrate otherwise. All stockpiling should comply with the requirements described in sub-section I. If visibly oily, discolored, or otherwise impacted soils are encountered during earthwork, the EP should be notified and those soils should be screened with a PID, segregated from other soils, and stored within their own poly-encapsulated stockpile.

H. Groundwater Management

No groundwater is anticipated to be encountered during this Project based on maximum proposed excavation depths and groundwater elevations understood in the area. Therefore, no groundwater management is included in this SMP. If this changes, the EP must be contacted prior to any dewatering.

I. Containment/Stockpiling/Storage

Poly-encapsulated soil stockpiles shall be securely enclosed with 6-mil (minimum thickness) polyethylene sheeting under and over the pile. The polyethylene sheeting covering the stockpile shall overlay the polyethylene sheeting underlying the stockpile, to shed precipitation away from the stockpile and prevent ingress of water into the stockpile. Seams between sheets of polyethylene shall overlap a minimum of four feet and shall also be arranged to prevent ingress of water into the stockpile. Poly-encapsulated soil stockpiles shall be covered during significant rain events and when not in active use, including overnight. Polyethylene sheeting shall be adequately secured with weights (potentially connected by ropes) to prevent damage or breaches due to wind. Polyencapsulated soil stockpiles shall be inspected daily by the Contractor, the inspections shall be documented, and any damaged polyethylene sheeting shall be replaced immediately, or as directed by the EP. Public access to the poly-encapsulated soil stockpiles shall be prohibited and posted with no trespassing signage to be placed and maintained by the Contractor.

J. Backfilling Criteria

The Project currently proposes backfilling with imported soils and/or engineered fill.

K. Disposal of Soil

Special waste characterization profiles that are required for solid waste disposal facility (i.e landfill) acceptance of non-hazardous contaminated soil shall be prepared by the Contractor, reviewed by the EP, signed by the owner, and approved in writing by the selected solid waste disposal facility prior to excavation of non-hazardous contaminated soil.

Number of truckloads, approximate truckload volume, and the location where the material was taken will be tracked and documented by the construction contractor for the relocation of this soil outside of the Project Area.

L. Documentation of Activities

The EP shall document the earthwork activities and prepare a post-construction report to be submitted to VRAP.

6

Modifications to Plan

Any modifications to this plan requires written approval from MEDEP VRAP.

Figure 1 Project Location Map (Area of Concern)



December 5, 2025

Skowhegan, Maine

SECTION 011000
GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Project information
 - 2. Work covered by the Contract Documents
 - 3. Phasing and Scheduling
 - 4. Future work
 - 5. Access to site
 - 6. Work restrictions
 - 7. Specification and drawing conventions
 - 8. Miscellaneous provisions.

1.2 PROJECT INFORMATION

- A. Project Location: as shown on the Drawings and generally found adjacent to the intersection of Patten Court and the Pedestrian Bridge in Skowhegan, Maine.
- B. Project Description: The scope of work includes construction services for an accessible boardwalk along a portion of the gorge bank of the Kennebec River with landscaping, hardscaping, lighting, and other amenities as indicated in the Contract Documents.
- C. Owner: Main Street Skowhegan (MSS) via a lease of land from the Town of Skowhegan. The terms "Owner " and "MSS" are synonymous.
- D. Design Team:
 - 1. Civil: VHB
 - 2. Architect: Principle Group
 - 3. Structural: Buro-Happold
 - 4. Electrical: Buro-Happold
 - 5. Geotechnical: SW Cole

1.3 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work includes all items necessary to deliver a complete and operational Project, whether or not each item is specifically mentioned, provided it is reasonably inferable from the Contract Documents.
- B. The Contractor shall provide temporary facilities, protection, safety measures, coordination, and construction services required for the proper execution and completion of the Work.

December 5, 2025

Skowhegan, Maine

1.4 PHASING and SCHEDULING

- A. Perform Work in phases as necessary to maintain Owner operations (if applicable).
- B. The Contractor shall prepare and maintain a construction schedule showing major work activities, submittals, delivery dates, and critical path items.
- C. Notify Owner in advance of shutdowns, utility interruptions, or restricted access.

1.5 FUTURE WORK

- A. Contractor will coordinate with Owner such that future work under separate contract and subsequent to this scope can be carried out smoothly without interfering or delaying work under this Contract.

1.6 ACCESS to SITE

- A. General: Contractor shall have full use of Project site for construction operations, including use of Project site, during the construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.
 - 1. Driveways, Walkways and Entrances: Keep drive aisles, loading areas, and entrances serving premises and adjacent buildings clear and available to Owner, abutters, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - 2. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - 3. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- B. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations and return to original condition.
- C. Do not load structure(s) with weight that will endanger structure.
- D. Contractor is responsible for protection and safe keeping of all materials, products, and equipment stored on the premises or incorporated into the Work until complete and acceptable to the Owner. Contractor will move any stored materials, products, or equipment that interferes with the operations of Owner or others.
- E. Special Owner Requirements: The Owner is not aware of existing hazardous materials. If during the performance of the Work suspected hazardous materials are encountered, notify Owner immediately. The Owner will negotiate a separate contract for the containment or removal of such

December 5, 2025

Skowhegan, Maine

materials.

1.7 WORK RESTRICTIONS

- A. General Work Restrictions: Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
 - 2. Limit use of the premises to areas required for proper execution of the Work.
 - 3. Maintain Owner and Public access to existing operations, parking areas, walkways and emergency routes.
 - 4. Keep driveways, fire lanes, and access roads free of obstruction.
 - 5. Confine operations to designated staging areas.
- B. On-Site Work Hours: Limit work during normal business working hours as permitted by Town of Skowhegan ordinance and approvals, Monday through Friday 7am to 7pm, except otherwise indicated.
 - 1. Weekend Hours: None unless specifically approved and permitted by the Town of Skowhegan
 - 2. Early Morning Hours: No noise generating activities prior to 7:00 AM as permitted by Town of Skowhegan ordinance and approvals.
 - 3. Hours for Core Drilling, pile driving, cut off saw work, and similar extraordinary noisy construction activities: No noise generating activities prior to 7:00 AM or as permitted by Town of Skowhegan ordinance and approvals, whichever is most restrictive.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Owner not less than 5 working days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Owner's written permission.
 - 3. Maintain a log of work, including preparation, work events, re-established service procedures, and final completion.
- D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner or abutters with Owner.
 - 1. Notify Owner not less than 5 working days in advance of proposed disruptive operations.
 - 2. Comply with Town of Skowhegan ordinance and approvals, except otherwise indicated.
 - 3. Obtain Owner's written permission before proceeding with disruptive operations.
- E. Restricted Substances: Use of controlled substances on Project site is not permitted.
- F. Parking: Use designated areas of Owner's existing parking only when authorized by Owner, and only in number and use limits as defined by Owner. Contractor is responsible for all parking for Contractor staff if on-site parking is available. If Owner makes existing parking available,

Contractor is responsible for all additional parking required in excess of spaces provided by Owner.

1. Construct and maintain temporary parking areas where indicated on Drawings.
2. Where temporary parking areas occur at same location as permanent areas, construct as specified under Division 32 paving sections, except omit top course, and reconstruct as specified to convert to permanent pavement.
3. Where temporary parking areas do not occur at same location as permanent areas, remove topsoil and excavate as required to install minimum 12-inches run-of-crusher limestone. After road is no longer needed, remove stone and restore to original condition, unless otherwise indicated.
4. All costs for contractor and sub-contractor parking shall be included in the bid.
5. The Owner does not provide designated parking or transportation to the job site from available parking areas.
6. Construction workers may park within a designated on-site construction yard if authorized by Owner. This area shall be fenced, and it is the responsibility of the Contractor project manager/construction foreman to inform workers that any vehicles parked outside the fenced area are subject to parking citation as applicable. Only contractor company vehicles or equipment are permitted to park inside the fenced construction area.

1.8 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 50-division format and CSI/CSC's "Master Format" numbering system.
 1. Section Identification: The Specifications use Section numbers and titles to help cross referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete because all available Section numbers are not used. Consult the Table of Contents at the beginning of the Project Manual to determine numbers and names of Sections in the Contract Documents.
 2. Division 01: Sections in Division 01 govern the execution of the Work of all Sections in the Specifications.
- B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall

be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
- C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- D. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings.
 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

1.9 MISCELLANEOUS PROVISIONS

- A. Pedestrian Bridge: The existing Pedestrian Bridge will remain an active walkway for the public during construction. Maintain a protected walkway, free of construction debris, to connect the Pedestrian Bridge to the public way of Patten Court.
 1. If necessary to complete construction, notify Owner not less than 5 working days in advance of a proposed temporary closure of the Pedestrian Bridge.
 2. Provide a bridge closure schedule for Owner approval.
- B. Soil Management Plan: The project's funding source obliges compliance with the HUD requirement of developing and following a Soil and Groundwater Management Plan. Please refer to the Appendix of the Project Manual for the Soil Management Plan prepared by VHB.
- C. Site-Specific Hazards: The site is directly adjacent to the top of the Kennebec River gorge. Provide a Site-Specific Safety Plan (SSSP) to outline safety protocols and procedures including but not limited to:
 1. Hazard Identification and Assessment
 2. Control Measures
 - i. Include fall protection systems.
 - ii. Include clearly marked warning signage to prevent unauthorized entry.
 3. Emergency Procedures: Include Rescue Plans

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PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012300
ALTERNATES

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the Contract and General Conditions and all Sections within Division 01 – General Requirements which are hereby made a part of this Section of the Specifications.

1.2 SUMMARY

- A. For each of the alternates Scheduled in this Section, state the amount in the proposal to be added to or deducted from the Contract Sum for the work.

1.3 ALTERNATES

- A. Definition: "Alternates" are alternate products, materials, equipment, systems, methods, units of work or major elements of the construction, which may, at the Owner's option and under terms established by the Contract of Agreement, be selected for the work in lieu of the corresponding requirements of the Contract Documents. Selection may occur prior to the Contract Date, or may, by the Agreement, be deferred for possible selection at a subsequent date.
- B. Coordinate pertinent related Work and modify surrounding Work as required to complete the project under each alternate selected by the Owner
- C. Include in the Base Bid the cost of all Work required by the Contract Documents except the additional cost (if any) of the alternates described below.

1.2 DESCRIPTION OF ALTERNATES

- A. Alternate One:
 - a. Name: Alternate One. Also referred to as "Phase 1 Add Alternate" or "Additive Alternate" in the Drawings.
 - b. Description: Provide additional extents of boardwalk and all surrounding and coordinating landscape, hardscape, infrastructure and amenities as shown in the Drawings.
- B. Alternate Two:
 - a. Name: Alternate Two.
 - b. Description: Provide a decorative hinged plinth door as shown in the Drawings.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012300

SECTION 012500
SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.

1.3 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
 - a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
 - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.

- g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners if requested
- h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
- i. Impact, if any, on the Contractor's construction schedule using proposed substitution compared with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
- j. Cost information, including a proposal of change, if any, in the Contract Sum.
- k. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

2. Architect's Action:

- 1. Incomplete forms will be rejected.
- 2. If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution.
- 3. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or within seven days of receipt of additional information or documentation, whichever is later.
- 4. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
- 5. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
 - 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record non-compliance with any of these requirements:

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- a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
- b. Requested substitution provides sustainable design characteristics that specified product provided.
- c. Substitution request is fully documented and properly submitted.
- d. Requested substitution will not adversely affect Contractor's construction schedule.
- e. Requested substitution has received necessary approvals of authorities having jurisdiction.
- f. Requested substitution is compatible with other portions of the Work.
- g. Requested substitution has been coordinated with other portions of the Work.
- h. Requested substitution provides specified warranty.
- i. If requested substitution involves more than one contractor, request for substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: same as above

PART 3 - EXECUTION (Not Used)

END OF 012500

SECTION 013300
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contract Documents, including but not limited to, the Drawings and individual Specification Sections and Contractor's Submission Schedule, apply to this Section.

1.2 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Sections:

1. Section 011000 – General Requirements

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require the Design Professional's responsive action. Action submittals are those submittals indicated in individual specification sections as action submittals.

B. Informational Submittals: Written and graphic information and physical samples that do not require the Design Professional's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual specification sections as informational submittals.

C. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

D. Required Submittal List Utility application: Interacts with and to be used with the Owner's Contract Manager system. The Design Professional uses the utility to itemize the list of submission items needed to be submitted by the Contractor in order to insure the design intent will be satisfied and inclusive of all Project turnover documents and/or Contract Closeout Requirements.

E. Contractor's Submission Schedule: The itemized list of project submission requirements printed as a report from Contract Manager. The Contractor enters the date each item needs to be submitted in order to meet the CPM schedule and returns this document to the Owner.

1.4 ACTION SUBMITTALS

A. Submittal Schedule: The Contractor's Submission Schedule is attached to this section, prepared by the Design Professional. The Contractor is to coordinate and cooperate with the Owner and Design

Professional to arrange in chronological order by dates required by the construction schedule. Coordinate time required for review, ordering, manufacturing, fabrication, and delivery to establish dates. Coordinate additional time required for making corrections or modifications to submittals noted by the Design Professional and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate the Contractor's Submission Schedule with list of subcontracts, the schedule of values, and coordinated CPM schedule.
2. Initial Submittal: Submit in accordance with start-up CPM schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
3. Final Submittal: Submit concurrently in accordance with the complete CPM schedule.
 - a. Coordinate with the Owner and Design Professional revised Contractor's Submission Schedule to reflect changes in current status and timing for submittals.

B. Format for Submittals: Submit required submittals in electronic (PDF) file format.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Design Professional's Digital Data Files: Electronic copies of CAD Drawings of the Contract Drawings will not be provided by the Design Professional for the Contractor's use in preparing submittals.

Coordination: Coordinate preparation and processing of submittals with the performance of the Work.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Commissioning Authority will review submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the Design Professional review and approval.
3. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
4. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
5. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Submit Operation and Maintenance Manuals concurrent with action submittal.

b. The Owner or Design Professional reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

B. Processing Time: Allow time for submittal review, including time for re-submittals, as follows. Time for review shall commence on the Design Professional's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including re-submittals.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. The Design Professional will advise the Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Re-submittal Review: Allow 15 days for review of each re-submittal.
4. Sequential Review: Where sequential review of submittals by the Design Professional's consultants, the Owner, or other parties is indicated, allow 21 days for initial review of each submittal.

C. Identification and Information: Place a permanent label or title block on each paper copy submittal item for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by the Design Professional.
3. Include the following information for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name of Design Professional.
 - d. Name of Construction Manager (if applicable).
 - e. Name of Contractor.
 - f. Name of subcontractor.
 - g. Name of supplier.
 - h. Name of manufacturer.
 - i. Submittal number including revision identifier.

- j. Drawing number and detail references, as appropriate.
- k. Location(s) where product is to be installed, as appropriate.
- l. Other necessary identification.

D. Identification and Information: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single indexed file with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.
3. Provide means for insertion to permanently record the Contractor's review and approval markings and action taken by the Design Professional.
4. Include the following information on an inserted cover sheet:
 - a. Project name.
 - b. Date.
 - c. Name and address of Design Professional.
 - d. Name of Construction Manager (if applicable).
 - e. Name of Contractor.
 - f. Name of firm or entity that prepared submittal.
 - g. Name of subcontractor.
 - h. Name of supplier.
 - i. Name of manufacturer.
 - j. Number and title of appropriate Specification Section.
 - k. Drawing number and detail references, as appropriate.
 - l. Location(s) where product is to be installed, as appropriate.
 - m. Related physical samples submitted directly.
 - n. Other necessary identification.
5. Include the following information as keywords in the electronic file metadata:

- a. Project name.
- b. Number and title of appropriate Specification Section.
- c. Manufacturer name.
- d. Product name.

E. Options: Identify options requiring selection by the Design Professional.

F. Deviations: Identify deviations from the Contract Documents on submittals.

G. Additional Copies: Unless the Design Professional observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.

H. Transmittal: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. The Design Professional will return submittals, without review, received from sources other than the Contractor.

1. Transmittal Form: Use the Contractor's office form.

2. Transmittal Form: Provide locations on form for the following information:

- a. Project name.
- b. Date.
- c. Destination (To:).
- d. Source (From:).
- e. Names of subcontractor, manufacturer, and supplier.
- f. Category and type of submittal.
- g. Submittal purpose and description.
- h. Specification Section number and title.
- i. Indication of full or partial submittal.
- j. Drawing number and detail references, as appropriate.
- k. Transmittal numbered consecutively.
- l. Submittal and transmittal distribution record.
- m. Remarks.

n. Signature of transmitter.

3. On an attached separate sheet, prepared on the Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by the Design Professional on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

I. Re-submittals: Make re-submittals in same form and format.

1. Note date and content of previous submittal.

2. Note date and content of revision in label or title block and clearly indicate extent of revision.

3. Resubmit submittals until they are marked with approval notation from the Design Professional's action stamp.

J. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, and installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

K. Use for Construction: Use only final submittals that are marked with approval notation from the Design Professional's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Submit electronic submittals via email as electronic (PDF) files, to the Design Professional. If applicable, the Design Professional will forward submittals to the Commissioning Authority for systems being commissioned. The Owner may request paper copies of certain submittals for onsite coordination.

a. The Design Professional, through the Owner, will return annotated file. Annotate and retain one copy of file as an electronic Project turnover document file.

b. The Commissioning Authority through the Design Professional will return annotated file.

2. Operation and Maintenance Manual Submittals: Submit concurrent with the Action Submittal, as related in individual Specification Sections.

3. Closeout Submittals: Comply with requirements specified in Section 017700 – Contract Closeout Requirements and as listed in the Contractor's Submission Schedule.

4. Permits, Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Permits, Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.

2. Mark each copy of each submittal to show which products and options are applicable.

3. Include the following information, as applicable:

- a. Submittal Package number and Submittal Item number.
- b. Manufacturer's catalog cuts.
- c. Manufacturer's product specifications.
- d. Standard color charts.
- e. Statement of compliance with specified referenced standards.
- f. Testing by recognized testing agency.
- g. Application of testing agency labels and seals.
- h. Notation of coordination requirements.
- i. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

- a. Wiring diagrams showing factory-installed wiring.
- b. Printed performance curves.
- c. Operational range diagrams.
- d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data concurrent with Samples.

6. Submit Product Data in electronic (PDF) file format.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

- a. Submittal Package number and Submittal Item number.
- b. Identification of products.
- c. Schedules.
- d. Compliance with specified standards.
- e. Notation of coordination requirements.
- f. Notation of dimensions established by field measurement.
- g. Relationship and attachment to adjoining construction clearly indicated.
- h. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.

2. Identification: Attach label on unexposed side of Samples that includes the following:

- a. Submittal Package number and Submittal Item number.
- b. Generic description of Sample.
- c. Product name and name of manufacturer.
- d. Sample source.
- e. Number and title of applicable Specification Section.

3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

- a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.

b. Samples not incorporated into the Work, or otherwise designated as the Owner's property, are the property of the Contractor.

4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

a. Number of Samples: For turnover purpose, submit six full sets of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. The Design Professional, through the Owner, will return submittal with options selected.

5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

a. Number of Samples: Submit six sets of Samples. The Design Professional, through the Owner, will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a turnover sample.

1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.

2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least six sets of paired units that show approximate limits of variations.

E. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, and telephone number of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.
4. Submit subcontract list in PDF electronic file, to the Owner.

F. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

G. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and

Procedure Qualification Record on American Welding Society (AWS) forms. Include names of firms and personnel certified.

H. OSHA Certificates: Upon the Owner's request, submit certificates of the OSHA 10-hour Construction Safety and Health Course – S1537-A, for all laborers, workers and mechanics working on site.

I. Installer Certificates: Upon the Owner's request, submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

J. Manufacturer Certificates: Upon the Owner's request, submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

K. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

L. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

M. Field Test Reports: Submit reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to the Design Professional.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date

of the Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 DESIGN PROFESSIONAL'S ACTION

A. General: The Design Professional will not review submittals that do not bear the Contractor's approval stamp and will return them without action.

B. Action Submittals: The Design Professional will review each submittal, make marks to indicate corrections or modifications required, and return it through the Owner. The Design Professional will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

C. Informational Submittals: The Design Professional will review each submittal and will return it if it does not comply with requirements.

D. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from the Design Professional.

E. Incomplete submittals are not acceptable, will be considered nonresponsive, and will be returned without review.

F. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

G. On projects that have commissioning, the Commissioning Authority will receive copies of the submittals through the Design Professional and will provide comments on the submittals via the Design Professional.

3.3 CONTRACTOR'S SUBMITTAL SCHEDULE

A. The Contractor's Submission Schedule: The Contractor's Submission Schedule, prepared by the Design Professional is attached following the end of this section. The Contractor shall provide the dates each item needs to be submitted to the Owner no later than 30 days after approval of CPM schedule. The schedule shall include the date of all shop drawings, samples, materials that shall be submitted and the date approval is required. The Contractor shall adhere to the submittal processing time as describe in paragraph 1.5 above when developing the submittal schedule. The Contractor is to coordinate and cooperate with the Owner and Design Professional to complete scheduling in accordance with the approved CPM schedule.

END OF SECTION 013300

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SECTION 01 5000

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Temporary utilities
2. Temporary telecommunications services
3. Temporary sanitary facilities
4. Temporary Controls: Barriers and fencing
5. Weather Protection.
6. Security of the job site
7. Environmental Protection
8. Vehicular access Contractor's operations
9. Waste removal facilities and services
10. Project identification sign
11. Field offices

1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including the General Conditions, and other Division 01 specification sections, apply to this section

1.3 TEMPORARY UTILITIES

- A. General: Cost or use charges for temporary facilities (all electrical power, lighting, water, heating and cooling, and ventilation), shall be included in the Contract Sum. Allow Owner to use temporary services and facilities without cost, including but not limited to, Owner maintenance and authorities having jurisdiction.
- B. Contractor may make use of existing utilities available at the site. All costs associated with preparing these utilities and temporary connection for project use shall be managed by the Contractor.
1. Provide temporary construction lighting to all areas of the work to permit a safe and secure work environment for all contractors.
- C. Owner will provide access to the following:
1. Electrical power, consisting of connection to existing facilities.
 2. Water supply, if available, consisting of connection to existing facilities.

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- D. Contractor is to take measure to conserve these resources. The Owner reserves the right to rescind this agreement if the Contractor fails to take appropriate conservation measures. The decision to rescind is solely the Owners. Contractor may install submeters to observe usage during construction.

1.4 TEMPORARY TELECOMMUNICATIONS SERVICES

- A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization.

1.5 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization:
 - 1. Facilities to consist of self-contained single-occupant chemical toilet units in quantity necessitated by size of workforce, to include hand sink with soap & towels.
 - 2. Facilities to be located within the project Construction Limits.
- B. Maintain daily in clean and sanitary condition.
- C. At end of construction, return facilities to same or better condition as originally found.

1.6 TEMPORARY CONTROLS: BARRIERS and FENCING

- A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
- B. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to existing building.
- C. Provide protection for plants designated to remain. Replace damaged plants.
- D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.
- E. Fencing: Provide 6-foot-high approved construction fencing around construction site; equip with vehicular and pedestrian gates with locks.

1.7 WEATHER PROTECTION

- A. The Contractor shall provide temporary enclosures and heat to permit work to be carried on during inclement weather. These specifications are not to be construed as requiring enclosures or heat for operations that are not economically feasible in the opinion of the Owner. Without limitation this includes such items as excavation, pile driving, steel erection, erection of boardwalk and similar operations.
- B. "Weather Protection" means the temporary protection of that Work adversely affected by

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moisture, wind, and cold by covering, enclosing, and/or heating. This protection shall provide adequate working areas during inclement weather and consistent with the construction schedule to permit the continuous progress of all Work necessary to maintain an orderly and efficient sequence of construction operations. The Contractor shall furnish and install "Weather Protection" material and be responsible for all costs, including heating required to maintain the minimum required temperature per working surface. This provision does not supersede any specific requirements for methods of construction, curing of materials, or the applicable conditions set forth in the Contract Documents with added regard to performance obligations of the Contractor.

- C. Within 30 calendar days after award of the Contract, the Contractor shall submit in writing, to the Architect for approval, the proposed methods for "Weather Protection".
- D. The Contractor shall assume the entire responsibility for weather protection during construction (until Substantial Completion), and shall be liable for any damage to any Work caused by failure to supply proper weather protection and proper ventilation.
- E. Work damaged by frost shall be removed and replaced by and at the Contractor's expense and as directed by the Architect.

1.8 SECURITY OF THE JOBSITE

- A. Provide security and facilities to protect Work, existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.
- B. Coordinate with Owner's security program for physical or electronic security measures.

1.9 ENVIRONMENTAL CRITERIA

- A. Soils Management Plan: comply with Soils Management Plan as provided by Owner

1.10 VEHICULAR ACCESS FOR CONTRACTOR'S OPERATIONS

- A. Comply with regulations Authorities Having Jurisdiction (AHJ), relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles. Refer to Section 011000 for working hours.
- B. If the work of the Contract affects public use of any street, road, or thoroughfare, the Contractor shall confer with the AHJ in addition to providing any barriers and signals that may be needed.
- C. Coordinate access and haul routes with (AHJ) and Owner.
- D. Provide and maintain access to fire hydrants, free of obstructions.
- E. Provide Mobilization Plan. Procedures must allow for deliveries to adjacent properties to continue throughout construction, refer to layout diagram on Architectural plans.

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1.11 WASTE REMOVAL

- A. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.
- B. Provide containers with lids. Remove trash from site weekly.
- C. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.

1.12 PROJECT IDENTIFICATION

- A. Erect on site at location established by A/E.
- B. Provide project identification sign. Design, construction, and location of sign as approved by Owner.
- C. No other signs are allowed without Owner permission except those required by law.

1.13 FIELD OFFICES

- A. Office: in lieu of providing a job trailer, the Contractor is invited to use the existing vacant building at 185 Water Street as the project field office. Contractor to provide temporary heat as needed. Take Note: There are no facilities in this building.
- B. Provide space for Project meetings, with table and chairs to accommodate 6 persons.
- C. Arrangement: prior to arrangement of Field Office, Owner to review and approve setup.

1.14 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.
- B. Clean and repair damage caused by installation or use of temporary work.
- C. Restore existing facilities used during construction to original condition.
- D. Restore new permanent facilities used during construction to specified condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 5000

SECTION 033000

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, finishes, inserts and embeds.
- B. Related Sections include the following:
 - 1. Division 1
 - 2. Division 31 Section "Earth Work"

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.
- B. Contract Documents: are the design drawings and the specifications.
- C. Contractor: includes any of the following: General Contractor and their sub-contractors, Construction Manager, Concrete Contractor and their sub-contractors.
- D. EOR: the Structural Engineer of Record for the structure in its final condition.
- E. Testing Agency: the independent testing and inspection service engaged by the Owner for quality assurance observation and testing of concrete construction.

1.4 PERFORMANCE REQUIREMENTS

- A. All work shall be performed in accordance with the 2021 International Building Code, requirements of the governmental authorities having jurisdiction and the requirements of the Contract Documents, whichever are the more stringent.
 - 1. The Contractor shall be responsible for the analysis and verification of all temporary shoring, and temporary assemblies for stresses and displacements that may be imposed

during temporary conditions and loads during construction. The analysis of such shall be performed by the Contractor's Engineer licensed in the state of Maine.

1.5 SUBMITTALS

- A. Qualification Data: For Installer, manufacturer and testing agency.
- B. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
 - 1. Aggregates
- C. Material Certificates: For each of the following, if used in the project, submit documentation signed by manufacturers and indicating compliance with contract documents:
 - 1. Cementitious materials
 - 2. Admixtures
 - 3. Form materials and form-release agents
 - 4. Steel reinforcement and accessories
 - 5. Curing compounds
 - 6. Floor and slab treatments
 - 7. Bonding agents
 - 8. Adhesives
 - 9. Semirigid joint filler
 - 10. Joint-filler strips
 - 11. Repair materials and procedures
- D. Submittal Schedule: The contractor shall submit for approval a schedule at least twenty (20) working days prior to commencing submittals.
 - 1. The schedule shall include a list, in order of date to be submitted, of all drawings, calculations and other required submittal items scheduled to be submitted. After submissions have started any modification or addition to this schedule must be submitted for approval at least twenty (20) working days before the modification or addition is proposed to take place. If a submittal schedule is not submitted, review turnaround time cannot be confirmed.
 - 2. If at any time the total number of shop drawings received in any one-week period exceeds the amount in the approved schedule by more than 10% for that week, the Design Professionals have the right to add two days to the average turnaround time for each 20% increment in excess of the scheduled quantity for that week's submissions. For example, if the weekly total exceeds the schedule by 10% to 20%, two days may be added; if it is exceeded by 21% to 40%, four days may be added. The return dates for subsequent submittals may be extended based on the additional review time stated above.
- E. Design Mixtures: Submit for each concrete mix at least 20 working days prior to placing concrete. Submit separate design mixes when characteristics of materials, project condition, weather, test results, or other circumstances warrant adjustments.
 - 1. Mix designs must be submitted with the mix design form attached at the end of this specification.

2. Design the mix to produce the strength, modulus of elasticity and density as indicated on the Contract Documents: Density per ASTM C 138. Design mix so that water is not required to be added on site.
 3. For each mix, obtain each type of cementitious material from the same brand and manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
 4. Mix designs shall be prepared or approved by a registered design professional licensed to practice as a Professional Engineer in the state of Maine and shall meet the design requirements in the Contract Documents. The mix designs shall include:
 - a. The locations on site where the mix will be used.
 - b. Information shown shall be from the same facility that will be used for this project.
 - c. Compressive Strength required by the contract documents
 - d. Gradation and quality of each type of ingredient including fresh (wet) unit weight and aggregates sieve analysis.
 - e. Include service record data for aggregates indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity
 - f. Water/cementitious material ratio.
 - g. Evaluate and classify fly ash in accordance with ASTM D 5759.
 - h. Report chemical analysis of fly ash in accordance with ASTM C 311.
 - i. Classify blast furnace slag in accordance with ASTM C 989.
 - j. Slump: ASTM C 143, sump flow: ASTM C1611
 - k. Certification and test results of the total water soluble chloride ion content of the design mix ASTM C 1218.
 - l. Air content of freshly mixed concrete by the pressure method, ASTM C 231, or the volumetric method, ASTM C 173.
 - m. Unit Weight of Concrete: ASTM C 138.
 - n. Design strength at 28 days: ASTM C 39.
 - o. Document strength based on basis of previous field experience or trial mixtures per ACI 301. Proportioning by Water-Cement Ratio is not permitted.
 5. Submit strength test records, mix design materials, conditions, and proportions for concrete used for record of tests, standard deviation calculation, and determination of required average compressive strength.
 6. Manufacturer's product data for each type of admixture, with manufacturer's certification that all admixtures used are compatible.
 7. Identify method of placement and method of curing.
 8. Indicate no water may be added at the Project site.
 9. For low shrinkage mixes, shrinkage tests in accordance with ASTM C157 Modified. (7-day moist cure)
- F. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement in accordance with ACI 315. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, spacing, clear cover, lengths and locations of splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

- G. Formwork Shop Drawings: Prepared by or under the supervision of the Contractor's qualified professional engineer licensed in the state where the project is located, detailing fabrication, assembly, and support of formwork.
- H. Shoring and Reshoring drawings: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring. Shoring shop drawings to be stamped and sealed by a Professional Engineer, licensed in the State of Maine. Drawings to be accompanied by supporting calculations.
- I. Construction Joint Layout: Indicate proposed construction joints and control joints locations and details required to construct the structure.
 - 1. Location of construction joints is subject to approval of the EOR and Contracting Officer
- J. Substitution Requests: Any deviation from the Contract Documents shall be submitted as a Substitution Request, clearly indicating the reason for the request, the cost associated with the change and schedule impact. Substitutions accepted by the EOR shall be coordinated and incorporated into the work by the Contractor.
- K. Project Archiving: At the completion of all concrete submittals the Contractor shall deliver to the Design Professionals two (2) copies of the electronic version of the final field use shop drawings on a DVD or other media acceptable to the Contracting Officer/Engineer.
- L. Preconstruction Survey: Where interface with existing construction occurs, before related shop drawings are prepared survey the existing construction and submit the survey prepared by a professional surveyor to the Design Professionals for record.
- M. Survey of Flat Plate or Flat Slab Concrete Floors during construction: Survey requirements are described on Drawings. Based on survey results, Contracting Officer/EOR may propose adjustments to formwork and camber.
- N. Survey of As-built Floor Conditions: Survey and report flatness (FF), levelness (FL), and final elevations of finished floors prior to shoring removal. For slabs that include camber, do not test for levelness (FL). Perform FF/FL testing in accordance with ASTM E 1155 requirements. Submit survey to Contracting Officer and Engineer within 5 working days of pouring.
- O. Structural Repairs: Submit procedures and product information.
- P. Patching Defective Concrete Finishes: Submit procedures and product information.

1.6 SHOP DRAWING PROCESS

- A. Each shop drawing shall be dated and identified with a unique drawing number. Resubmitted shop drawings shall be given a new revision number with each resubmission, and all changes/additions/deletions from the previous submission shall be clearly and individually identified. Resubmissions received without revision numbers or identification of changes/additions/deletions will be returned unreviewed.

- B. Include a transmittal letter with each submission, clearly labeled with current drawing numbers and revision numbers.
- C. Shop drawings shall be clearly initialed by the draftsman and checker responsible for their preparation.
- D. Submittal of shop drawings and other submittals by the Contractor shall constitute Contractor's representation that the Contractor has verified all quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers and similar data with respect thereto and reviewed or coordinated each drawing with other drawings and other trades. The Contractor shall place their shop drawing stamp on all submittals confirming the above.
- E. Shop drawings: Submit in complete packages so that individual parts and the assembled unit may be reviewed together. This Specification Section and the applicable drawings used in the development of the shop drawings shall be referenced on each shop drawing to facilitate checking.
- F. The Contractor shall submit to the Design Professionals one (1) electronic PDF copy for shop drawing review. The naming convention of each drawing must follow the submittal numbering system and include the submittal number, specification number, revision number and drawing number in the prefix of the drawing name.
- G. The Contractor shall allow at least ten (10) working days between receipt and release by the EOR for the review of shop drawings and submittals.
- H. All modifications or revisions to submittals and shop drawings must be clouded, with an appropriate revision number clearly indicated. The following shall automatically be considered cause for rejection of the modification or revision whether or not the drawing has been approved by the Design Professionals:
 - 1. Failure to specifically cloud modifications
 - 2. Unapproved revisions to previous submittals
 - 3. Unapproved departure from Contract Documents
- I. Resubmittals: Completely address previous comments prior to resubmitting a drawing. Resubmit only those drawings that require resubmittal. Do not include new content not previously reviewed.
- J. Resubmittals Compensation: The Contractor shall compensate the Design Professionals for submittals that must be reviewed more than twice due to contractors' errors. The Contractor shall compensate the Design Professionals at standard billing rates plus out-of-pocket expenses incurred at cost + 10%.
- K. Request for Information (RFIs)
 - 1. Submit an RFI immediately when the need for clarification of the Contract Documents arises. Allow for 5 working day response time from the EOR from receipt by EOR to return. RFI's received after 3pm will be considered received on the following business day.

- L. RFIs that contain corrective field work, request for substitutions or submittal information as describe above, shall be rejected and must be submitted as a submittal or Substitution Request.

1.7 QUALIFICATIONS

- A. Qualification Data: Submit qualification data including personnel resumes and project experience with references for the Concrete Contractor, Ready Mix Supplier, Reinforcement Detailer and Formwork and Shoring Engineer.
- B. The Concrete Contractor shall have 10 years of comparable experience in complex buildings and shall employ labor and supervisory personnel familiar with the type of installation.
- C. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- D. Manufacturer Qualifications: A company experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- E. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- F. Contractor's Engineer Qualifications: A professional engineer who is a registered professional engineer in the state of Pennsylvania and shall have 10 years of comparable experience in providing the engineering of formwork and shoring and reshoring installations for a project of this type, size and complexity.
- G. Reinforcement Detailer Qualifications: A firm with 10 year minimum experience in the preparation of reinforcement drawings for projects of a similar type, size and complexity. Firm to employ a Professional Engineer experienced in this types, size and complexity of work to review all reinforcement drawings prior to issue to the EOR.

1.8 CONTRACTOR'S QUALITY CONTROL

- A. Comply with the provisions of the following specifications and documents:
 - 1. Maine Building Code
 - 2. American Concrete Institute (ACI) Manual of Concrete Practice, including but not limited to:
 - 3. ACI 117 – Standard Specifications for Tolerances for Concrete Construction and Materials.
 - 4. ACI 301 – Standard Specifications for Structural Concrete.
 - 5. ACI 305 – Hot Weather Concreting
 - 6. ACI 306 – Cold Weather Concreting
 - 7. ACI 315 – Details and Detailing of Concrete Reinforcement
 - 8. ACI 318 – Building Code Requirements for Structural Concrete.

- B. The Contractor shall maintain a program of quality control to ensure that the minimum standards specified herein are attained.
- C. The Owner's Testing Agency services are to inform the Owner of the performance by the Contractor but shall in no way replace or augment the Contractor's quality control program or relieve the Contractor of total responsibility for quality control.
- D. The Contractor shall immediately report to the Design Professionals any deficiencies in the work which are departures from the Contract Documents. The Contractor shall propose corrective actions and their recommendations in writing and submit them for review by the Design Professionals. After proposed corrective action is accepted by the Contracting Officer, EOR, the Contractor shall correct the deficiency at no cost to the Owner and shall reimburse the Contracting Officer/EOR and/or Testing Agency at their standard rates for their time required.
- E. Pre-Concrete Construction Conference: Conduct conference at Project site.
 - 1. At least 30 working days prior to the start of concrete placement the Contractor shall hold a meeting to review the requirements of the concrete construction.
 - 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection
 - 3. The agenda shall be prepared by the Contractor with assistance from the EOR and at a minimum including the following:
 - a. The review proposed concrete design mixtures and procedures for ensuring quality of concrete materials.
 - b. Review special inspection and testing and inspecting agency procedures for field quality control concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.
 - 4. For Concrete Exposed to View: Review specific concrete finishes and finishing techniques, curing procedures and compounds, construction joint locations, forms and form liners, reinforcement accessories, aesthetics of concrete repair procedures, and protection of cast-in-place concrete.
 - 5. The Contractor shall take and distribute minutes to all attendees within 5 working days of the meeting.
 - 6. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent and finisher foreman.
 - b. Owner's's Testing and Inspection Agency
 - c. Contractor's Engineer responsible for concrete design mixtures.
 - d. Ready-mix concrete manufacturer.

- e. Concrete subcontractor
 - f. Admixture manufacturer's representative
 - g. EOR
 - h. Contracting Officer
7. The concrete contractor shall state that the proposed mix designs will enable contractor to properly place, pump, finish and achieve the required concrete quality required by the specifications. This statement shall be included in the minutes.
- F. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

1.9 QUALITY ASSURANCE BY OWNER'S TESTING AGENCY

- A. The Owner's Testing and Inspection Agency does not replace the Contractor's responsibility for testing and inspection as part of their submitted quality control program. The Owner's Testing and Inspection Agencies shall be engaged and paid by the Owner, except when testing or inspection are required due to non-conformance by the Contractor.
- B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
- 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- C. Questionable work may require re-evaluation. Re-inspection of questionable or rejected work and inspection of replacement work shall be performed at the expense of the Contractor.
- D. The Contractor shall coordinate their work with the Owner's Testing and Inspection Agency to assure that all test and inspection procedures required by the Contract Documents are completed. The Contractor shall cooperate with the testing and inspection agency in the performance of their work and shall provide the following:
- 1. Access to places where concrete work is being performed for tests and inspections.
 - 2. Coordinate with the inspectors so all shop fabrication is inspected in the shop
 - 3. Schedule information one week prior to starting work that shows the time and place of shop fabrication, field work and an erection schedule.
 - 4. Contractor to provide EOR approved submittals to shop and site inspectors. Submittals provided must bear the EOR submittal review stamp, unstamped "field drawings" are not acceptable for inspections.

- E. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform shop and field inspections, tests and prepare reports. Their responsibilities include:
1. Rejection: The right is reserved to reject any material, at any time, when the material or workmanship does not conform to the contract requirements. Notify the EOR, Contracting Officer and Owner daily of rejected work.
 2. Reports: Daily reports shall be submitted including weather, work progress and description of the area of work with photographs, tests conducted and results, including deficiencies and corrections made and conformance to the structural documents. The daily reports shall be submitted to the EOR and Contracting Officer. The daily reports shall be bound together in a weekly report submitted to the EOR, Contracting Officer and Owner.
 3. Report Format: Daily reports are required to be submitted to the EOR and Contracting Officer in PDF digital format at the end of each day with non-conformance items clearly highlighted. Final, typed, weekly reports in PDF digital format are due within 2 working days of the last day inspected in that week.
 4. Non-conformance Log: The inspector shall be responsible to maintain an Excel Spreadsheet list of structural non-conformance items updated daily and submitted to the EOR, Contracting Officer and Owner with their reports.
 5. Document Control: Contractor to provide EOR approved submittals to inspectors. Do not inspect from submittals not bearing evidence of the EOR's approval.
 6. Certification: When all work is completed and approved by the Owner's Testing Agency, submit a letter to the EOR, Contracting Officer and Owner certifying that the installation is in accordance with the Contract Documents and the requirements of applicable codes.
- F. Inspections: 100 percent of the following work items shall be inspected for conformance with the contract documents.
1. Steel reinforcement placement and supporting devices. Contractor shall not be permitted to place concrete until reinforcing steel has been inspected and approved, by approved testing agency.
 2. Steel reinforcement welding.
 3. Headed bolts and studs
 4. Embed plates
 5. Verification of use of required design mixture
 6. Concrete placement, including conveying and depositing.
 7. Curing procedures and maintenance of curing temperature.
 8. Verification of concrete strength before removal of shores and forms from beams and slabs.
 9. Formwork dimensions that control member finished dimensions
- G. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172, ASTM C 31, and ASTM C 39 shall be performed according to the following requirements:
1. For 28 day mixes mold FIVE (5) lab cured and FIVE (5) field cured 6"x12" cylinders. For each lab and field cured set, test two cylinders at 7 days and two cylinders at 28 days. The strength for each test shall be the average of two cylinders. One cylinder shall be retained in reserve for later testing if required.
 2. Alternately, for 28 day mixes mold SIX (6) lab cured and SIX (6) field cured 4"x8" cylinders. For each lab and field cured set, test two cylinders at 7 days and three cylinders at 28 days.

The strength for the 7 day test shall be the average of two cylinders and the strength for the 28 day test shall be the average of three cylinders. One cylinder shall be retained in reserve for later testing if required.

3. High recycled content concrete mix designs may require 56 day tests and will require additional cylinders to be tested. This will be determined upon submission of the contractor's engineered mix designs.
4. Testing Frequency: Obtain at least one strength test for each 50 cu. Yd. or fraction thereof of each concrete mixture placed each day. The 28 day strength test shall be the average of two 6" by 12" cylinders or three 4" by 8" cylinders made from the same sample of concrete.
 - a. When the frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
5. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
6. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Water Content and W/CM: For all architecturally exposed concrete or mixes designated as low shrinkage. Verify water content in accordance with AASHTO T318, "Standard method of Test for Water Content Using the Microwave Oven Drying". Test slump in accordance with ASTM C143. 1 test at point of placement at the same rate as strength tests but not less than 1 test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
8. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
9. Record total water quantity added to concrete batches.
10. Obtain certified mill test results for each load of cement delivered to the concrete producer for use of this project.
11. Record types and amounts of admixtures added to concrete batches, including that added after departure of concrete trucks from batch plant.
12. Record amounts of and monitor dosing of high-range water-reducing admixtures added at site for project site added admixtures and redosing for plant-added admixtures.
13. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
14. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
15. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
16. Test results shall be reported in writing to EOR, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and

inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

17. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by EOR but will not be used as sole basis for approval or rejection of concrete.
18. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Contracting Officer or Engineer of Record. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by EOR.
19. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
20. Rejection of concrete not meeting specification requirements and immediate reporting to the Contracting Officer and Engineer of Record.
21. Measure floor and slab flatness Ff and levelness Fl according to ASTM E 1155 within 48 hours of finishing.
22. Collect batch tickets from each truck for each concrete batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

H. Attendance at the Pre-Concrete Conference

1.10 REVIEW AND CORRECTIONS BY CONTRACTING OFFICER OR ENGINEER

- A. Review: The Contracting Officer and/or Engineer as appropriate will review the construction for general compliance with the provisions of the contract documents during various phases of construction.
- B. Compensation for Additional Services: Should additional work and/or visits be required which are necessitated by failure of the Contractor to perform his work in accordance with the contract documents, or if additional design or drafting time is required for corrective measures caused by failure of the Contractor to perform in accordance with the contract documents, the Contractor shall compensate the Contracting Officer and Engineer at their hourly rates plus out-of-pocket expenses incurred at cost + 10%. Additional costs for testing and inspection by the Owner shall also be compensated by the Contractor
- C. Review of Corrective Measures by Contracting Officer and/or Engineer: Should additional work and/or visits be required which are necessitated by failure of the Contractor to perform work in accordance with the Contract Documents, the Contractor shall compensate the Contracting Officer and Engineer at their standard hourly billing rates plus out-of-pocket expenses incurred at cost + 10%.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging any coatings on steel reinforcement.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 - 1. Plywood, metal, or other approved panel materials.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
- E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch minimum.
- G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- H. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- I. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.

3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed bars, ASTM A 775/A 775M or ASTM A 934/A 934M, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.
- D. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60, deformed bars, assembled with clips.
- E. Plain-Steel Wire: ASTM A 82, as drawn.
- F. Deformed-Steel Wire: ASTM A 496.
- G. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, deformed-steel wire, with less than 2 percent damaged coating in each 12-inch wire length.
- H. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.
- I. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.
- J. Galvanized-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from galvanized steel wire into flat sheets.
- K. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, deformed steel.

2.3 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.
- B. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, ASTM A 775/A 775M epoxy coated.
- C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.
- D. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.

- E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
 - 3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.
- F. Mechanical Couplers: Provide "Tension-Compression" mechanical couplers where specified to develop a minimum of 125% of the specified yield strength of the connecting reinforcing bars. Detailing and stagger as per CRSI, "Concrete Reinforcing Steel Institute" requirements and manufacturer's recommendations.

2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I/II, gray or white. Supplement with the following:
 - 2. Fly Ash: ASTM C 618, Class C or F.
 - 3. Maximum percent retained on #325 sieve: 28%
 - 4. Maximum water requirement, stated as percentage of control, 100%
 - 5. Percentage of fly ash in mix design shall be weight not by volume. Water cement ratio will be calculated by as water / cementitious (total cement plus fly ash) ratio.
 - 6. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- B. Silica Fume: ASTM C 1240, amorphous silica.
- C. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.
 - 1. Maximum Coarse-Aggregate Size: ASTM C33 size 6 (3/4 inch nominal).
 - 2. Fine Aggregate: ASTM C33. Free of materials with deleterious reactivity to alkali in cement.
- D. Lightweight Aggregate: ASTM C 330, 3/8-inch nominal maximum aggregate size.
- E. Water: ASTM C 94/C 94M and potable.
- F. Chloride Ion Content of Mix (including all constituents): Shall not exceed .15 percent chloride ions by weight of cement and comply with ASTM C 1152.

2.5 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.

- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- C. Air Entraining Admixture:
1. ASTM C 260
 2. BASF "MICRO-AIR" or "MB-AE-90"
 3. W. R. Grace's "Darex Series" or "Daravair Series"
 4. Euclid Chemical's "AEA -92 or Air 40".
- D. Water-Reducing Admixture:
1. ASTM C 494, Type A
 2. BASF "POZZOLITH 220-N"
 3. Euclid Chemical's "EUCON NW" or "EUCON WR 91".
- E. Retarding Admixture, ASTM C 494, Type B
1. BASF POZZOLITH 100-XR"
 2. The Euclid Chemical Company "EUCON RETARDER 100".
 3. Approved equal
- F. Non Corrosive Accelerating Admixture ASTM C 494, Type C:
1. BASF "POZZUTEC 20
 2. The Euclid Chemical Company "ACCELGUARD 80", "ACCELGUARD NCA" or "ACCELGUARD 90"
 3. Approved equal
- G. Water-Reducing and Retarding Admixture ASTM C 494, Type D:
1. BASF "POZZOLITH 100-XR"
 2. The Euclid Chemical Company "EUCON RETARDER 75" or "EUCON DS".
 3. Approved equal
- H. Water-Reducing and Accelerating Admixture ASTM C 494, Type E:
1. BASF "POZZUTEC 20
 2. The Euclid Chemical Company "ACCELGUARD 80" or "ACCELGUARD 90"
 3. Approved equal
- I. High-Range Water-Reducing Admixture ASTM C 494, Type F:
1. BASF "RHEOBUILD 1000" or "GLENIUM SERIES"
 2. Euclid Chemical's "EUCON 37" or "PLASTOL SERIES"
 3. Approved equal

- J. High-Range Water-Reducing and Retarding Admixture: ASTM C 494, Type G:
 - 1. The Euclid Chemical Company "EUCON 537".
 - 2. Approved equal
- K. Viscosity Modifying Admixture (VMA) for Self-Consolidating Concrete (SCC), ASTM C494/C494M, Type S:
 - 1. BASF "Rheomac VMA"
 - 2. Sika Chemical "Sika Stabilizer VMA"
 - 3. W.R. Grace "V-MAR3"
 - 4. "EUCON ABS" or "EUCON Stasis", The Euclid Chemical Company
- L. Corrosion Inhibiting Admixtures: ASTM C 494, Type C:
 - 1. W.R. Grace's "DCI or DCI-S"
 - 2. The Euclid Chemical Company's "EUCON CIA"
 - 3. Sika Chemical "Ferroguard 901"
- M. Shrinkage Reducing Admixtures ASTM C 157:
 - 1. W.R. Grace's "ECLIPSE PLUS", or "ECLIPSE FLOOR"
 - 2. The Euclid Chemical Company's "EUCON SRA or Conex"
 - 3. Approved equal

2.6 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
 - 1. Products:
 - a. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
 - b. Euclid Chemical Company (The); Kurez DR VOX.
 - c. Meadows, W. R., Inc.; 1100 Clear.
 - d. Nox-Crete Products Group, Kinsman Corporation; Resin Cure E.
 - e. Symons Corporation, a Dayton Superior Company; Resi-Chem Clear Cure.
- F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.
 - a. ChemMasters; Safe-Cure & Seal 20.
 - b. Dayton Superior Corporation; Safe Cure and Seal (J-18).

- c. Euclid Chemical Company (The); Aqua Cure VOX.
 - d. Meadows, W. R., Inc.; Vocomp-20.
 - e. Nox-Crete Products Group, Kinsman Corporation; Cure & Seal 150E.
 - f. Unitex; Hydro Seal.
- G. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.
- a. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; High Seal.
 - b. Dayton Superior Corporation; Safe Cure and Seal (J-19).
 - c. Euclid Chemical Company (The); Diamond Clear VOX.
 - d. Meadows, W. R., Inc.; Vocomp-20.
 - e. Metalcrete Industries; Metcure 0800.
 - f. Nox-Crete Products Group, Kinsman Corporation; Cure & Seal 200E.
 - g. Sonneborn, Div. of ChemRex; Kure-N-Seal.
- H. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
- a. Euclid Chemical Company (The); Super Diamond Clear VOX.
 - b. Kaufman Products, Inc.; Sure Cure 25 Emulsion.
 - c. Meadows, W. R., Inc.; Vocomp-30.
 - d. Unitex; Hydro Seal 25.
 - e. US Mix Products Company; US Spec Radiance UV-25.

2.7 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin compound with a Type A shore durometer hardness of 80 or aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 per ASTM D 2240. Provide one of the following:
- 1. Euco 700 or QWIKjoint UVR by The Euclid Chemical Company
 - 2. Sikadur 51 SL by Sika
 - 3. Approved equal
- C. Bonding Agent: ASTM C 1059, Type II. The compound shall be a latex, non-resettable, polymer modified bonding grout containing an acrylic or styrene butadiene bonding admixture. Products subject to compliance with manufacturers requirements, provide one of the following:
- 1. Flex-Con, SBR Latex of AKKRO-7T by The Euclid Chemical Company
 - 2. Approved equal
- D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete. Provide one of the following:
 - a. Dural 452 Series by The Euclid Chemical Company
 - b. Sikadur Hi-Mod Series by Sika
 - c. Approved equal
- E. Reglets: Fabricate reglets of not less than 0.0217-inch- thick, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- F. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.8 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
 4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109.
 5. EucoFloor SL 160 or Tammspatch II by The Euclid Chemical Company.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
 4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109.
 5. Thin-Top Supreme or Concrete Top-Supreme by The Euclid Chemical Company.

2.9 CONCRETE MIXES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301, Section 4.2.3.
 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

2. Design mixes with higher percentages of Fly Ash, blast-furnace slag and silica fume will require additional time to achieve design strength and will be subject to testing regimes that include a 56 day test as well as additional cylinders in order to justify strength by statistical methods since these mixes are not predesigned.
- B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash: 25 percent.
 2. Combined Fly Ash and Pozzolan: 25 percent.
 3. Ground Granulated Blast-Furnace Slag: 50 percent.
 4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
 5. Silica Fume: 10 percent.
 6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
 7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use high range water-reducing admixture in pumped concrete, architectural concrete, concrete for heavy-use industrial slabs, macro synthetic fiber concrete, self consolidating concrete, parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
 4. Use corrosion-inhibiting admixture in concrete mixtures where indicated. 3 gallons/cy unless otherwise noted.
 5. Use a non-corrosive accelerator in all concrete less than 8" in thickness placed at temperatures below 50 degrees Fahrenheit. Do not use calcium chloride, salts or other admixtures containing more than 0.05% chloride ions by weight.

2.10 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A.

1. Proportion concrete on a basis of previous field experience or laboratory trial batches with the materials to be employed in the work. However, mixtures shall have limiting quantities

or values listed below for each strength concrete with coarse aggregate less than 1 ½ inches.

- a. Normal-weight mixture Minimum Compressive Strength of 5000 psi at 28 days
Maximum Net Water-Cementitious Material Ratio: 0.40.
Minimum Cementitious Material Content: 658 lbs/cu. yd.
 - b. Normal-weight mixture Minimum Compressive Strength of 4000 psi at 28 days
Maximum Net Water-Cementitious Material Ratio: 0.51.
Minimum Cementitious Material Content: 564 lbs/cu. yd.
 2. Maximum allowable net water content is the total water in the mix at the time of mixing, including free water on aggregate.
 3. Consider any fly ash or silica fume as part of the cement content for purposes of establishing cementitious material content and water-cementitious material ratio.
 4. Use maximum water-cementitious material ratio equal to 0.45 for concrete subject to freezing and thawing, repeated surface wetting or deicers.
 5. Use High-Range Water Reducing admixture to water-cementitious material ratios equal to or less than 0.45
- B. Concrete shall arrive at the job site at a slump of 2 to 3 inches and at the time of deposit shall be as follows:
1. Footings, Wall footings: Recommended Slump 2" / Maximum range 1" – 3"
 2. Walls, Columns: Recommended Slump 4" / Maximum range 3" – 5"
 3. Slabs, Beams: Recommended Slump 3" / Maximum range 2" – 4"
- C. Air Content: 5 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size (3/8-inch nominal aggregate size for concrete on metal deck). Do not allow air content of troweled finished floors to exceed 3 percent.
- D. Pile Caps, Footings, Wall Footings, Grade Beams, shall be normal-weight concrete and have a Minimum Compressive Strength per drawings, but a minimum 4000 psi at 28 days.
- E. Slabs-on-Grade shall be normal-weight concrete and have a Minimum Compressive Strength: per drawings, but a minimum 4000 psi at 28 days.
- F. Foundation Walls, Retaining Walls, Suspended Slabs, Building Frame Members, Beams, Girders, Columns, Building Shear Walls shall be normal-weight concrete and have a Minimum Compressive Strength per drawings, but a minimum 5000 psi at 28 days.

2.11 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice" latest edition.

2.12 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
2. Provide batch ticket to Testing Agency for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 1. Class A, 1/8 inch for smooth-formed finished surfaces as specified by the Contracting Officer.
 2. Class B, 1/4 inch for rough-formed finished surfaces as specified by the Contracting Officer.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 1. Install keyways, reglets, recesses, and the like, for easy removal.
 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Do not chamfer exterior corners and edges of permanently exposed concrete as specified by the Contracting Officer.

- J. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- K. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- L. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- M. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 - 2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 - 3. Install dovetail anchor slots in concrete structures as indicated.
 - 4. Embedded items:
 - a. Give ample notice and opportunity to introduce, furnish, or install embedded items and work related to concrete or for support before concrete is placed.
 - b. Position embedded items accurately and support against displacement.
 - c. Position embedded items to avoid conflicts with reinforcement. Provide ½ inch clear cover between reinforcement and inserts, anchors, and embedded items, and between sleeves and reinforcement. Notify Contracting Officer of conflicts between embedded items and reinforcement prior to correction.
 - d. No embedded items made of aluminum shall be permitted, unless completely coated or covered to prevent aluminum concrete reaction or electrolytic action between aluminum and steel.

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
 - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.

2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Contracting Officer.

3.4 SHORES AND RESHORES

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
 1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 VAPOR RETARDERS

- A. See relevant alternate specification section.

3.6 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
 1. Weld reinforcing bars according to AWS D1.4, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- F. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

3.7 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Contracting Officer.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 - 3. Roughen surface of joints to 0.25" amplitude
 - 4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 5. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces
 - 6. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 7. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 8. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
 - 3. Locate joints at column lines where applicable, with spacing, aspect ratio and maximum area not to exceed that indicated on the drawings.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 7 Section "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless pre-approved by Contracting Officer or Engineer.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
 4. Self-Consolidating Concrete (SCC) does not require vibration.
- D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleed water appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

- E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- F. Hot-Weather Placement: Comply with ACI 305 and as follows:
 - 1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.9 FINISHING FORMED SURFACES

- A. Exposed to View Concrete: See sections 033000 "Cast-In-Place"
- B. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to public view.
- C. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces as shown on the Contracting Officer's drawings.
- D. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated on the Architectural drawings:
 - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 - 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
- E. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.10 FINISHING FLOORS AND SLABS

- A. Exposed to View Concrete: See sections 033000 "Cast-In-Place Concrete"
- B. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- C. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in 1 direction.
 1. Apply scratch finish to surfaces indicated by the Contracting Officer and to receive concrete floor toppings to receive mortar setting beds for bonded cementitious floor finishes.
- D. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 1. Apply float finish to all surfaces unless otherwise indicated and surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- E. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 1. Apply a trowel finish to surfaces indicated by the Contracting Officer or exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
 2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
 - a. At lab spaces and other sensitive spaces, Specified overall values of flatness, F(F) 45; and of levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 24. For suspended slabs on steel deck only flatness F(F) applies. F(F) and F(L) apply to Level C topping slab on grade.
 - b. At offices and other non-sensitive spaces, Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of

levelness, F(L) 15. For suspended slabs on steel deck only flatness F(F) applies. F(F) and F(L) apply to Level C topping slab on grade.

- F. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated by the Contracting Officer and where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
 - 1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.
- G. Broom Finish: At locations indicated or at exterior concrete platforms steps and ramps that do not have alternate finishing specified elsewhere, apply a broom finish.
 - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Contracting Officer before application.

3.11 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.12 CONCRETE PROTECTING AND CURING

- A. Exposed to View Concrete: See sections 033000 "Cast-In-Place Concrete"
- B. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- C. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

- D. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- E. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- F. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project..
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. After curing period has elapsed, remove dissipating curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
 - 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.13 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 - 1. Defer joint filling until concrete has aged at least six month(s). Do not fill joints until construction traffic has permanently ceased.

- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening. Concave joints are not acceptable.

3.14 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Contracting Officer. Repair and patch defective areas. Remove and replace concrete that cannot be repaired and patched. Submit to Contracting Officer, in writing, remedial procedures for review prior to beginning work.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with the specified polymer repair material or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Contracting Officer.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 - 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 - 2. After concrete has cured at least 14 days, correct high areas by grinding.
 - 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with concrete. Finish repaired areas to blend into adjacent concrete.

4. Correct other low areas scheduled to receive floor coverings with a specified repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 5. Correct other low areas scheduled to remain exposed with a specified repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Contracting Officer's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Contracting Officer's approval.

CONCRETE MIX DESIGN SUBMITTAL FORM

Project: _____
 City: _____
 General Contractor: _____
 Concrete Contractor: _____
 Concrete Strength (Class): _____
 Use (describe): _____

Design Mix Information

Based on Standard Deviation Analysis ☐ *check one*
 Trial Mix Test Data ☐

Design Characteristics:

Density pcf
 Strength psi (28 day)
 Air % specified

MATERIALS

	<i>Type/ Source</i>	<i>Specific Gravity</i>	<i>Weight/lb.</i>	<i>Absolute Vol. cu.ft.</i>
Cement				
Fly Ash				
Slag				
Coarse Aggregate				
Fine Aggregate				
Water				
Air				
Other				
<i>TOTAL</i>				27.0 cu. ft.

* Water/Cementitious Ratio (lbs. water/lbs. cement) = _____ %

Maximum Shrinkage: (ASTM C157 Modified, 7-day moist cure.
 0.04% @ 28 days or 0.02% @ 28 days). _____ %

ADMIXTURES

	<i>Manufacturer</i>	<i>Dosage oz/cwt</i>
Water Reducer		

Air Entraining Agent		
High Range Water Reducer		
Non-Corrosive Accelerator		
Shrinkage Reducing/Shrinkage Compensating Admixture		
Other		

Slump before HRWR _____ inches

Slump after HRWR _____ inches

Standard Deviation Analysis (from experience records):

# of Test Cylinders Evaluated:	
Standard Deviation:	

$$f'_{cr} = f'_c + 1.34s \text{ or } f'_{cr} = f'_c + 2.33s - 500$$

$$f'_{cr} = f'_c + 1.34s \text{ or } f'_{cr} = 0.90 f'_c + 2.33s \text{ (Strengths over 5000 psi)}$$

(Refer to ACI 301 for increased deviation factor when less than 30 tests are available)

LABORATORY TEST DATA

Compressive Strength

Age (days)	Mix # 1	Mix #2	Mix #3
7	psi	psi	psi
7	psi	psi	psi
28	psi	psi	psi
28	psi	psi	psi
28 average	psi	psi	psi

$$f'_{cr} = f'_c + 1200 \text{ psi}$$

$$f'_{cr} = 1.10 f'_c + 700 \text{ psi} \quad (\text{Strengths over 5000 psi})$$

REQUIRED ATTACHMENTS:

Combined Aggregate Gradation Report (% retained on all _____ sieves).

Standard Deviation Analysis of Compressive Strength Data or Trial Mixture Test Data

28 day Shrinkage Results

check if attached

Admixture Compatibility Certification

Submitted by:	
Name:	
Signature:	Date:
Address:	

December 5, 2025

SKOWHWGAN RIVERFRONT WALKWAY
Skowhegan, Maine

Phone:	
Main Plant Location:	Miles from Project:

END OF SECTION

SECTION 033055
CAST-IN-PLACE CONCRETE (SITE)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specifies requirements for concrete cast-in-place on the site.
- B. The work includes cast-in-place concrete pavement, walkways bases, site feature foundations, structures, and thrust blocks. The work does not include the boardwalk footings and other structural related cast-in-place concrete.

1.02 RELATED SECTIONS

- A. Sections which directly relate to the work of this Section include:
 - 1. Section 310000 – EARTHWORK
 - 2. Section 321610 - CURBING

1.03 REFERENCE STANDARDS

- A. References herein are made in accordance with the following abbreviations and all work under this Section shall conform to the latest editions as applicable.
 - 1. American Concrete Institute (ACI):

301	Specifications for Structural Concrete
305R	Hot Weather Concreting
306R	Cold Weather Concreting
325.9R	Guide for Construction of Concrete Pavements and Concrete Bases
 - 2. ASTM International (ASTM):

A82	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
A1064	Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
C33	Standard Specification for Concrete Aggregates
C94	Standard Specification for Ready-Mixed Concrete
C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
C150	Standard Specification for Portland Cement
C171	Standard Specification for Sheet Materials for Curing Concrete
C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C260	Standard Specification for Air-Entraining Admixtures for Concrete
C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C494	Standard Specification for Chemical Admixtures for Concrete
C1116	Standard Specification for Fiber-Reinforced Concrete
3. Concrete Reinforcing Steel Institute (CRSI):
- | | |
|--------|------------------------------|
| Manual | Manual of Standard Practice. |
|--------|------------------------------|
4. United States Department of Justice - Americans with Disabilities Act (ADA):
- | | |
|-----|--|
| ADA | ADA Accessibility Guidelines for Buildings and Facilities; 28 CFR Part 36. |
|-----|--|
5. State Regulations regarding Accessibility.

1.04 QUALITY ASSURANCE

- A. Work and materials for construction of the cement concrete walks shall conform to ACI 316R. Other cast-in-place concrete shall conform to ACI 301.

- B. Work, materials, and color of the wheelchair ramp paving shall conform to applicable sections of Americans with Disabilities Act (ADA) and State Standards, whichever is more stringent.
- C. Dimensions, locations, and details of equipment pads, anchors, supports, and similar features shown on the Drawings are approximate. Manufacturer's approved shop Drawings of equipment to be supported, anchored, or contained thereby shall be consulted for exact location, size, and details.

1.05 SUBMITTALS

- A. Submit description of methods and sequence of placement for each type of specially finished concrete, including description of methods and sequence of placement.
- B. Submit manufacturer's product data for the following:
 - 1. Form release agent.
 - 2. Concrete coloring additive.
 - 3. Preformed joint filler.
 - 4. Concrete reinforcement specification data from manufacturer.
 - 5. Stamp and imprinting tools, manufacturer's literature.
 - 6. Manufacturer's literature for protective coating for sidewalks.
 - 7. Detectable Warning including manufacturer's certification that product complies with ADA

1.06 TESTING

- A. The Owner may employ an independent testing laboratory to inspect and test concrete paving and other cast-in-place concrete work.
- B. When requested, Contractor shall prepare test specimens in accordance with ASTM C31, standard cylinder size 4-inch x 8 inch.
- C. Testing of materials and installed work may occur at any time during progress of the work. Rejected materials and installed work shall be removed and replaced.

PART 2 - PRODUCTS

2.01 STEEL REINFORCEMENT

- A. Steel reinforcing bars shall conform to ASTM A615, Grade 60, deformed.
1. Bars employed as dowels shall be hot-rolled plain rounds.
- B. Steel Wire: ASTM A82, plain cold drawn steel.
- C. Welded Wire Reinforcement: Welded wire reinforcement shall conform to the applicable requirements of ASTM A1064. Fabric reinforcement shall be furnished in flat sheets. Fabric reinforcement in rolls will not be permitted.
- D. Supports for Reinforcement: Bolsters, chairs, and other devices for spacing, supporting, and fastening reinforcing bars, and welded wire fabric in place shall be wire bar-type supports complying with CRSI Manual.
1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
 2. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI Class 1).

2.02 PORTLAND CEMENT CONCRETE

- A. Portland cement concrete shall conform to the following:
1. Maximum water-cement ratio shall be 0.45 conforming to ACI 316R.
 2. Concrete shall be air-entrained type conforming to ASTM C94. The air-entraining admixture shall conform to ASTM C260 and shall be added to achieve an air content of $6\% \pm 1.5\%$ for $\frac{3}{4}$ -inch nominal aggregate size and $7\% \pm 1.5\%$ for $\frac{1}{2}$ -inch nominal aggregate size, as determined by ASTM C231.
 3. Slump of concrete shall be determined in accordance with ASTM C143 and shall be as follows:
 - Not less than 5 inches nor greater than 8 inches for high-range water reducing admixture
 - Not less than 4 inches nor greater than 7 inches for mid-range water reducing admixture
 - Not less than 3 inches nor greater than 6 inches for low-range water reducing admixture

4. Cement for concrete shall be a Portland cement conforming to ASTM C150, Type I or II. Only one color of cement, all by the same manufacturer, shall be used for the work.
5. Fine and coarse aggregates for concrete shall conform to ASTM C33.
6. Concrete shall contain a water reducing agent to minimize cement and water content of the concrete mix at the specified slump. Water reducing agent shall conform to ASTM C494, Type A, and shall be added in accordance with the manufacturer's instructions to achieve desired workability.
7. Concrete shall contain no calcium chloride or admixtures containing calcium chloride. No admixtures other than those specified shall be used in the concrete without the specific written permission of the Engineer.

2.03 CONCRETE AGGREGATES

- A. Fine Aggregates: Fine aggregates shall conform to ASTM C33, part 6.
- B. Coarse Aggregates: Coarse aggregates shall conform to ASTM C33, Parts 9 through 11 and Tables 2 and 3, with the following Class designations:
 1. Class 1S: For footings and foundations not exposed to the weather.
 2. Class 4S: For pavements, driveways, curbs, walkways, sidewalks, and retaining walls that are exposed to the weather.
 3. Class 1N: For pavements, driveways, curbs, walkways, sidewalks, and retaining walls that are not exposed to the weather.
- C. Exposed Aggregate: Exposed aggregate for ADA curb ramps shall be selected, hard, durable, washed rounded stones free of deleterious reactivity to cement with graded sizes between 1/2 to 3/4-inch diameter nominal sieves.

2.05 CURING MATERIALS FOR UNCOLORED CONCRETE

- A. Curing shall be accomplished by the following methods:
 1. Moist curing with burlap covering.
 2. Curing paper, non-staining, fiber reinforced laminated Kraft bituminous product conforming to ASTM C171. Four mil polyethylene sheeting may be substituted for curing paper.
 3. Curing compound, a resin-base, white pigmented compound conforming to ASTM C309, Type 2.

2.06 WATER REDUCING AGENTS

- A. Water-reducing agents shall comply with ASTM C494, Type A.
- B. The water-reducing agent shall be a high-range water reducer (HRWR) or superplasticizer as necessary to produce the required workability without excessive water.
- C. Additive shall be used as per the manufacturer's recommendations and shall be compatible with other admixtures.
- D. Examples of approved water-reducing agents include but are not limited to: Sika ViscoCrete, BASF MasterGlenium, and Grace ADVA.

2.07 AIR-ENTRAINING ADMIXTURES

- A. Air-entraining admixtures shall comply with ASTM C260.
- B. The air-entraining agent shall be compatible with all other admixtures.
- C. Examples of approved air-entraining admixtures include but are not limited to: Sika Air, BASF MasterAir, and Grace Darex.

2.08 EXPANSION JOINTS

- A. Expansion joint filler shall be preformed, non-bituminous type conforming to ASTM D1752, Type II, similar to Sealtight Cork Expansion Joint Filler, manufactured by W.R. Meadows, Inc., or approved equivalent.
 - 1. Pre-molded filler shall be one piece for the full depth and width of the joint.
- B. Smooth dowel shall be hot rolled plain steel dowel bonded at one end and operating in smooth close-fitting sleeve (of same material) at the other end.
- C. Backer rod to be polyethylene foam similar to Kool-Rod manufactured by W.R. Meadows, Inc. or equivalent.
- D. Joint Sealant shall be Elastomeric sealants meeting ASTM C920; SikaFlex-1A or approved equivalent. Color shall match adjacent darker surface or as indicated on drawings.

2.10 FORMS

- A. Cylindrical Forms: Sonotube Fibre Forms, wax-impregnated strippable forms manufactured by Sonoco Products Company, General Products Division, ABS or PVC plastic reusable forms, or approved equivalent.
- B. Forms for Exposed Finish: Plywood, metal, metal-framed plywood faced, or other acceptable panel materials. Plywood shall conform to U.S. Product Standard PS-1 and APA Graded B-B (Concrete Form) Class I Exterior Grade plywood or B-B or A-C Class I high density overlay concrete form plywood. Formwork materials shall produce smooth, continuous, straight and level surfaces.
- C. Forms for Unexposed Finish: Plywood, lumber, or metal, with lumber dressed on at least two edges and one side.
- D. Form Ties: Prefabricated, adjustable length galvanized steel snap-off ties, with brackets, cones, cornerlocks, and other accessories as necessary.
- E. Form Release Agent: Commercial formulation compounds that will not bond with, stain or adversely affect concrete.
- F. Imprinting Tools: Mats and tools used to stamp projecting texture and patterns onto plastic concrete surfaces and which shall be specifically designed with rigid back supports to enable a clean, sharp, stamping image. Stamps for curb ramps shall be designed to meet ADA detectable warning requirements.

2.11 FIBROUS REINFORCING

- A. Material shall meet ASTM C1116 and shall be as manufactured by NyCon Incorporated, or approved equal.
- B. Mix fibrous reinforcement in accordance with manufacturer's instructions including product data and technical bulletins.
 - 1. Add fibrous reinforcement to concrete mix at the concrete batch facility.
 - 2. Adding and mixing fibrous reinforcement at the job site will not be allowed.
- C. Provide job mix design data to show concrete mix will attain specified strength requirements.

2.12 EXPOSED CONCRETE PROTECTIVE COATING

- A. Surface sealer shall be silane-siloxane non-yellowing type which breathes water vapor, Saltguard WB by ProSoCo or approved equivalent.

2.13 DETECTABLE WARNINGS

- A. Detectable warnings shall meet ADA and State Standards, whichever is more stringent, and shall be ADA Solutions Cast Iron Detectable Warning Plates (or approved equal).

PART 3 - EXECUTION

3.01 PREPARATION OF SUBGRADE

- A. The subgrade of areas to be paved shall be graded and compacted as specified in Section 310000, EARTHWORK.
- B. Excavation required in pavement subgrade shall be completed before fine grading and final compaction of subgrade are performed. Where excavation must be performed in completed subgrade, subbase, base, or pavement, subsequent backfill and compaction shall be performed as required by the Engineer and as specified in Section 310000, EARTHWORK.
- C. Materials shall not be stored or stockpiled on subgrade.
- D. Prepared subgrade will be inspected by the Engineer. Subgrade shall be approved for installation of the gravel base course. Disturbance to subgrade caused by inspection procedures shall be repaired.

3.02 BASE COURSE

- A. Base course for concrete paving shall be pavement subbase course or gravel base materials specified in Section 310000, EARTHWORK as shown on the Drawings.
- B. Width of base course shall extend beyond edge of the proposed pavement as shown on the Drawings.
- C. Material shall be placed in lifts no more than 6 inches thick, compacted measure. Each lift shall be separately compacted to specified density.
 - 1. Material shall be placed adjacent to wall, manhole, catch basin, and other structures only after they have been set to required grade.
 - 2. Rolling shall begin at sides and progress to center of crowned areas, and shall begin on low side and progress toward high side of sloped areas. Rolling shall continue until material does not creep or wave ahead of roller wheels.
 - 3. Surface irregularities which exceed 1/2 inch as measured by means of a 10-foot-long straightedge shall be regraded and recompacted.

- D. Base course shall be compacted at optimum moisture content to not less than 95 percent of maximum density as determined by ASTM D1557.
- E. The base course shall be kept clean and uncontaminated. Less select materials shall not be permitted to become mixed with the base course material.

3.03 STEEL REINFORCEMENT

- A. Before being placed in position, reinforcing steel shall be thoroughly cleaned of loose mill and rust scale, dirt, ice, and other foreign material which may reduce the bond between the concrete and reinforcing. Where there is delay in placing concrete after reinforcement is in place, bars shall be re-inspected and cleaned when required.
- B. Any bar showing cracks after bending shall be discarded.
- C. Unless otherwise shown on the Drawings, reinforcing shall extend within 2 inches of formwork and expansion joints. Reinforcing shall continue through control joints. Adjacent sheets of fabric reinforcing shall lap 6 inches.
- D. After forms have been coated with form release agent, but before concrete is placed, reinforcing steel shall be securely wired in the required position and shall be maintained in that position until concrete is placed and compacted. Chair bars and supports shall be installed in a number and arrangement approved by the Engineer.

3.04 FORMS

- A. General: Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits.
 - 1. Provide Class A tolerances for concrete surfaces exposed to view.
 - 2. Provide Class C tolerances for other concrete surfaces.
- B. Construct forms to provide for openings, offsets, sinkages, keyways, recesses, moldings, chamfers, blocking, screeds, bulkheads, anchorages, and inserts, and other features required for the work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent cement paste from leaking.

- C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Kerf wood inserts for forming keyways, reglets, recesses, and other features for easy removal.
- D. Chamfer exposed corners and edges, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- E. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Re-tighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

3.05 INSTALLING EMBEDDED ITEMS

- A. General: Set and build into formwork the anchorage devices and other embedded items required for work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.
- B. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.06 PREPARING FORM SURFACES

- A. Coat contact surfaces of forms with an approved, nonresidual, low-VOC form-coating compound before placing reinforcement.

3.07 CONCRETE PLACING

- A. Equipment, methods of mixing and placing, and precautions to be observed as to weather, and condition of base shall meet the requirements of ACI 316R.
- B. The Engineer shall be notified of scheduled concrete placement sufficiently in advance of start of operation to allow preliminary inspection of the work, including subgrade, forms, and reinforcing steel.
- C. Work shall not be performed during rainy weather or when temperature is less than 40°F. (4.4°C.).
- D. Adjacent work shall be protected from stain and damage. Damaged and stained areas shall be replaced or repaired to equal their original conditions.
- E. Existing concrete, earth, and other water-permeable material against which new concrete is to be placed shall be thoroughly damp when concrete is placed. There shall be no free water on surface.

- F. Concrete which has set or partially set, before placing shall not be used. Retempering of concrete will not be permitted.
- G. Concrete shall be thoroughly vibrated, or otherwise consolidated to secure a solid and homogeneous mass, thoroughly worked around reinforcement and into corners of forms.
- H. When joining fresh concrete to concrete which has attained full set, latter shall be cleaned of foreign matter, and mortar laitance shall be removed by chipping and washing. Clean, roughened base surface shall be saturated with water, but shall have no free water on surface. A coat of 1:1 cement-sand grout, approximately 1/8 inch thick, shall be well scrubbed into the thoroughly dampened concrete base. New concrete shall be placed immediately, before grout has dried or set.

3.08 FINISHING

- A. Concrete surfaces shall be screeded and finished true to line and grade, and free of hollows and bumps. Surface shall be dense and smooth.
 - 1. Finished concrete surface for concrete subbases shall be wood floated to a slightly rough surface. Surface shall not deviate more than 1/4 inch in 10 feet.
 - 2. Finished concrete surfaces shall be wood floated and steel troweled, or broom finished, to a uniform surface. Surface shall not deviate more than 1/8 inch in 10 feet.
- B. Horizontal surfaces of concrete surfaces which will be exposed shall be given a medium broomed finish, with direction of grooves in concrete surface perpendicular to length of concrete band, slab, or pad. After concrete has set sufficiently to prevent coarse aggregate from being torn from surface, but before it has completely set, brooms shall be drawn across the surface to produce a pattern of small parallel grooves. Broomed surface shall be uniform, with no smooth, unduly rough or porous spots, or other irregularities. Coarse aggregate shall not be dislodged by brooming operation.
- C. Immediately following finishing operations, arises at edges and both sides of expansion joints shall be rounded to a 1/4- inch radius. Control joints to be tooled shall be scored into slab surface with scoring tool. Adjacent edges of control joint shall at same time be finished to a 1/4-inch radius.
- D. Where finishing is performed before end of curing period, concrete shall not be permitted to dry out, and shall be kept continuously moist from time of placing until end of curing period, or until curing membrane is applied.

- E. Sidewalks, walkways, accessible routes, and ramps shall be constructed and finished in accordance with the Americans with Disabilities Act (ADA) and state and local requirements. Provide protective coating in accordance with manufacturer's recommendations.
- F. Exposed Aggregate Finish: Expose coarse aggregate in pavement surfaces as follows:
 - 1. Immediately after float finishing, spray-apply chemical surface retarder to pavement according to manufacturer's written instructions.
 - 2. Cover pavement surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
 - 3. Without dislodging aggregate, remove excess mortar by lightly brushing surface with a stiff, nylon-bristle broom.
 - 4. Fine-spray surface with water and brush. Repeat water flushing and brushing cycle until cement film is removed from aggregate surfaces to depth required.

3.09 STAMPING

- A. Mat Stamping: While initially finished concrete is plastic accurately align and place stamp mats in sequence. Uniformly load mats and press into concrete to produce requirement imprint pattern and depth of imprint on concrete surface. Remove stamp mats immediately. Hand stamp edges and surfaces unable to be imprinted using stamp mats.
- B. Tool Stamping: While initially finished concrete is plastic, cover surface with polyethylene film, stretch taut to remove wrinkles, lap sides and ends 3 inches (75 mm), and secure to edge forms. Lightly broom surface to remove air bubbles. Accurately align and place stamp tools in sequence and tamp into concrete to produce required imprint pattern and depth of imprint on concrete surface. Remove stamp tools immediately. Hand stamp edges and surfaces unable to be imprinted by stamp tools. Unroll and remove polyethylene film immediately after tool stamping.

3.10 CURING

- A. Concrete shall be kept continuously damp from time of placement until end of specified curing period or cured by other methods. Water shall not be added to surface during floating and troweling operations, and not earlier than 24 hours after concrete placement. Between finishing operations, surface shall be protected from rapid drying by a covering of waterproofing paper. Surface shall be damp when the covering is placed over it, and shall be kept damp by means of a fog spray of water, applied as often as necessary to prevent drying, but not sooner than 24 hours after

placing concrete. None of the water so applied shall be troweled or floated into surface.

- B. Concrete surfaces shall be cured by completely covering with curing paper or application of a curing compound.
 - 1. Concrete cured using waterproof paper shall be completely covered with paper with seams lapped and sealed with tape. Concrete surface shall not be allowed to become moistened between 24 and 36 hours after placing concrete. During curing period, concrete surface shall be checked frequently, and sprayed with water as often as necessary to prevent drying, but not earlier than 24 hours after placing concrete.
 - 2. Concrete cured with a curing compound shall have the compound applied at a rate of 200 square feet per gallon, in two applications perpendicular to each other.
 - 3. Curing period shall be seven (7) days minimum.
- C. Only if additional protection is absolutely required, the surface should remain uncovered after the seven (7) day period for at least four (4) days, after which time new and unwrinkled non-staining reinforced waterproof Kraft curing paper may be used.

3.11 EXPANSION JOINTS

- A. Expansion joints shall be 1/2-inch-wide and located to provide a maximum spacing of 50 feet between joints or where shown on the Drawings. Expansion joints shall be troweled in the concrete to required width with preformed joint filler in place. Joint filler shall extend the full depth of the slab and full length of the expansion joint.
 - 1. For concrete walks, pavements, and pads, depth of joint filler shall be placed to form a 1-1/4 inch deep recess for sealant and backer rod below finished concrete surface.
 - 2. Use of multiple pieces to make up required depth and width of joint will not be permitted.

3.12 CONSTRUCTION JOINTS

- A. Construction joints shall be placed whenever placing of concrete is suspended for more than 30 minutes.
 - 1. Butt joint with dowels or use a thickened edge joint if construction joints occur at control joint locations.

2. Keyed joints with tie-bars shall be used if the joint occurs at any other location.

3.13 CONTROL JOINTS

- A. Control Joints shall be sawcut to form panels of patterns as shown on the Drawings. If no pattern is shown, then pattern shall result in square shape with a maximum area of 36 square feet. Use sawcuts 1/8-inch wide by one-fourth of slab depth unless otherwise indicated.

3.14 PROTECTIVE COATING

- A. Sealant shall be applied per manufacturer's recommendations

3.15 COLD WEATHER CONCRETING

- A. Materials for concrete shall be heated when concrete is mixed, placed, or cured when the mean daily temperature is below 40°F. or is expected to fall to below 40°F. within 72 hours. The concrete, after placing, shall be protected by covering, heat, or both.
- B. Details of handling and protecting of concrete during freezing weather shall be subject to the approval and direction of the Engineer. Procedures shall be in accordance with provisions of ACI 306R.

3.16 HOT WEATHER CONCRETING

- A. Concrete just placed shall be protected from the direct rays of the sun and the forms and reinforcement just prior to placing shall be sprinkled with cold water. Every effort shall be made to minimize delays which will result in excessive mixing of the concrete after its arrival on-site.
- B. During periods of excessively hot weather (95°F., or above), ingredients in the concrete shall be cooled with cold mixing water to maintain the temperature of the concrete at permissible levels in accordance with the provisions of ACI 305R. Any concrete with a temperature above 95°F., when ready for placement, will be rejected.
- C. Temperature records shall be maintained throughout the period of hot weather giving air temperature, general weather conditions (calm, windy, clear, cloudy, etc.) and relative humidity. Records shall include checks on temperature of concrete when delivered to Project site and after placing in forms. Data should be correlated with the progress of the work so that conditions surrounding the construction of any part of the structure can be ascertained.

3.17 PROTECTION OF CONCRETE SURFACES

- A. Concrete surfaces shall be protected from traffic or damage until surfaces have hardened sufficiently.

3.18 DETECTABLE WARNINGS

- A. Detectable warnings shall be installed at locations as shown on plans and per manufacturer's recommendations.

END OF SECTION 033055

SECTION 047200
ARCHITECTURAL CAST STONE

PART 1 - GENERAL

1.0 SUMMARY

- A. Copyright notice: This specification contains technical information proprietary to the Cast Stone Institute®. Content is used by permission for project-specific application. No part of this specification may be reproduced for redistribution or commercial use without the express written consent of the Cast Stone Institute

1.1 SCOPE

- A. Cast Stone shown on architectural drawings and as described in this specification
- B. Manufacturer shall furnish Cast Stone covered by this specification.

1.2 RELATED REQUIREMENTS

- A. Section – 01 33 00 – Submittal Procedures.
- B. Section – 04 05 13 – Masonry Mortaring.
- C. Section – 04 05 16 – Masonry Grouting.
- D. Section – 04 05 19 – Masonry Anchorage and Reinforcing.
- E. Section – 04 20 20 – Unit Masonry.
- F. Section – 07 90 00 – Joint Protection.

1.3. REFERENCES

ACI 318 – Building Code Requirements for Reinforced Concrete.
ASTM A615/A615M – Standard Specification for Deformed and Plain Billet-Steel Bars for Reinforced Concrete.
ASTM A1064 / A1064M – Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
ASTM C33 – Standard Specification for Concrete Aggregates. ASTM C150 – Standard Specification for Portland Cement.
ASTM C595/C595M – Specification for Blended Hydraulic Cements ASTM C1157/C1157M – Performance Specification for Hydraulic Cement
ASTM C173 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Volume Method.
ASTM C231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
ASTM C260 – Standard Specification for Air-Entrained Admixtures for Concrete. ASTM C270 – Standard Specification for Mortar for Unit Masonry.
ASTM C426 – Standard Test Method for Linear Shrinkage of Concrete Masonry Units. ASTM C494/C494M – Standard Specification for Chemical Admixtures for Concrete.
ASTM C618 – Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
ASTM C666/666M – Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
ASTM C979 – Standard Specification for Coloring Pigments for Integrally Colored Concrete. ASTM C989 – Standard Specification for Ground Granulated Blast-Furnace Slag for Use in

Concrete.

ASTM C1116 – Standard Specification for Fiber Reinforced Concrete and Shotcrete.

ASTM C1194 – Standard Test Method for Compressive Strength of Architectural Cast Stone.

ASTM C1195 – Standard Test Method for Absorption of Architectural Cast Stone.

ASTM C1364 – Standard Specification for Architectural Cast Stone.

ASTM D1729 – Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials.

ASTM D2244 – Standard Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.

ASTM D7957/D7957M – Standard Specification for Solid Round Glass Fiber Reinforced Polymer Bars for Concrete Reinforcement

TMS 404-504-604 – Standards for Architectural Cast Stone Design – Fabrication - Installation

1.4. DEFINITIONS

- A. Cast Stone - a refined architectural concrete building unit manufactured to simulate natural cut stone, used in Division 4 masonry applications.
- B. Dry Cast – manufactured from zero slump concrete.
 - 1. Vibrant Dry Tamp (VDT) casting method: Vibratory ramming of earth moist, zero-slump concrete against a rigid mold until it is densely compacted.
 - 2. Machine casting method: Manufactured from earth moist, zero-slump concrete compacted by machinery using vibration and pressure against a mold until it becomes densely consolidated.
- C. Wet Cast – Manufactured from measurable slump concrete.
 - 1. Wet casting method: Manufactured from measurable slump concrete and vibrated into a mold until it becomes densely consolidated.

1.5. SUBMITTAL PROCEDURES

Comply with Section 01 33 00 – Submittal Procedures.

Samples: Submit pieces of the Cast Stone that are representative of the general range of finish and color proposed to be furnished for the project.

Test results: Submit manufacturers test results of Cast Stone previously made by the manufacturer.

Shop Drawings: Submit manufacturers shop drawings including profiles, cross-sections, reinforcement, exposed faces, arrangement of joints (optional for standard or semi-custom installations), anchoring methods, anchors (if required), annotation of stone types and their location.

Warranty: Submit Cast Stone Institute® Member Limited Warranty. Certification: Submit valid Cast Stone Institute® Plant Certification.

1.6. QUALITY ASSURANCE

Manufacturer Qualifications:

- Cast Stone shall be produced in a plant certified by the Cast Stone Institute®.
- Manufacturer shall have sufficient plant facilities to produce the shapes, quantities and size of Cast Stone required in accordance with the project schedule.
- Manufacturer shall submit a written list of projects similar in scope and at least three (3) years of age, along with owner, architect and contractor references.

Standards: Comply with the requirements of the Cast Stone Institute® Technical Manual and the project specifications. Where a conflict may occur, the contract documents shall prevail.

Mock-up (Optional) Provide full size unit(s) for use in construction of sample wall. The approved mock-up shall become the standard for appearance and workmanship for the project.

Warranty Period: 10 years.

PART 2 - PRODUCTS

2.1. ARCHITECTURAL CAST STONE

Comply with current version ASTM C1364

Physical properties: Provide the following:

- Compressive Strength - ASTM C1194: 6,500 psi minimum at 28 days.
 - Absorption – ASTM C1195: 6.0% maximum at 28 days.
 - Air Content – Provide sufficient air content to meet the freeze-thaw requirements for wetcast products, when the air content is tested in accordance with Test Method C173/C173M or Test Method C231/C231M. Air entrainment is not required for Vibrant Dry Tamp (VDT) products.
 - Freeze-thaw – ASTM C666/C666M in accordance with ASTM C1364. The CPWL shall be less than 5.0% after 300 cycles of freezing and thawing.
 - Linear Drying Shrinkage – ASTM C426: Test and report in accordance with ASTM C1364.
- Job site testing – One sample from production units may be selected at random from the field for each 500 cubic feet (14 m³) delivered to the job site.
- Three field cut cube specimens from each of these samples shall have an average minimum compressive strength of not less than 85% with no single specimen testing less than 75% of design strength as allowed by ACI 318.
 - Three field cut cube specimens from each of these samples shall have an average maximum cold-water absorption of 6.0%.
 - Field specimens shall be tested in accordance with ASTM C1194 and C1195.

2.2. RAW MATERIALS

Portland cement – Type I or Type III, white and/or grey, ASTM C150 or ASTM C595 Blended Hydraulic Cement (Type 1L).

Coarse aggregates - Granite, quartz or limestone, ASTM C33, except for gradation, and are optional for the Vibrant Dry Tamp (VDT) casting method.

Fine aggregates - Manufactured or natural sands, ASTM C33, except for gradation.

Colors - Inorganic iron oxide pigments, ASTM C979 except that carbon black pigments shall not be used.

Admixtures - Comply with the following:

- ASTM C260 for air-entraining admixtures.
- ASTM C494/C495M Types A - G for water reducing, retarding, accelerating, and high range admixtures.
- Other admixtures: Integral water repellents and other chemicals, for which no ASTM standard exists, shall be previously established as suitable for use in concrete by proven field performance or through laboratory testing.
- ASTM C618 mineral admixtures of dark and variable colors shall not be used in surfaces intended to be exposed to view.
- ASTM C989 granulated blast furnace slag may be used to improve physical properties. Tests are required to verify these features.

Water – Potable

Reinforcing bars:

- ASTM A615/A615M: Grade 40 or 60.
- ASTM D7957/D7957M: Standard Specification for Solid Round Glass Fiber Reinforced Polymer Bars for Concrete Reinforcement
- Welded Wire Fabric: ASTM A1064 / A1064M where applicable for wet cast units. Fiber reinforcement (optional): ASTM C1116

All anchors, dowels and other anchoring devices and shims shall be standard building stone anchors commercially available in a non-corrosive material such as zinc plated, galvanized steel, brass, or stainless steel Type 302, 304 or 316.

2.3. COLOR AND FINISH

Match sample on file in architect's office.

All surfaces intended to be exposed to view shall have a fine-grained texture similar to natural stone, with no air voids in excess of 1/32 in. and the density of such voids shall be less than 3 occurrences per any 1 in.² and not obvious under direct daylight illumination at a 5 ft distance.

Units shall exhibit a texture approximately equal to the approved sample when viewed under direct daylight illumination at a 10 ft distance.

- ASTM D2244 permissible variation in color between units of comparable age subjected to similar weathering exposure.

- oTotal color difference – not greater than 6 units.

- oTotal hue difference – not greater than 2 units.

Minor chipping resulting from shipment and delivery shall not be grounds for rejection. Minor chips shall not be obvious under direct daylight illumination from a 20 -ft distance.

The occurrence of crazing or efflorescence shall not constitute a cause for rejection. Remove cement film, if required, from exposed surfaces prior to packaging for shipment.

2.4. REINFORCING

Reinforce the units as required by the drawings and for safe handling and structural stress. Minimum reinforcing shall be 0.25 percent of the cross section area.

Reinforcement shall be noncorrosive where faces exposed to weather are covered with less than 1.5 in. of concrete material. All reinforcement shall have minimum coverage of twice the diameter of the bars.

Panels, soffits and similar stones greater than 24 in. (600 mm) in one direction shall be reinforced in that direction. Units less than 24 in. (600 mm) in both their length and width dimension shall be non-reinforced unless otherwise specified.

Welded wire fabric reinforcing shall not be used in dry cast products.

2.5. CURING

Cure units in a warm curing chamber approximately 100°F (37.8°C) at 95 percent relative humidity for approximately 12 hours, or cure in a 95 percent moist environment at a minimum 70°F (21.1°C) for 16 hours after casting. Additional yard curing at 95 percent relative humidity shall be 350 degree-days (i.e. 7 days @ 50°F (10°C) or 5 days @ 70°F (21°C)) prior to shipping. Form cured units shall be protected from moisture evaporation with curing blankets or curing compounds after casting.

2.6. MANUFACTURING TOLERANCES

Minimum Thickness shall be 2.5" to facilitate testing for compressive strength and absorption as specified in ASTM C-1364 Standard Specification for Architectural Cast Stone. Cross section dimensions shall not deviate by more than $\pm 1/8$ in. from approved dimensions.

Length of units shall not deviate by more than length/ 360 or $\pm 1/8$ in., whichever is greater, not to exceed $\pm 1/4$ in.

Maximum length of any unit shall not exceed 15 times the average thickness of such unit unless otherwise agreed by the manufacturer.

Warp, bow or twist of units shall not exceed length/ 360 or $\pm 1/8$ in., whichever is greater.

Location of dowel holes, anchor slots, flashing grooves, false joints and similar features – On formed sides of unit, 1/8 in., on unformed sides of unit, 3/8 in. maximum deviation.

2.7. PRODUCTION QUALITY CONTROL

Testing:

- Test compressive strength and absorption from specimens taken from every 500 cubic feet of product produced.

- Perform tests in accordance ASTM C1194 and C1195.

- Have tests performed by an independent testing laboratory every six months.

- New and existing mix designs shall be tested for strength and absorption compliance prior to producing units.

- Retain copies of all test reports for a minimum of two years.

2.8. DELIVERY, STORAGE AND HANDLING

Mark production units with the identification marks as shown on the shop drawings. Package units and protect them from staining or damage during shipping and storage. Provide an itemized list of product to support the bill of lading.

PART 3 EXECUTION

3.1. EXAMINATION

Installing contractor shall check Cast Stone materials for fit and finish prior to installation. Unacceptable units shall not be set.

3.2. SETTING TOLERANCES

Comply with Cast Stone Institute® Technical Manual.

Set stones 1/8 in. or less, within the plane of adjacent units. Joints, plus - 1/16 in., minus - 1/8 in.

3.3. JOINTING

Joint size:

- At stone/brick joints 3/8 in.
- At stone/stone joints in vertical position 1/4 in. (3/8 in. optional).
- Stone/stone joints exposed on top 3/8 in.

Joint materials:

- Mortar, Type N, ASTM C270.
- Use a full bed of mortar at all bed joints.
- Flush vertical joints full with mortar.
- Leave all joints with exposed tops or under relieving angles open for sealant.
- Leave head joints in copings and projecting components open for sealant.

Location of joints:

- As shown on shop drawings.
- At control and expansion joints unless otherwise shown.

3.4. SETTING

Drench units with clean water prior to setting.

Fill dowel holes and anchor slots completely with mortar or non-shrink grout. Set units in full bed of mortar, unless otherwise detailed.

Rake mortar joints 3/4 in. in for pointing.

Remove excess mortar from unit faces immediately after setting. Tuck point unit joints to a slight concave profile.

3.5. JOINT PROTECTION

Comply with requirements of Section 07 90 00.

Prime ends of units, insert properly sized backing rod and install required sealant.

3.6. REPAIR AND CLEANING

Repair chips with touchup materials furnished by manufacturer.

Saturate units to be cleaned prior to applying an approved masonry cleaner. Consult with the manufacture for appropriate cleaners.

3.7. INSPECTION AND ACCEPTANCE

Inspect finished installation according to Cast Stone Institute® Technical Bulletin #36.

December 5, 2025

SKOWHEGAN RIVERFRONT WALKWAY
Skowhegan, Maine

Do not field apply water repellent until repair, cleaning, inspection and acceptance is completed.

3.8. WATER REPELLENT

Apply water repellent in accordance with Cast Stone Institute® Technical Bulletin #35 or water repellent manufacturer's directions.

SECTION 051200

STRUCTURAL STEEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Structural steel.
 - 2. Grout.
- B. Related Sections include the following:
 - 1. Division 1
 - 2. Division 5 Section "Metal Fabrications" for steel lintels or shelf angles not attached to structural-steel frame miscellaneous steel fabrications and other metal items not defined as structural steel.

1.3 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.
- B. Architecturally Exposed Structural Steel (AESS): Structural steel designated, by the Architect, as architecturally exposed structural steel in the Contract Documents.
- C. Heavy Sections: Rolled and built-up sections as follow:
 - 1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches
 - 2. Welded built-up members with plates thicker than 2 inches
 - 3. Column base plates thicker than 2 inches
- D. The term "Contract Documents" in this specification is defined as all the design team drawings and specifications as well as all other documents which define the scope and the contractual requirements of the project.
- E. The term "EOR" in this specification is defined as the Structural Engineer of Record for the structure in its final condition.
- F. The term "Contractor" in this specification is defined to include any of the following:
- G. General Contractor and their sub-contractors, Construction Manager, Structural Steel Fabricator or Structural Steel Erector.

- H. Testing Agency: the independent testing and inspection service engaged by the Owner for quality assurance observation and testing of concrete construction.

1.4 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand LRFD loads indicated and comply with other information and restrictions indicated.
 - 1. Select and complete connections using AISC's "Manual of Steel Construction"
 - 2. Engineering Responsibility:
 - 3. Engineering Responsibility:
- B. Status of the Design: The Contract Documents indicate the design for all primary structural systems and provide general geometrical configuration of steel elements that forms the basis for the analysis and design of structural connections details not indicated on the Contract Documents. The Contract Documents provide general specifications and load criteria for detail development of all connections not indicated as "Fully Designed Connection" on the Contract Documents.
 - a) Delegation of Design Responsibility for Steel Connections: The contractor is fully responsible for the design and detailing of all steel connections that are not indicated as "Fully Designed Connection" in the drawings. To satisfy this requirement, the Contractor shall retain a Professional Engineer licensed in the state in which the project is located to prepare calculations, oversee the design and detailing of steel connections not fully detailed in the drawings, and to ensure shop drawing compliance with the Contract Documents, governing codes, and prevailing standards of practice. The connections shall be designed to withstand the forces provided and satisfy any additional design criteria provided. The Contractor's Professional Engineer shall be professionally responsible for this delegated design work and shall sign and seal the shop drawings and calculations as evidence of conformance with these requirements.
 - C. Contractor shall submit all design delegated connection designs, including shop drawings and design calculations prepared by Contractor's Professional Engineer for review by the EOR. Review by the EOR will be limited to general conformance with the project requirements, design intent, and project performance criteria.
 - D. All work shall be performed in accordance with the applicable Building Codes, requirements of the governmental authorities having jurisdiction or the requirements of this specification, whichever are the more stringent.
 - E. The Contractor shall be responsible for the analysis and verification of all temporary components and assemblies for stresses and displacements that may be imposed by fabrication, shipping, handling, erection, temporary conditions and loads during construction. The analysis of such shall be performed by the Contractor's Engineer.

1.5 COORDINATION WITH OTHER TRADES

- A. The steel contractor and steel contractor's engineer shall include provision for coordination of the steel with other trades including but not limited to the following:
- B. Mechanical, Electrical, Plumbing and Fire Protection equipment, ductwork, conduit and pipework penetrations etc.
- C. Hanging equipment and hoists

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Quality Control: Submit for each shop performing fabrication and for each erector an internal quality control program description that describes who is responsible for quality control and how the quality control program is implemented.
- C. Submittal Schedule: The contractor shall submit for approval a typical connection design calculation and shop drawing submission schedule at least twenty (20) working days prior to commencing submission of connection design calculations and shop drawings. See Division 1 sections for further requirements.
 - 1. The schedule shall include a list, in date order, of all drawings and other required submittal items scheduled to be submitted. The schedule shall list the proposed submittals for each week, including but not limited to the quantity of calculation sheets, erection drawings, and piece drawings, as well as their formats. Once shop drawing submissions have commenced any modification or addition to this schedule must be submitted for approval at least twenty (20) working days before the modification or addition is proposed to take place.
 - 2. If at any time the total number of connection design calculations, erection drawings and/or shop drawings received in any one week period exceeds the amount in the approved schedule by more than 10% for that week, the EOR and Architects have the right to add two days to the average turnaround time for the submittals in excess of the previously approved amount. If the drawings received are 25% more than previously approved amount, the submittal schedule must immediately be reset and the EOR and Architect shall add four days to the turnaround time for submittals in excess of the approved amount.
- D. The Contractor shall allow ten (10) working days between receipt and release by the EOR for the review of piece and erection drawings submittals. The Contractor shall allow fifteen (15) working days between receipt and release by the EOR for the review of calculations, erection procedures, and performance design criteria submittals.
 - 1. Contractor to include in their submittal scheduling ten (10) public holidays per year where the EOR's office will be closed. A list of holiday's can be provided upon request.
- E. Shop Drawings: Show fabrication of structural-steel components.

1. Erection drawings and piece drawings shall include layouts and details for each member showing the steel type and grade, size, connections, cuts, copes, splices, camber, holes, bolts, welds, surface treatments (cleaning, shop paint, etc.) and provisions for the connection of other work. Steel type, grade and size for all attached elements shall also be shown.
 2. Uniquely identify all structural steel pieces and elements across all Shop Drawings and Structural Calculations.
 3. Identify all structural steel materials by the ASTM designation.
 4. Indicate structural steel member by the AISC designation and/or as 'custom fabricated shape'. If 'custom fabricated shape,' identify all plate thicknesses and fabrication welds by standard AWS symbols.
 5. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 6. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections. Identify size and grade variation of bolts on erection plans. Identify pretensioned and slip critical connections on erection plans.
 7. Indicate which direction bolt heads should be oriented where required by Contract Drawings.
 8. Indicate surface preparation.
 9. Indicate special tolerances and erection requirements as noted within Contract Drawings or defined herein.
 10. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed prepared by the qualified professional engineer responsible for their preparation.
 11. For each connection on each fabrication drawing, include the connection design forces and reference to the applicable connection calculation. Connections that are not easily keyed to the associated calculation will be rejected.
- F. Erection Drawings: Provide erection drawings with complete dimensional information clearly identifying the layout of each piece, field welds, field bolts and surface requirements for slip critical connections
- G. Connection Design Submittals: The Contractor is responsible for the design of all steel connections required by the Contract Documents, even if not specifically shown. The Contractor's Engineer shall submit connection calculations for all steel connections prior to submitting shop or erection drawings. The connection designs shall withstand the combined effects of shears, axial forces, moments and torques and as required by applicable codes, reference standards and the Contract Documents. The Contractor's Engineer shall provide a letter certifying that the calculations have been prepared under their supervision. The connection submittals shall meet the following criteria:

1. Typed (no hand calculations shall be submitted) using a spreadsheet, computer program or other method approved by the engineer. All inputs, steps in the calculations and results shall be shown.
2. Provide calculations checks for all forces shown on the drawings. If no calculation is provided (ie "OK by inspection") the calculation shall be rejected.
3. Provide sketches for each calculation, with all dimensions relating to the calculations (including pitch, gage, edge distance, unbraced lengths, Whitmore lengths, etc.) clearly shown. Geometry must be shown accurately and to scale. Provide enough sketches to clearly document the full range of geometric conditions applicable to each job standard proposed.
4. Provide drawings showing the overall locations of the connections that are referenced to each connection calculation
5. Number each calculation in an orderly numbering system.
6. Once submitted for review, calculations shall not be renumbered. Resubmitted calculations shall be indicated by using the same number with an "R" suffix. Any unclouded changes shall result in the entire submittal package being rejected.
7. All AISC code requirements apply. Provide calculations for each check, "OK by inspection" is not permitted.
- H. Connection Criteria: The Contractor shall design and provide any supplemental plates, stiffener plates, doubler plates, reinforcing plates, etc. at connections as required to develop and transfer the forces for the connection design criteria called for in the Contract Documents. If no transfer or pass-through forces are shown on the Contract Documents, the most critical combinations of member forces and directions shall be assumed for the connection design.
- I. Connection Letters: To avoid signing and sealing every submittal, the Contractor shall submit signed and sealed letters from the Contractor's Engineer, who supervises the preparation of connection designs included in the shop and erection drawings.
 1. One letter shall be submitted along with the first submission of calculations and include:
 - a) "All connection design calculations for this project will be designed, by me, or by personnel under my direct supervision, to resist the loads indicated on the Contract Documents and meet all applicable codes."
 2. A second letter shall be submitted upon the completion of all submittals and include:
 - a) "All details and connections as shown on the final shop and erection drawings for this project have been designed by me, or by personnel under my direct supervision, to resist the loads indicated on the Contract Documents and meet all applicable codes."
- J. Erection Procedure: Submit a steel erection procedure, prepared by the Contractor's Engineer, for the review of loads imposed by the EOR. The review by EOR shall only be for

the effects of the steel erection procedures on the final completed structure. This erection procedure shall, as a minimum, meet requirements outlined on the Contract Documents and shall be signed and sealed by the Contractor's Engineer licensed in the state in which the project is located. Modifications or deviations from the approved procedure will be permitted only with prior written approval by the Contractor's Engineer and review by the EOR.

- K. All modifications or revisions to submittals, shop drawings, connection design calculations, models and erection drawings must be clouded or clearly indicated by color, and a revision number appended to the original file or sheet name. The following shall automatically be considered cause for rejection of the modification or revision whether or not the drawing has been approved by the Architect/EOR:
 - 1. Failure to specifically indicate modifications
 - 2. Failure to submit calculations for the modifications
 - 3. Substitution requests that have not been approved by the EOR
 - 4. Revisions to previous submittals that have not been approved by the EOR
- L. Request for Information (RFIs)
 - 1. Submit an RFI immediately when the need for clarification of the Contract Documents arises. Allow for five (5) working day response time from the EOR from receipt by EOR to return. RFI's received after 3pm will be considered received on the following business day.
 - 2. RFIs that contain corrective field work, request for substitutions or submittal information as describe above, shall be rejected and must be submitted as a submittal or Substitution Request.
- M. Substitution Requests: Any deviation from the Contract Documents shall be submitted as a Substitution Request, clearly indicating the reason for the request, the cost associated with the change and schedule impact. Substitutions accepted by the EOR shall be coordinated and incorporated into the work by the Contractor.
- N. Welding Procedure Specifications: Contractor shall submit welding procedure specifications (WPS) for each shop and field welding joint type, for review by the Engineer and the Testing Agency. The WPS shall be prepared and signed by a welding professional, whose qualifications include a minimum of 5 years' experience with the welding technology proposed and complete familiarity with AWS D1.1. The WPS shall completely describe the entire welded joint, including fit-up, materials, technique, procedure for all weld passes and Procedure Qualification Records (PQR), where required. WPS's may be prequalified providing they meet all requirements of AWS D1.1 for prequalified welds. Any single deviation from AWS D1.1 prequalified weld requirements shall necessitate qualification by test per AWS D1.1, Section 4, Part B. The WPS shall contain all data indicated in AWS D1.1, Annex IV and Appendix H, and any other information necessary to produce welded joints in compliance with this specification, and shall include the following:
 - 1. The WPS shall contain a unique WPS number, and shall denote the joint application, the name of the WPS author, the name of the contractor and the date of last revision.
 - 2. The WPS shall indicate the base metal type and thickness.

3. The WPS shall show welding joint details, including joint type, weld type, joint geometry and applicable dimensions, including tolerances.
4. The WPS shall clearly list all applicable welding and thermal cutting processes.
5. The WPS shall indicate the filler metal AWS specification and classification, details regarding shielding materials, and proposed Filler Metal Manufacturers designation, data and recommendations
6. The WPS shall indicate preheat, interpass and post-heat requirements.
7. The WPS shall list all applicable electrical characteristics for the process employed. The WPS shall clearly indicate the specific values required for each welding pass. Where multi-pass welds are required, identify each pass with a mark, and provide applicable electrode characteristics for each pass. These electrical characteristics shall include at a minimum the following:
 - a) The type of current and polarity and acceptable ranges of current measured in amperage. For wire feed processes, at contractor's option, wire feed speed may be listed in lieu of a specific current value or range.
 - b) Voltage (for wire feed processes).
 - c) Travel Speed
 - d) Electrode extension for wire feed processes
 - e) Amperage, voltage, travel speed and electrode extension (as applicable) shall be within the filler metal manufacturers recommendations.
- O. Mill Test Reports: Certificates shall be obtained from the mills producing the steel and shall certify in a cover letter submitted with the certificates, that the steel meets the minimum requirements as to physical properties, inspection, marking and tests for structural steel as defined by the current edition of the relevant ASTM Standard Specifications. The following products shall comply with the requirements:
 - a) Structural steel including chemical and physical properties.
 - b) Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - c) Direct-tension indicators.
 - d) Tension-control, high-strength bolt-nut-washer assemblies.
 - e) Shear stud connectors.
- P. Preconstruction Survey: Submit for record. For all steel construction, before steel erection commences, perform a complete survey for position and alignment at all points where construction by other trades will support steel elements, including by not limited to concrete structure, pockets, embedded plates, anchor rods and base plates. Include plan location positions relative to the building gridlines, and elevations of bearing surfaces and tops of bolts relative to building Datum elevation. Submittal shall identify any out of tolerance dimensions that deviate from the approved documents.
- Q. Source quality-control test reports.

- R. Project Archiving: The Contractor shall deliver to the EOR and Architect at the completion of the job final as-built shop drawings in an electronic format acceptable to the EOR, suitable for archiving the project.

1.7 QUALIFICATIONS

- A. Qualification Data: For fabricator, Contractor's connection design engineer and erector.
1. Qualification Data: Submit qualification data including personnel resumes and project experience with references for the Structural Steel Fabricator, Steel Detailer, Contractor's Engineer(s) and Structural Steel Erector.
 2. The Fabricator and Erector shall have 10 years of comparable and shall employ labor and supervisory personnel familiar with the type of installation, experienced in fabrication and erection of structural steel for projects of similar size and complexity.
 3. The Contractor's Engineer shall have 10 years of comparable experience in steel connection design for projects of similar size and complexity. They shall be licensed in the state of Massachusetts.
 4. The Steel Detailer shall have 10 years of comparable experience in the preparation of shop drawings for projects of this size and complexity.
- B. At the time of bid the following certifications are required and must be submitted with the bid documents. These certifications must remain in place until the occupancy of the building.
1. Erector Qualifications: A qualified erector who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
 2. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, For Steel Building Structures, Category STD.
 3. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

1.8 CONTRACTOR'S QUALITY ASSURANCE

- A. Comply with the provisions of the following specifications and documents:
1. 2021 International Building Code.
 2. American Institute of Steel Construction (AISC 303), "Code of Standard Practice", latest edition.
 3. American Institute of Steel Construction (ANSI/AISC 360) "Specification for Structural Steel Buildings".
 4. AISC's "Seismic Provisions for Structural Steel Buildings" and "Supplement No. 2."
 5. AISC's "Specification for the Design of Steel Hollow Structural Sections."
 6. AISC's "Specification for Load and Resistance Factor Design of Single-Angle Members or Specification for Allowable Stress Design of Single-Angle Members."
 7. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 8. AISC's "Detailing for Steel Construction."
 9. SSPC's "Steel Structures Painting Manual"
 10. ASTM's "A6 - General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet, Piling and Bars for Structural Use."
- B. Connection Design Meeting Conduct meeting at EOR office or project site.

1. Prior to starting connection design the Fabricator shall hold a meeting to verify all connection design assumptions and procedures and shop drawing preparation and submittal procedures.
 2. The agenda shall be prepared by the EOR with the Contractors' input. The Contractor shall take and distribute minutes to all attendees within 3 working days of the meeting. The minutes shall serve as the written record of the direction of connection design. Substitution request shall be submitted separately.
 3. Attendees shall include representatives concerned with the connection design and detailing, including:
 - a. EOR
 - b. General Contractor
 - c. Fabricator
 - d. Erector
 - e. Contractor's connection engineer
 - f. Detailer
 - g. Erector
 - h. Architect
- C. Pre-installation Conference: Conduct conference at project site.
1. At least 30 working days prior to the start of steel erection the Fabricator shall hold a meeting to review the requirements of the steel erection and field inspections. The approved erection procedure and survey procedures shall be reviewed at this meeting.
 2. The agenda shall be prepared by the Contractor. The Contractor shall take and distribute minutes to all attendees within 5 working days of the meeting.
 3. Attendees shall include representatives concerned with the steel erection, including:
 - a. EOR
 - b. General Contractor
 - c. Fabricator
 - d. Erector
 - e. Surveyor
 - f. Owner's Testing and Inspection Agency
 - g. Detailer
 - h. Erector
 - i. Architect
- D. The Contractor at a minimum shall follow their submitted quality control program and shall ensure that the minimum standards specified in the Contract Documents are met.
- E. The Owner's Testing and Inspection Agency shall in no way replace or supplement the Contractor's quality control program or relieve the Contractor of responsibility for their quality control.
- F. The Contractor shall immediately bring to the attention of the EOR and Owner's Testing and Inspection Agency any work that does not conform with the Contract Documents. The Contractor shall propose corrective actions as a submittal for review by the EOR and Architect.

1.9 OWNER'S TESTING AND INSPECTION AGENCY

- A. The Owner's Testing and Inspection Agency does not replace the Fabricator's and Erector's responsibility for testing and inspection as part of their submitted quality control program. The Owner's Testing and Inspection Agencies shall be engaged and paid by the Owner, except when testing or inspection are required due non-conformance by the Contractor.
- B. All fabrication facility locations must be identified in the bid documents. If additional fabrication locations are utilized after award, the cost for inspections at the additional fabrication locations will be borne by the fabricator.
- C. Questionable work may require re-evaluation. Re-inspection of questionable or rejected work and inspection of replacement work shall be performed at expense of Contractor
- D. Shop Inspections: work performed on the premises of a structural steel fabricator certified by the AISC Fabricator Certification Program is not subject to special inspections by the Owner's inspector. Such fabricators must perform the special inspections and submit a certificate of compliance to the registered design professional indicating that the work was performed in accordance with the approved construction documents.
- E. This specification requires an AISC Certified fabricator. However, if, for whatever reason, a certified fabricator that is not used for all or any portion of the work, that portion of the work is to be inspected by the Owner's Inspector per the requirements of field inspections below.
- F. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field inspections, tests and prepare reports. Their responsibilities include:
 - 1. Rejection: The right is reserved to reject any material, at any time, when the material or workmanship does not conform to the contract requirements. Notify the EOR, Architect and Owner daily of rejected work.
 - 2. Reports: Daily reports shall be submitted including weather, work progress and description of the area of work with photographs, tests conducted and results, including deficiencies and corrections made and conformance to the structural documents. The daily reports shall be submitted to the EOR and Architect. The daily reports shall be bound together in a weekly report submitted to the EOR, Architect and Owner.
 - 3. Report Format: Daily reports are required to be submitted to the EOR and Architect in PDF digital format at the end of each day with non-conformance items clearly highlighted. Final, typed, weekly reports in PDF digital format are due within 2 working days of the last day inspected in that week.
 - 4. Non-conformance Log: The inspector shall be responsible to maintain an Excel Spreadsheet list of structural non-conformance items updated daily and submitted to the EOR, Architect and Owner with their reports.
 - 5. Document Control: Contractor to provide EOR approved submittals to shop and site inspectors. Do not inspect from submittals not bearing evidence of the EOR's approval.
 - 6. Certification: When all work is completed and approved by the Owner's Testing Agency, submit a letter to the EOR, Architect and Owner certifying that the installation is in accordance with the Contract Documents and the requirements of applicable codes.

- G. The Contractor shall coordinate their work with the Owner's Testing and Inspection Agency to assure that all test and inspection procedures required by the Contract Documents are completed. The Contractor shall cooperate with the testing and inspection agency in the performance of their work and shall provide the following:
1. Access to places where structural steel work is being fabricated or installed to perform tests and inspections.
 2. Coordinate with the inspectors so all shop fabrication shall be inspected in the shop
 3. Schedule information one week prior to starting work that shows the time and place of shop fabrication, field work and an erection schedule.
 4. Contractor to provide EOR approved submittals to shop and site inspectors.
- H. The Owner's Testing and Inspection Agency shall verify:
1. The qualifications of the following and note any discrepancies with the project requirements immediately to the Engineer of Record and Owner:
 - a. Shop welding procedures (WPS) and qualification tests if deviations from prequalified procedures
 - b. Welder Certifications using AWS procedures and in AWS format
 - c. Shop stud welding setup and operators
 - d. Shop bolting procedures
 - e. Review mill certifications for compliance with the Contract Documents
 - f. Daily Skidmore calibration tests
 - g. Grout procedures
- I. The Owner's Testing and Inspection Agency shall field inspections required in the Contract Documents and as required by applicable codes and local jurisdictions.
1. Shop inspection by AISC Certified Fabricator shall include:
 - a. Alignment and straightness of members
 - b. Camber
 - c. Connections
 - d. Dimensions
 - e. Bolt holes
 - f. Testing of shop bolts
 - g. Weld preparations
 - h. Observation of welding procedures including preheat monitoring
 - i. Cuts, weld access holes and copes of heavy shapes
 - j. Testing of welds, headed studs and deformed bar anchors
 - k. Cutting of heavy shapes
 - l. Finishing of column ends and bearing surfaces
 - m. Cleaning
 - n. Painting
 - o. Storage of material
 2. Field inspection of steel shall include:
 - a. Connections
 - b. Proper tensioning of bolts
 - c. Storage of steel
 - d. Levelness, plumbness and alignment of the frame
 - e. Conformance to AWS welding methods and examination of surface before welding including preheat monitoring

- f. Testing of welds, headed studs and deformed bar anchors
 - g. Field painting and touch-up
 - 3. Bolted Connections Testing: Shop-bolted and field-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 - 4. Direct tension indicators (DTIs): Where DTI's are used the inspector need not be present during the entire installation and tightening operation provided that at all bolts the inspector:
 - a. Has inspected the surface and bolt type for conformance to plans and specifications prior to start of bolting and
 - b. At completion of all bolting, verify the minimum specified bolt tension visually by sighting across the bolt heads
 - c. Where bolting is by turn-of-nut or calibrated wrench, the inspector shall be present to observe procedures and/or check wrench calibration each day that bolting is being performed. They will also observe that bolt size, type and condition of thread and lubricant for bolts being installed is consistent with the bolts used for calibrating the wrenches that day.
 - d. For all bolted connections that are indicated as pre-tensioned or slip critical:
 - i. Has performed pre-installation verification testing in accordance with RCSC.
 - ii. Has observed of 20% of the bolts in each connection, as defined in RCSC and that the pre-tensioning methods of RCSC, are performed.
 - 5. Welding Tests: The testing agency shall certify that all welded connections meet or exceed applicable AISC, AWS and ASTM standards. The following minimum testing requirements may be increased at the testing agency's option to meet this requirement.
 - a. 100% visual inspection of all welds.
 - b. In addition to visual inspection, the following welded connections require non-destructive testing (NDT):
 - i. Full penetration welds: 100% of full penetration welds shall be tested for soundness by means of either radiographic or ultrasonic testing in accordance with AWS D1.1 procedures.
 - ii. Partial penetration welds or Multi-pass Fillet Welds: 100% of partial penetration welds shall be tested for soundness by means of visual and magnetic particle inspection.
 - iii. Fillet welds (Single Pass): 10% of the fillet welds of each connection shall be test by magnetic particle or dye penetrant. If a weld is rejected, all welds in the connection shall be tested, at the contractor expense. If further rejections are found 100% of fillet welds may be required to be tested, at the contractors expense.
 - c. Welds shall be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - i. Liquid Penetrant Inspection: ASTM E 165.
 - ii. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - iii. Ultrasonic Inspection: ASTM E 164.
 - iv. Radiographic Inspection: ASTM E 94.

6. Shear Studs: All shear shop-welded and field welded shear connectors will be visually inspected and tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:
 - i. Bend tests will be performed on all studs where visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector. Tested studs do not require re-straightening.
 - ii. If more than ten percent of studs fail on one member, check all studs on member. In addition for each member with any defective studs, test an additional member.
 - iii. Contractor to replace any studs that crack or break at their expense and the cost of additional inspections.
 - iv. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.
7. Cleaning & Painting: Prior to shop painting, examine all fabricated pieces to verify surface preparation is in conformance with project requirements. Examine all shop painting for conformance with project requirements and paint vendor requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from water and deterioration, including storing members to avoid accumulation of water.
 1. Store fasteners in a protected place in sealed containers with the manufacturer's labels intact at all times.
 2. Clean and relubricate bolts and nuts that become dry or rusted before use.
 3. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers
 4. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.
 5. Storage of welding electrodes shall be per AWS D1.1.
- B. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed by EOR.

1.11 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.12 ADDITIONAL SERVICES BY EOR

- A. Should additional work by the EOR be required for the incorporation of the Contractor requested substitutions, Contractor non-conformance item review and corrections, or submittals that must be reviewed more than three time due to Contractor's mistakes, the Contractor is responsible for paying for additional work performed by the EOR at the EOR's standard hourly rates. Any additional service work will be identified by the EOR prior to undertaking the work.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

- A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:
1. W-Shapes: 60 percent.
 2. Channels, Angles-Shapes: 60 percent.
 3. Plate and Bar: 35 percent.
 4. Cold-Formed Hollow Structural Sections: 35 percent.
 5. Steel Pipe: 35 percent.
 6. All Other Steel Materials: 35 percent.
- B. W-Shapes & Channels: ASTM A 992/A 992M or ASTM A 572/A 572M, Grade 50.
- C. Angles-Shapes: ASTM A 36/A 36M.
- D. Plate and Bar: ASTM A 572/A 572M, Grade 50.
- E. Rectangular Cold-Formed Hollow Structural Sections: ASTM A 500, Grade C, structural tubing.
- F. Circular Cold-Formed Hollow Structural Sections: ASTM A 500, Grade C, structural tubing.
- G. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
1. Weight Class: Standard, Extra strong or Double-extra strong.
 2. Finish: Black, except where indicated to be galvanized.
- H. Medium-Strength Steel Castings: ASTM A 27/A 27M, Grade 65-35, carbon steel.
- I. High-Strength Steel Castings: ASTM A 148/A 148M, Grade 80-50, carbon or alloy steel.
- J. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
1. Finish: Plain, expect at connections to steel that is galvanized or primed with zinc-rich primer, where finish to be: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.
 2. Direct-Tension Indicators: ASTM F 959, Type 325 compressible-washer type.

3. Finish: Plain or Mechanically deposited zinc coating, ASTM B 695, Class 50 to match bolt finish.
- B. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers, plain.
 1. Direct-Tension Indicators: ASTM F 959, Type 490, compressible-washer type, plain.
- C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy hex head steel structural bolts with splined ends; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
 1. Finish: Plain or Mechanically deposited zinc coating, ASTM B 695, Class 50.
- D. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
- E. Threaded Rods: ASTM A 36/A 36M.
 1. Nuts: ASTM A 563 heavy hex carbon steel.
 2. Washers: ASTM F 436 hardened carbon steel.
 3. Finish: Plain except at where steel that is galvanized or primed with zinc-rich primer, where finish to be: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.
- F. Clevises and Turnbuckles: ASTM A 108, Grade 1035, cold-finished carbon steel.
- G. Eye Bolts and Nuts: ASTM A 108, Grade 1030, cold-finished carbon steel.
- H. Sleeve Nuts: ASTM A 108, Grade 1018, cold-finished carbon steel.

2.3 PRIMER

- A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer. Provide manufacturer's certification of compatibility with spray fireproofing. All steel to receive primer unless galvanized or specifically indicated to not receive primer elsewhere in the Construction Documents.
- B. Primer for Architecturally Exposed Structural Steel (AESS): to be confirmed by Architect. Contractor shall submit all components/procedures of the paint system for AESS as a single coordinated submittal. As a minimum identify required surface preparation, primer, intermediate coat (if applicable) and finish coat. All of the items shall be coordinated with the finish coat specified in division 9. Provide manufacturer's certification of compatibility.
- C. Zinc-rich Primer: Inorganic zinc rich meeting AISC class B surface requirements for slip critical connections. Primer shall comply with all federal standards for VOC, lead and chromate levels. Provide manufacturer's certificate of compatibility with fire proofing coating.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds and repair painting galvanized steel, with dry film containing not less than 93 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.

2.4 GROUT

- A. Premixed, non-shrink cement based grout. Grout shall be ready-to-use, non-metallic aggregate product requiring only addition of water at project site, meeting requirements of

ASTM C1107, and shall produce a flowable grouting material having no drying shrinkage at any age and 4.0 percent maximum expansion when tested meeting requirements of ASTM C827. Compressive strength of grout (2" x 2" cubes) shall be 5,000 psi minimum at 7 days and 8,000 psi minimum at 28 days when tested meeting requirements of ASTM C109, except grout shall be restrained from expansion by a top plate.

2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Load and Resistance Factor Design Specification for Structural Steel Buildings."
 - 1. Camber structural-steel members where indicated.
 - 2. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
 - 3. Mark and match-mark materials for field assembly.
 - 4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Architecturally Exposed Structural Steel: requirements to be per Architecturally Exposed Structural Steel Specification. Refer to relevant specification sections.
- C. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.
- D. Manual gas-cutting in the shop is acceptable only when be done with a mechanically guided torch.
- E. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- F. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- G. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, "Power Tool Cleaning."
- H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.
- I. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 - 2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 CONNECTIONS

- A. Bolted Connections: Bolting requirements are the same for shop-bolting and field-bolting.

1. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - a. Where bolt sizes and grades are not indicated on the Drawings, Contractor may select the bolt sizes and choose between ASTM A325 and A490 bolts, subject to the limitations of the RCSC specification.
 2. Connection Type: Fully-tensioned slip critical connections are required in the following locations. Bolts at these connections shall be proportioned using strength slip-critical values unless noted otherwise on drawings.
 - a. Bolts indicated in the drawings as slip-critical (SC).
 - b. At connections of beams and girders to columns, where oversized holes have been specified for installation.
 - c. At locations required by the AISC or RCSC specification.
 - d. At bracing connections where hole sizes are more than 1/16" larger than the bolt diameter.
 - e. At slotted holes not specifically noted as "finger-tight".
 3. Connection Type: Fully-tensioned connections are required in the following locations. These connections do not require slip critical surface preparation and may be designed using non-slip critical "bearing" values.
 - a. Bolts indicated in the drawings as pre-tensioned or fully-tensioned.
 - b. Bolts loaded in direct tension.
 - c. At bolted column splices.
 - d. At connections of beams and girders to braced frames, where the beam/girder aligns within 12" of the bracing workpoint.
 - e. At connections designated as having a horizontal design load.
 4. Bolts not required to be slip critical, pre-tensioned or fully-tensioned may be snug-tight or fully-tensioned at Contractor's discretion.
 5. Bolt-Tensioning Method: Bolts required to be fully-tensioned shall be tensioned by one of the following methods:
 - a. Turn-of-the-nut.
 - b. Calibrated wrench tightening.
 - c. Twist-off tension control bolts.
 - d. Direct tension indicator tightening.
 6. Bolt Re-Use: A490 bolts and galvanized A325 bolts may not be retensioned and shall be discarded.
 7. At bolts that are not fully-tensioned, provide lock-nuts, double nuts or thread locking compound to prevent bolts from loosening.
 8. Bolted AESS Connections: Install with bolt heads on side indicated in approved shop drawings.
- B. Weld Connections: Welding requirements are the same for shop-welding as for field welding.
1. Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
5. Grind butt welds flush.
6. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.
7. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Load and Resistance Factor Design Specification for Structural Steel Buildings" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
8. Brittle Fracture and Lamellar Tearing: Contractor shall take measures including selection of proper materials, fabrication methods, welding procedures, preheating and post heating to minimize the likelihood of brittle fracture and lamellar tearing.

2.7 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 2. Surfaces to be field welded.
 3. Surfaces to be high-strength bolted with slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials.
 5. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 1. SSPC-SP 2, "Hand Tool Cleaning."
 2. SSPC-SP 3, "Power Tool Cleaning."
 3. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
 4. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 5. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
 6. SSPC-SP 8, "Pickling."
 7. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
 8. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
 9. SSPC-SP 14/NACE Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 2.4 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

2.8 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/ A 123M.
 1. Fill vent holes and grind smooth after galvanizing.
 2. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Load and Resistance Factor Design Specification for Structural Steel Buildings."
- B. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 - 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of base plate.
 - 3. Snug-tighten or pretension anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
 - 4. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges." For architecturally exposed structural steel erection tolerances refer to relevant specification sections.
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated on approved shop drawings.

- F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
- G. Do not use thermal cutting during erection unless approved by Engineer/Architect. Finish thermally cut sections within smoothness limits in AWS D1.1.
- H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

3.4 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.
 - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 - 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.
- C. Touchup Painting: Cleaning and touchup painting are specified in Division 9 painting Sections.

END OF SECTION

SECTION 055200
METAL GUARDRAIL SYSTEM

PART 1 – GENERAL

1.00 SUMMARY

- A. Section Includes: Exterior guardrail system for the boardwalk fabricated from solid steel bars and plates, hot-dip galvanized for corrosion resistance.

1.01 RELATED SECTIONS

- A. 013300 – Submittal Procedures.
- B. 062000 – Finish Carpentry (for handrail)

1.02 PERFORMANCE REQUIREMENTS

- A. Structural Loads (MUBEC/IBC 2021):
 - 1. Top Rail: 200lb concentrated load or 50lb/ft uniform load.
 - 2. Infill (Balusters/Plates): 50lb concentrated load on an area of 1sq. ft.
- B. Thermal Movement: Design system to allow for expansion and contraction over a range of 120°F without distortion or failure of fasteners.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM A143/A143M: Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
- D. ASTM A384/A384M: Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
- E. ASTM A385/A385M: Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
- F. ASTM A780/A780M: Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

1.04 QUALITY ASSURANCE

- A. MANUFACTURER QUALIFICATIONS:
 - 1. Manufacturer shall be a member of the American Galvanizers Association.
 - 2. Manufacturer shall have sufficient plant facilities to produce the shapes, quantities and size of railing components required in accordance with the project schedule.
 - 3. Manufacturer shall submit a written list of projects similar in scope and at least three (3) years of age, along with owner, architect and contractor references.

PART 2 - PRODUCTS

2.01 METALS

- A. Steel Plates and Bars: ASTM A36/A36M.
- B. Steel Bar Stock: ASTM A29/A29M, hot-rolled carbon steel.

2.02 FABRICATION

- A. Design: Fabricate railings from solid flat bars and square/round bar stock as indicated on Drawings.
- B. Edge Preparation: All sharp corners of plates and bars must be eased to a radius of approximately 1/16 inch (1.6mm) prior to galvanizing.
 - 1. Reason: Zinc coating tends to thin out on sharp 90-degree corners; rounding the edges ensures uniform thickness.
- C. Welding: Fabricate by welding. All welds to be continuous. Grind exposed welds smooth and flush to match the profile of the adjacent bar stock.
- D. Non-Hollow Construction: As this system utilizes solid bars, internal venting is not required; however, ensure that any overlapping plates are seal-welded to prevent "bleeding" of cleaning acid during the galvanizing process.

2.03 FINISHES

- A. Hot-Dip Galvanizing: * Standard: ASTM A123/A123M for all fabricated assemblies.
 - 1. Grade: Grade 85 (minimum 2.0 oz/sq. ft. of zinc).
- B. Surface Quality: The finish shall be free of "dross" (zinc-iron alloy inclusions) and "pimples." Given the high visibility of plate railings, the galvanizer shall use extra care to avoid "white rust" (wet storage stain) during transport.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Fasteners: Use only ASTM A153 hot-dip galvanized bolts, nuts, and washers.
- B. Anchoring: * For plate-mounted railings, use galvanized wedge anchors or adhesive anchors into concrete.
 - o Base plates must be leveled using galvanized shims; grout with non-shrink, non-metallic grout.

3.02 REPAIR OF GALVANIZED SURFACES

- ASTM A780: Any scratches or damage from installation must be repaired immediately.
- Method: Clean to bare metal using a wire brush and apply two coats of organic cold-galvanizing spray or brush-on compound containing a minimum of 94% zinc dust in the dry film.

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel railings.

1.2 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's product lines of mechanically connected railings.
2. Fasteners.
3. Post-installed anchors.
4. Handrail brackets.
5. Nonshrink, nonmetallic grout.
6. Anchoring cement.
7. Metal finishes.

B. Sustainable Design Submittals:

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

D. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters, including finish.
2. Fittings and brackets.
3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
 - a. Show method of connecting and finishing members at intersections.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.
- D. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.
- B. Structural Performance: Railings, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.

- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

- 1. Temperature Change: 180 deg F, material surfaces

2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
 - 1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

2.3 STEEL RAILINGS

- A. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Hollaender Mfg. Co.
 - 2. TrueNorth Steel
 - 3. Tuttle, a Dant Clayton Division
 - 4. VIVA Railings, LLC
 - 5. Wagner Companies (The); R&B Wagner, Inc.
- B. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- C. Tubing: ASTM A500/A500M (cold formed).
- D. Pipe: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
 - 1. Provide galvanized finish for exterior installations and where indicated.
- E. Plates, Shapes, and Bars: ASTM A36/A36M.
- F. Cast Iron Fittings: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.
 - 1. Style Designation: 3/4 number 13

2.4 FASTENERS

- A. Fastener Materials:
 - 1. Ungalvanized-Steel Railing Components: Plated steel fasteners complying with

ASTM F1941/F1941M, Class Fe/Zn 5 for zinc coating.

2. Hot-Dip Galvanized Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
 3. Finish exposed fasteners to match appearance, including color and texture, of railings.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction.
- C. Fasteners for Interconnecting Railing Components:
1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
 2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
 3. Provide square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.
- B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint, complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- E. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
1. Water-Resistant Product: Where indicated on Drawings, provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions,

member sizes and spacing, details, finish, and anchorage.

- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.
 - 1. Clearly mark units for reassembly and coordinated installation.
 - 2. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
 - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water.
 - 1. Provide weep holes where water may accumulate.
 - 2. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with **welded** connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
 - 4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 welds; ornamental quality with no evidence of a welded joint.
- I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 1. Fabricate splice joints for field connection, using an epoxy structural adhesive, if this is manufacturer's standard splicing method.
- J. Form changes in direction as follows:
 - 1. As detailed.
 - 2. By flush bends or by inserting prefabricated flush-elbow fittings.
- K. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- L. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.

- M. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
 - 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.
 - 1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
 - 2. Coordinate anchorage devices with supporting structure.
- P. For removable railing posts, fabricate slip-fit sockets from stainless steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height.
 - 1. Provide socket covers designed and fabricated to resist being dislodged.
 - 2. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

2.7 STEEL AND IRON FINISHES

- A. Galvanized Railings:
 - 1. Hot-dip galvanize **indicated** steel railings, including hardware, after fabrication.
 - 2. Comply with ASTM A123/A123M for hot-dip galvanized railings.
 - 3. Comply with ASTM A153/A153M for hot-dip galvanized hardware.
 - 4. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
 - 5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner and as follows.
 - 1. Comply with SSPC-SP 16.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

- A. Perform cutting, drilling, and fitting required for installing railings.
 - 1. Fit exposed connections together to form tight, hairline joints.
 - 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
 - 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
 - 4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 5. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 - 6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
 - 1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws, using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve,

extending 2 inches beyond joint on either side; fasten internal sleeve securely to one side; and locate joint within 6 inches of post.

3.4 ANCHORING POSTS

- A. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material.
- B. Leave anchorage joint exposed with anchoring material flush with adjacent surface.
- C. Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For steel railings, weld flanges to post and bolt to metal supporting surfaces.
- D. Install removable railing sections, where indicated, in slip-fit stainless steel sockets cast in concrete.

3.5 ATTACHING RAILINGS

- A. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.

3.6 CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

3.7 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 055213

SECTION 061000

ROUGH CARPENTRY

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Structural floor and deck framing.
2. Sill gaskets and flashings.
3. Preservative treatment of wood.
4. Miscellaneous framing

- B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 033000 – CONCRETE
2. Section 061050 - MISCELLANEOUS CARPENTRY for wood furring, grounds, nailers, and blocking.

1.3 SUBMITTALS

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

1. Submit two samples of exposed-to-view wood structural joists, deck, illustrating wood grain, stain, and finish.
2. Manufacturer's Certificate: In lieu of grade stamping exposed-to-view lumber, submit manufacturer's certificate certifying that products meet or exceed specified requirements.
3. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used, net amount of preservative retained, and chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

6. Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body.
7. For adhesives, documentation including printed statement of VOC content.
8. For composite wood products, documentation indicating that product contains no added urea formaldehyde.

1.4 QUALITY ASSURANCE

- A. Inspection: Prior to work of this Section, carefully inspect the installed work of other trades and verify that such work is completed to the point where this installation may properly commence.
- B. Discrepancies: In the event of discrepancy, immediately notify the Project Manager. Do not proceed with installation in areas of discrepancy until such discrepancies have been fully resolved.
- C. Lumber may be rejected by the Architect, whether or not it has been installed, for excessive warp, twist, bow, crook, mildew, fungus, or mold, as well as for improper cutting and fitting.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials in a dry, well-ventilated, weather tight place.

1.6 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with exterior finish carpentry installation only if substrate is completely dry and if existing and forecasted weather conditions permit exterior finish carpentry to be installed according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Certified Wood: Materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
- B. Lumber: DOC PS 20 and applicable rules of lumber grading agencies certified by the American Lumber Standards Committee Board of Review.
 1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 3. Provide dressed lumber, S4S, unless otherwise indicated.

4. Provide dry lumber with 15 percent maximum moisture content at time of dressing for 2inch nominal thickness or less, unless otherwise indicated.

2.2 WOOD PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
 2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- B. Kiln-dry material after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark each treated item with the treatment quality mark of an inspection agency approved by the American Lumber Standards Committee Board of Review.
- D. Application: Treat items indicated on Drawings.

2.3 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
 1. Fasteners for treated lumber: Stainless steel or hot-dipped galvanized (meeting ASTM 153) and hot-dipped galvanized connectors (meeting ASTM A653). Electro-galvanized fasteners are not acceptable. Where fasteners connecting structural members are exposed to high moisture, or are in contact with ground or concrete, use Type 316 stainless steel fasteners.
 2. Use hot-dipped galvanized steel nails and end nailing for all blocking in wet walls and exterior walls; do not toe nail within 1/2" of the edge of blocking or the supporting structural member. Do not use staples to secure blocking.
- B. Nails and Staples: ASTM F1667.
- C. Power-Driven Fasteners: CABO NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Bolts: Steel bolts complying with ASTM A307, Grade A with ASTM A 563 hex nuts and, where indicated, flat washers.

- F. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capacity to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

2.4 ACCESSORIES

- A. Structural framing connectors: hot-dipped galvanized steel, sized to suit framing conditions.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Rough carpentry shall produce joints true, tight, and well nailed with members assembled in accordance with Drawings and with applicable codes and regulations.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit.
- C. Apply field treatment complying with AWWA M4 to cut surfaces of preservative-treated lumber and plywood.
- D. Securely attach work as indicated and according to applicable codes and recognized standards.
- E. Use fasteners of appropriate type and length. Predrill members when necessary to avoid splitting wood.

F. FRAMING

1. Carefully select all members. Select individual pieces so that knots and defects will not interfere with placement of bolts, when nailing or making connections. Discard defective pieces.
2. Set structural members level and plumb, in correct position.
3. Fasten framing according to the 2021 International Building Code.
4. Make provisions for erection loads and for sufficient temporary bracing to maintain structure safe, plumb, and in alignment until completion of erection and installation of permanent bracing.
5. Place horizontal members, crown side up.
6. Construct load bearing framing and curb members full length without splices.
7. Double members at openings over 12 inches wide. Space short studs over and under opening to stud spacing.
8. Construct double joist headers at floor and ceiling openings and under wall stud partitions parallel to floor joists. Frame rigidly into joists.
9. Bridge framing in excess of 1 foot span. Fit solid blocking at ends of members.
10. Place full-width continuous sill flashings under framed walls on cementitious foundations. Lap flashing 4 inches.

11. Place sill gasket directly on sill cementitious foundation. Puncture gasket clean, and fit tight to protruding foundation anchor bolts.

G. SITE-APPLIED WOOD TREATMENT

1. Brush-apply one coat of preservative treatment on wood in contact with cementitious materials and roofing and related metal flashings.
2. Treat site sawn cuts. Apply preservative to site sawn cuts according to AWPA M4.
3. Allow preservative to dry prior to erecting members.

3.2 TOLERANCES

- A. Framing and furring members to receive a finished wall or ceiling: Align finish surface to vary not more than 1/8 inch from a theoretical plane or surfaces of the room or space.
- B. Other framing members: 1/4 inch from indicated position, maximum.
- C. Surface flatness of floor: 1/4 inch in 10 feet minimum, and 1/2 inch in 30 feet maximum.

END OF SECTION

SECTION 061053

MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section Includes:
 - 1. Framing with dimension lumber.
 - 2. Wood blocking, cants, and nailers.
 - 3. Wood furring and grounds.
 - 4. Wood sleepers.
- C. Related Requirements:
 - 1. Section 061000 "Rough Carpentry" for deck framing, wood treatment.
 - 2. Section 061753 "Shop-Fabricated Wood Trusses" for wood trusses made from dimension lumber.

1.2 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater size but less than 5 inches nominal size in least dimension.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Power-driven fasteners.
3. Post-installed anchors.
4. Metal framing anchors.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. Dress lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWPAC U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
 2. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
1. For exposed lumber indicated to receive a stained or natural finish, omit marking and provide certificates of treatment compliance issued by inspection agency.
- D. Application: Treat items indicated on Drawings, and the following:
1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
 3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
 4. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
 5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 DIMENSION LUMBER FRAMING

- A. Other Framing: unless noted otherwise on drawings. No. 2 grade of the following species:
1. Hem-fir (north); NLGA.
 2. Southern pine; SPIB.
 3. Douglas fir-larch; WCLIB or WWPA.
 4. Southern pine or mixed southern pine; SPIB.
 5. Spruce-pine-fir; NLGA.
 6. Douglas fir-south; WWPA.
 7. Hem-fir; WCLIB or WWPA.
 8. Douglas fir-larch (north); NLGA.
 9. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Cants.
4. Furring.
5. Grounds.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any of the following species:

1. Hem-fir (north); NLGA.
2. Mixed southern pine or southern pine; SPIB.
3. Spruce-pine-fir; NLGA.
4. Hem-fir; WCLIB or WWPA.
5. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
6. Western woods; WCLIB or WWPA.
7. Northern species; NLGA.
8. Eastern softwoods; NeLMA.

C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

E. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Nails, Brads, and Staples: ASTM F1667.

C. Screws for Fastening to Metal Framing: ASTM C954, length as recommended by screw manufacturer for material being fastened.

D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 as appropriate for the substrate.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B633, Class Fe/Zn 5.

2. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2

2.6 METAL FRAMING ANCHORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. KC Metals Products, Inc.
 2. Simpson Strong-Tie Co., Inc.
 3. USP Structural Connectors.
- B. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, G60 coating designation.
 1. Use for interior locations unless otherwise indicated.
- C. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A653/A653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.
 1. Use for wood-preserved-treated lumber and where indicated.
- D. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
 1. Use for exterior locations and where indicated.

2.7 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
- D. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- E. Do not splice structural members between supports unless otherwise indicated.
- F. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- G. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- H. Comply with AWP A M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- I. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- J. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 - 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
 - 3. ICC-ES evaluation report for fastener.
- K. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILER

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

3.3 INSTALLATION OF WOOD FURRING

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- size furring horizontally and vertically at 24 inches o.c.
- C. Furring to Receive Gypsum Board: Install 1-by-2-inch nominal-size furring vertically at 16 inches o.c.

3.4 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 061500
WOOD DECKING AND LUMBER

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials and equipment necessary to complete the work of this Section, including the following:

1. Wood decking, lumber and timbers for the following applications: boardwalk

- B. Related Work: The following items are not included in this Section and will be performed under the designated Sections.

1. Section 061000 – ROUGH CARPENTRY for other rough carpentry work.

2. Section 062000 – FINISH CARPENTRY for other finish carpentry work.

- C. Reference Standards: Comply with applicable requirements of the following:

ASTM D143-14 – Standard Test Methods for Small Clear Specimens of Timber.

ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

ASTM D 4761-13, Section 8.5.3.1 – Standard Test Methods for Mechanical Properties of Lumber and Wood-Based Structural Materials

U.S. Lacey Act – Full Compliance as product is from FSC Managed Forest FSC

ASTM E648-17 "Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source". The foregoing test procedure is comparable to NFPA No. 253

International Code Council (ICC) Evaluation Service Report (ESR) issued and active, meeting the criteria of Acceptance Criteria AC47: ESR-3756.

ENVIRONMENTAL PRODUCT DECLARATION (EPD) in accordance with ISO 14025, ISO 21930 and EN 15804.

1.02 SUBMITTALS

- A. Submittals: Submit under provisions of Division 01.
- B. Product Literature: Manufacturer's product literature describing all components. Include installation recommendations and instructions.
- C. Verification Samples: For each type of decking and lumber.
- D. Certificate of Compliance, Forest Stewardship Council: FSC Controlled Wood, Chain of Custody.
- E. Certificates of Compliance: Submit documentation of the following:
1. MSDS (Material Safety Data Sheet) – Submit a Material Safety and Data Sheet for the wood products supplied on the project.
 2. ENVIRONMENTAL PRODUCT DECLARATION (EPD) in accordance with ISO 14025, ISO 21930 and EN 15804.
 3. ICC ESR-3756.

1.3 QUALITY ASSURANCE

- A. Manufacturer/Vendor Qualifications: Products covered under this Section shall be supplied by a single manufacturer/vendor unless otherwise specified with a minimum of ten years proven production or supply experience.
- B. Installer Qualifications: Installer shall have a minimum of three years proven construction

experience and be capable of estimating and building from drawings and details, determining elevations, in addition to proper material handling.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect materials during shipment, storage and construction against damage.
- B. All units shall be individually strapped to wood pallets or blocking of a minimum thickness to allow the egress of lift forks using high strength strapping.
- C. Store a minimum of 4 inches off the ground in a dry location and cover with polyethylene to protect from contact with materials which would cause staining or discoloration.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Basis-of-Design:
 - a. Kebony™ Deck Board, clear #2637, 5/4x6 by Kebony AS, Tel: 855.230.5656, info@kebony.us, www.kebony.us
 - b. Thermory Benchmark Ash, smooth unoiled, by Thermory USA, Tel: 585-591-6590, www.thermoryusa.com.
 - c. Mataverde 1x6 Thermally modified Ash Decking by Mataverde, Tel: 855.545.4284, www.mataverdedecking.com
 - d. Or approved equal

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to starting work inspect the substrate to ensure that it has been properly prepared to accept materials specified in this Section. Commencement of work shall imply acceptance of surfaces and deck conditions.
 - 1. Review drawings for heavy static items such as planters, hot tubs, sculptures or equipment that will be installed on top of wood decking, lumber and timbers.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved submittals including the following:
 - 1. Install materials plumb, true to line, cut and fitted.
 - 2. Scribe and cope as required for accurate fit to adjacent construction.
 - 3. Use manufacturer's recommended fasteners.
 - 4. Fasten tight to supports. Provide shims if there are variations in framing.

3.3 CLEANING AND PROTECTION

- A. Protect from damage during construction operations. Promptly repair any damaged surfaces. Remove and replace work which cannot be satisfactorily repaired.

SECTION 062000
EXTERIOR FINISH CARPENTRY

PART 1 – GENERAL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section Includes: Exterior wood handrails and associated mounting hardware.
- B. Related Sections:
 - 1. 06 10 00 – Rough Carpentry
 - 2. 05 52 00 – Metal Railings

1.02 References

- A. AWP (American Wood Protection Association): Standards for pressure-treated wood.
- B. AWI (Architectural Woodwork Institute): Architectural Woodwork Standards for exterior grade work.

1.03 Submittals

- A. Product Data: Manufacturer's specifications for hardware and wood treatments.
- B. Shop Drawings: Provide detailed plans, elevations, and attachment details for handrails.
- C. Samples: 12-inch long sample of specified handrail profile with the intended finish.

1.04 Quality Assurance

- A. Lumber Grading: All wood must be graded by an agency recognized by the American Lumber Standard Committee (ALSC).
- B. Moisture Content: Wood shall be kiln-dried to a maximum moisture content of 15% to 19% at the time of installation.

PART 2: PRODUCTS

2.01 Wood Materials

- A. Species: Western Red Cedar
- B. Grade: Clear.
- C. Handrail Profile: custom molded profile per drawings.

2.02 Fasteners and Hardware

- Material: All fasteners must be Type 304 or 316 Stainless Steel or hot-dipped galvanized (ASTM A153) to prevent corrosion and wood staining.
- Adhesives: Waterproof, exterior-grade glue (Type I or II) meeting ASTM D4317.

2.03 Fabrication

- Joinery: Use glued-and-screwed joints. Scarf joints are required for long runs.
- Surface Finish: All exposed surfaces must be sanded smooth to remove mill marks and sharp edges. All exterior corners must be slightly eased (3/16-inch radius) to hold finish better.

PART 3: EXECUTION

3.01 Examination

- Verify that structural blocking is in place to support handrail loads
- Do not install wood that is warped, checked, or shows signs of rot.

3.02 Installation

- Layout: Install handrails at a height indicated in drawings.
- Fastening: Pre-drill all holes to prevent splitting. Countersink screws and fill with matching wood plugs or exterior wood filler if a painted finish is specified.
- End Treatments: Miter handrail ends or terminate in a manner that does not create a snagging hazard.
- Corner treatments: miter handrail corners in a manner that continues smooth transitions at exterior and interior edges.

3.03 Cleaning and Protection

- Remove all sawdust and construction debris from the site.
- Touch up any nicks or abrasions.
- Cover and protect the handrails from subsequent construction activities until final acceptance.

SECTION 101455
TRAFFIC AND REGULATORY SIGNAGE (SITE)

PART 1 – GENERAL

1.01 DESCRIPTION

- A. This Section specifies requirements for site traffic and regulatory signs and supports.
- B. The work includes:
 - 1. The furnishing and installation of new signs and sign supports.
 - 2. The removal of existing signs.

1.02 SUBMITTALS

- A. Shop Drawings:
 - 1. Shop Drawings of all signs and supports. Do not order material or begin fabrication until Engineer's approval has been obtained.
 - 2. Show sizes and thicknesses of all members, types of materials, methods of construction and assembly, type of surface treatment, complete dimensions, hangers, brackets, anchorage, fasteners, relationship to surrounding work by other trades, shop finishes, sign designs, layouts, and lettering, and other pertinent details of fabrication and installation.

1.03 QUALITY ASSURANCE

- A. The manufacturer shall have experience in the type of work required and a reputation for producing satisfactory work on time.
- B. Deliver and store in a manner that prevents cracking, chipping, stress of the components, and damage.

PART 2 – PRODUCTS

2.01 ALUMINUM SIGN PANELS

- A. Aluminum Sign Panel: Fabricated from flat aluminum sheeting, ASTM B209, Alloy 6061-T6 or Alloy 5052-H38, of the following thickness and mounting, unless otherwise specified:

Area of Sign (square feet)	Mounting	Thickness (Inches)
Less than or equal to 10	Single Post	0.080
Between 10 and 20	Two Posts	0.080
Between 6 and 25	Single Post (Top Mounted)	0.250

- B. Sign supporting hardware shall be aluminum or stainless steel.

2.02 REFLECTIVE SHEETING

- A. Reflective sheeting shall meet the requirements of AASHTO M 268.
 - 1. Panel sheeting shall be Type II (Engineering Grade).
 - 2. Legend sheeting shall be Type III (High Intensity).
- B. Reflective sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified for the manufacture of traffic control signs by the sheeting manufacturer. Heat activated adhesive coating sheeting shall be pre-perforated.
 - 1. No splices shall be allowed on sign panels.
- C. When pressure sensitive adhesive coating reflective sheeting is used all sheeting splices and sign edges shall be sealed with materials recommended by and in a manner specified by the sheeting manufacturer.
 - 1. Dry heat activated adhesive coated reflective sheeting when applied to aluminum shall be edge sealed as specified by the sheeting manufacturer.
- D. Reflective sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified by the sheeting manufacturer.
- E. The numerals shall be black, die-cut, pre-spaced, conforming to the detail on the Drawings. Numerals shall have a pre-coated, pressure-activated adhesive applied as recommended by the manufacturer of the reflective sheeting or be opaque black permanent inks applied on approved high intensity sheeting.
- F. Treatment of Aluminum Sign Panels Prior to Application of Reflective Sheeting.
 - 1. Degreasing:
 - a. Vapor degreasing: By total immersion of the panel in a saturated vapor or trichloroethylene. Trademark printing shall be removed with lacquer thinner or controlled alkaline cleaning system.
 - b. Alkaline degreasing: By total immersion of the panel in a tank containing alkaline solutions, controlled and titrated to the solution manufacturer's specification.
 - 2. Rinsing: After satisfactory degreasing, the panels shall be thoroughly washed with running water.
 - 3. Drying: The panel shall be thoroughly dried by use of a forced hot air dryer.
 - 4. Metal shall not be handled between cleaning and etching operation and the application of reflective sheeting, except with devices or clean canvas gloves.
 - 5. Metal shall not come in contact with greases, oils, or other contaminants prior to the application of reflective sheeting.

2.03 LEGENDS

- A. Permanently Applied Legends:
 - 1. Permanently applied legends shall be reflective or opaque sheeting applied directly to clean, dust-free background in a manner specified by the sheeting manufacturer.
 - 2. Heat activated adhesive-coated material shall be applied only by mechanical means.
 - 3. Finishes shall be as recommended by and applied in the manner specified by the sheeting manufacturer.
 - 4. Legends shall be neatly cut.
- B. Silk Screen Processed:

1. The legends shall be of the series and size specified in the AASHTO Manual for "Signing and Pavement Markings" (current edition), and the dimension and details of the letters in to each series shall be as specified in the U.S. Department of Transportation FHWA publication "Standard Alphabets for Highway Signs and Pavement Markings" (current edition), or as shown on the Drawings.

2.04 FASTENERS AND ANCHORS

- A. The sign fabricator shall design a complete system of fastenings and anchorage devices for the various signs, as required for attachment to the various supporting structures. These may include concealed clip systems, face screws and epoxy adhesives. Wherever reasonably possible, fastenings and anchorage devices shall be fully concealed and shall be vandal proof. The Contractor shall provide safe and secure installations in strict conformance to the governing laws and building code.

2.05 SIGN SUPPORTS

- A. Type A Sign support shall be 2-1/2" steel post; paint color shall be selected by Architect.
- B. Type B Sign supports shall be breakaway type.

PART 3 – EXECUTION

3.01 PROTECTION AND TEMPORARY COVERS

- A. Completed sign panels shall be protected and maintained in good condition, free from dirt, scratches, hand marks or other blemishes. The panels shall be transported in a manner that prevents damage.
- B. Subsequent to erection, if required by the Engineer, exterior signs shall be covered until the actual use is desired. Material used to temporarily cover any sign panel shall effectively conceal the message, be non-injurious to the panel, its finish, its structural integrity, and shall be of sufficient durability for the time period required.

3.02 INSTALLATION

- A. Erection of all signs shall be performed by experienced sign erectors. Signs shall be installed true, plumb, and level, located where shown on the Drawings or as required by the Engineer. No field cutting of any sign work will be allowed. Exercise extreme care in all handling and stacking of signs to avoid chipping.
- B. All work shall be rigidly anchored to the supporting construction in accordance with the approved shop drawings.

3.03 CLEAN-UP

- A. Surfaces of signs shall be cleaned as recommended by the sign manufacturer after installation.

- B. All defective work shall be removed and replaced with work conforming to the specified requirements.

3.04 ERECTION OF POSTS

- A. Posts specifically indicated on the drawings to be driven, shall be driven a minimum of four feet into firm ground.
- B. Steel Posts shall be supported in a concrete base as detailed in the drawings.
- C. The height of signs above ground surfaces shall meet Americans with Disabilities Act (ADA) requirements.
- D. Edge of signs shall be located two feet (min) from face of curb or as required per Manual of Uniform Traffic Control Devices (MUTCD).

END OF SECTION 101455

SECTION 260500
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 1 - General Requirements, and shall include all Sections of Division 26 and shall apply to all Work specified, indicated in the Drawings, and as required to furnish a complete installation of mechanical systems for the Project. Review all Sections of the Specifications for related work and coordinate the work of this Section with all other Sections.

1.2 SUMMARY

- A. Section includes common work results related to all Division 26 Sections.
- B. Furnish all labor, services, materials, tools, equipment, appliances, facilities, transportation and incidental work and appurtenances required to furnish a complete and properly operating system.
- C. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and shall coordinate the work with that of the other trades to avoid interference. The plans are diagrammatic and show the general arrangement of the conduit, panels, transformers and equipment. All dimensions and existing conditions shall be the responsibility the Contractor. Before proceeding with work check and verify all dimensions.
- D. The Contractor shall assume all responsibility for fitting of materials and equipment to other parts of equipment and structure. Make adjustments that may be necessary or as requested, in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades. Where existing pipes, conduits and/or ducts prevent installation of new work as indicated, relocate, or arrange for relocation with the applicable trades, existing pipes, conduits and/or ducts.
- E. Where the project involves interface with existing building and site systems, the Consultant has used reasonable care to identify existing utilities and services. The Contractor is responsible to thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available i.e. concealed conditions, which exist in the existing building affected by this work.

- F. Documents do not represent to show or list every item to be provided. When an item not shown or listed, is necessary for proper operation of the system and/or equipment, the Contractor shall provide the item which will allow the system to function properly at no increase in Contract Sum.
- G. Related work specified elsewhere: The following work, unless otherwise noted is not included in this section shall be performed in other sections:
 - 1. Provision of circuit breakers testing and connections for DDC control power wiring.
 - 2. Excavation and backfill.
 - 3. Concrete work, including concrete housekeeping pads and other pads and blocks for vibrating and rotating equipment, duct bank envelopes and cast in place manholes and handholes, except as part of an inertia base. See Division 3
 - 4. Cutting and patching of masonry, concrete, tile and other parts of structure, with the exception of drilling for hangers and providing holes and openings in metal deck.

1.3 QUALITY ASSURANCE

- A. General:
 - 1. All equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacturer.
 - 2. All equipment and accessories shall be new and free from defects.
 - 3. Supply all equipment and accessories in compliance with the applicable standards listed in this Section and with all applicable National, State and Local Codes.
 - 4. All items of a given type shall be the product of the same manufacturer.
 - 5. Install work by craftsmen skilled in trade involved and by apprentices as indicated in the general conditions. Rough work will be rejected.
 - 6. The subcontractor must, within the last five years, prior to the bid opening, have successfully completed in a timely fashion at least three projects similar in scope and type to the required work.
- B. Electrical Equipment, Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Requirement of regulatory agencies:
 - 1. In accordance with requirements of Division 1 and as specified herein.
 - 2. Nothing in the Drawings or Specifications shall be construed to permit Work not conforming to applicable laws, ordinances, rules or regulations.
 - 3. When Drawings or Specifications exceed requirements of applicable laws, ordinances, rules or regulations, Drawings and Specifications take precedence.
 - 4. It is not the intent of Drawings and Specifications to repeat requirements of codes except where necessary for completeness or clarity.

- 1.4 If any of the requirements of the above are in conflict with one another, or with the requirements of these specifications, the most stringent requirements shall govern. APPLICABLE REGULATIONS, CODES, PUBLICATION, PERMITS AND FEES
- A. Materials and equipment shall be manufactured, installed and tested as specified in latest editions of applicable publications, standards, rulings and determinations of:
1. Local and state building, plumbing, mechanical, electrical, fire and health department codes.
 2. American National Standards (ANSI).
 3. American Society of Testing and Materials (ASTM).
 4. Underwriter's Laboratories (UL).
 5. National Electric Code (NEC)
 6. Insulated Cable Engineers Association (ICEA).
 7. Institute of Electrical and Electronic Engineers (IEEE).
 8. National Electrical Manufacturers' Association (NEMA).
 9. National Electrical Testing Association, Inc (NETA).
 10. National Fire Protection Association (NFPA).
 11. Occupational Safety and Health Act (OSHA)
 12. Certified Ballast Manufacturers (CBM).
 13. Owner's Insurance Underwriter.
- B. All materials and equipment shall be listed by Underwriters' Laboratories (UL), and approved by ANSI, ASTM, and NEC for intended service.
- C. Most recent editions of applicable specifications and publications of the following organizations form part of these Contract Documents.
1. American National Standards Institute (ANSI)
 2. American Society of Testing and Materials (ASTM).
 3. Underwriter's Laboratories (UL).
 4. National Electric Code (NEC)
 5. Insulated Cable Engineers Association (ICEA).
 6. Institute of Electrical and Electronic Engineers (IEEE).
 7. National Electrical Manufacturers' Association (NEMA).
 8. National Electrical Testing Association, Inc (NETA).
 9. National Fire Protection Association (NFPA).
 10. Occupational Safety and Health Act (OSHA)
 11. Certified Ballast Manufacturers (CBM)
 12. Illuminating Engineering Society (IES)
- D. Conform to all rules, regulations, standards, ordinances and laws of local, state, and Federal governments and other authorities that have legal jurisdiction over the site.

- E. Prior to commencement of work, notify State and applicable authorities as required and submit all of the applicable notifications for construction, operation and demolition. Secure required permits and inspections from any of the authorities having jurisdiction, for this work and pay for all fees required for permits, inspections and review, including special agency construction.
- F. Include all utility and local building department charges for providing temporary and permanent electric services to buildings.
- G. Provide Owner, Owner's Representative and Inspectors from any of the authorities / agencies having jurisdiction access to work at all times.
- H. Contractor shall be responsible for all law violations caused by the work under this Division. Notify Construction Manager in writing when a discrepancy occurs between code requirements and work shown on drawings and resolve matter before proceeding with work.
- I. When requirements cited in this specification conflict with each other or with Contract Documents, most stringent shall govern work. Consultants may relax this requirement when such relaxation does not violate ruling of authorities that have jurisdiction. Approval for such relaxation shall be obtained in writing.
- J. Make corrections in the work as required by the Owner's Representative or Inspector to pass local regulations.
- K. Contractor shall deliver to the Construction Manager any and all certificates of inspections, permits, and approvals. Contractor shall submit final inspection certificates signed by governing authorities to the Owner.
- L. Make all necessary submissions to the Department of Environmental Protection, Bureau of Air Resources and Management, Department of Labor and Industry and other agencies having jurisdiction. Pay all required fees for review, registration and sign off.

1.5 DEFINITIONS

- A. "Provide" means "furnish and install", complete, the specified material, equipment or other item and perform all required labor to make a finished and properly operational installation.
- B. "Furnish" means to purchase and deliver to project site complete with all appurtenance and support. "Install" means to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project
- C. "Consultant" means "Prime Design Consultant". An individual or organization engaged by the owner or the architect to render professional engineering consulting services complementing or supplementing the architect's services concerning the content of the Mechanical, Electrical, Plumbing & Fire Protection sections of specifications.

- D. "Owner" means the individual or entity with whom Contractor has entered into the Agreement for whom the Work is to be performed
- E. "Construction Manager Advisor" or "CMA" means the Construction Manager that provides services to advise the Owner and Architect on design and materials decisions during the design and document development process. The CMA coordinates the entire design process using his skills and knowledge of construction to clarify cost and time considerations of design decisions, to advise on feasibility of single, multiple-contract or fast-track delivery systems, recommend the construction process, and to handle the bidding and award, as well as to manage the construction of the Project.
- F. "Construction Manager Constructor" or "CMC" means the Construction Manager that in addition to acting as an advisor to the Owner during a design period, assumes responsibility for the construction of the Project. The CMC become contractually bound to provide the labor and material for the Project. The CMC may also serve as administrator of multiple prime contract construction; however, some states prohibit that practice.
- G. General Contractor/ Prime Contractor means the contractor who contracts with a property owner and, in turn, employs a subcontractor or subcontractors to perform some of all of the work.
- H. "Contractor" or "Subcontractor" means the trade contractor responsible for the work in this Division of the specification.
- I. "Owner's Representative" means the Consultant, Engineer, or other Specialty Consultant retained by the Owner.
- J. "RFI" means "Contractor's Request for Information".
- K. "Above Grade": Not buried in the ground and not embedded in concrete slab on ground.
- L. "Accessible": Ability to perform recommended maintenance without removal of services or equipment and requiring no special platforms.
- M. "Actuating" or "Control" Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.
- N. "Below Grade": Buried in the ground or embedded in concrete slab on ground.
- O. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.
- P. "Connect": Complete hook-up of item with required service.
- Q. "Exposed": Not installed underground or "concealed."

- R. "Indicated," "Shown" or "Noted": As indicated, shown or noted on Drawings or Specifications.
- S. "Install": To erect, mount and connect complete with related accessories.
- T. "Piping": Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.
- U. "Reviewed," "Satisfactory" or "Directed": As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner.
- V. "Rough-In": Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.
- W. "Shall": An exhortation or command to complete the specified task.
- X. "Similar" or "Equal": Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.
- Y. "Supply": To purchase, procure, acquire and deliver complete with related accessories.
- Z. "Typical" or "Typ": Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.
- AA. "Will": A desire to complete the specified task. Allows some flexibility in application as opposed to "Shall."
- BB. "Wiring": Raceway, fittings, wire, boxes and related items.
- CC. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.
- DD. Reference by abbreviation may be made in the specifications and the Contract Drawings for Mechanical and Electrical Work in accordance with the following list:
 - 1. HVAC Heating, Ventilating and Air Conditioning
 - 2. GC General Contractor
 - 3. AWG American Wire Gauge
 - 4. USSUnited States Standards
 - 5. ASTM American Society of Testing Materials
 - 6. ASA American Standards Association
 - 7. AC: Alternating Current.
 - 8. AIC:Ampere Interrupting Capacity.
 - 9. ADA: Americans with Disabilities Act.
 - 10. ANSI: American National Standards Institute.
 - 11. AWG: American Wire Gauge.
 - 12. CBM: Certified Ballast Manufacturers.

- 13. DC: Direct Current.
- 14. ETL: Electrical Testing Laboratory.
- 15. HID: High Intensity Discharge.
- 16. HP: Horsepower.
- 17. ICEA: Insulated Cable Engineers Association
- 18. IEEE: Institute of Electrical and Electronic Engineers.
- 19. NEMA: National Electrical Manufacturers' Association.
- 20. NETA: National Electrical Testing Association, Inc.
- 21. NFPA: National Fire Protection Association.
- 22. OSHA: Occupational Safety and Health Act.
- 23. PVC: Polyvinyl chloride.
- 24. UBC: Uniform Building Code.
- 25. UL: Underwriters' Laboratories,

1.6 SCOPE

- A. Perform work and provide material and equipment as shown on the drawings and/or as specified and/or as indicated in this section of the specifications. Completely coordinate all work of this section with work of other trades and provide a complete and fully functional installation.
- B. Drawings and Specifications form complimentary requirements; provide work specified and not shown, and work shown and not specified as though explicitly require by both. Although work is not specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for sound, secure and complete installation.
- C. Give notices, file plans, obtain permits and licenses, pay fees and back-charges, and obtain necessary approvals from authorities that have jurisdiction as required to perform work in accordance with all legal requirements and with Specifications, Drawings, Addenda and Change Orders, all of which are part of Contract Documents.
- D. Contractor shall be responsible with obtaining all the final inspection as required by Local Code and ordinances.

1.7 UTILITY COMPANY BACK-CHARGES

- A. The Electrical Subcontractor shall carry in the bid price all Utility Company and Municipal back-charges for all materials furnished and all work performed by them in conjunction with this Contract and pay same to the respective agency upon demand. The Electrical Subcontractor shall not be entitled to additional compensation after the submittal of his bid price should he fail, for any reason, to obtain the total back-charges to be incurred by the local Utility company or municipal agency. When a cost is not available, this electrical subcontractor shall carry a sum of \$10,000.00.

- B. THE BALANCE OF THE ALLOWANCE FOR THE UTILITY BACKCHARGES NOT UTILIZED DURING THE PROJECT CONSTRUCTION SHALL BE RETURNED TO THE OWNER IN THEIR ENTIRETY.

1.8 CONTRACT DOCUMENTS

- A. Listing of Documents does not limit responsibility of determining full extent of work required by these Contract Documents. Refer to the Consultant's, Electrical, HVAC, Plumbing and Fire Protection, Structural, Site Utility and all other drawings and other sections that types of and work of other trades with which work of this section must be coordinated.
- B. Except where modified by a specific notation to the contrary; it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.
- C. Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.
- D. Drawings are diagrammatic. They are not intended to be absolutely precise; they are not intended to specify coordinated routings and component. The purpose of the document is to indicate systems concept, the main components of the systems, and the approximate geometric relationships. Based on the systems concept, the main components and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational.
- E. Information and components shown on riser diagrams, but not shown on plans, and vice versa, shall apply and be provided as if expressly required on both.
- F. Data that may be furnished electronically by the Consultant is diagrammatic. Such electronically furnished information is subject to the same limitation of precision as heretofore described. If furnished, such data is for convenience and generalized reference, and shall not be substitute for Consultant's sealed or stamped construction documents.

1.9 ELECTRONIC MEDIA FILES

- A. Construction drawings for this project have been prepared utilizing Autodesk Revit.
- B. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
- C. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Release" form provided by Buro Happold.

- D. The electronic contract documents can be used to assist in the preparation of shop drawings and as-built drawings however the electronic media files obtained from Buro Happold are for reference only. The information may not be used in whole or in part for any other project.
- E. The drawings prepared for bidding purposes may not be used directly for layout drawings or coordination drawings.
- F. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
- G. The information is provided to expedite the project and assist the Contractor with no guarantee by Buro Happold as to the accuracy or correctness of the information provided. Buro Happold accepts no responsibility or liability for the Contractor's use of these documents.

1.10 COORDINATION DRAWINGS

- A. The General Contractor shall appoint a BIM Coordination Manager to prepare a BIM Execution Plan developed specifically for the project, and based on the Computer Integrated Construction (CIC) Research Program's BIM Planning procedures. The BIM Execution Plan will establish the protocols, expected levels of development, and authorized uses of Building Information Models on this Project and assigns specific responsibility for the development of each Model Element to a defined Level.
- B. Clash Detection: Perform three-dimensional component conflict analysis as part of coordination process with all other trades. Resolve component conflicts prior to submittal of shop drawings. Indicate where conflict resolution requires modification of design requirements by Construction Manager.
- C. A single set of coordination drawings shall be mutually prepared by all mechanical, electrical, plumbing and fire protection trades.
- D. The initiation of these drawings begins with Sheet Metal Subcontractor.
- E. A Subcontractor who fails to promptly review and incorporate his work on the drawings shall assume full responsibility of any installation conflicts affecting his work and of any schedule ramifications.
- F. The review of coordination drawings shall not diminish responsibility under this Contract for final coordination of installation and maintenance clearances of all systems and equipment with the other trades, structural and other work.
- G. After review:
 - 1. After review of coordination drawings, the method used to resolve interferences not previously identified shall be as in "MODIFICATIONS IN LAYOUT" above.

2. All changes to reviewed coordination drawings shall be in writing by the Consultants/Engineer prior to start of work in affected area.
- H. Distribution of Coordination Drawings - The Sheet Metal Subcontractor shall provide the following distribution of documents:
1. One sepia (reproducible) of each Coordination Drawing to each specialty trade and affected Contractor for their use.
 2. One reproducible of each Coordination drawing to Owner.
 3. One sepia (reproducible) of each coordination drawing to the General Contractor/Construction Manager.
 4. The above documents can be submitted as electronic media upon agreement of all parties.
- I. Coordination Drawings shall include, but not limited to:
1. Electrical distribution, systems and equipment.
 2. Lighting systems and fixtures.
 3. Structural.
 4. Major electrical conduit runs, panel-boards, feeder conduit and racks of branch conduit.
- J. 3D Assets: The contractor shall hand over all digital data files related to the BIM execution plan at the end of the construction process, including all, but not limited to the shop drawings, as built conditions and native 3D BIM file.
- K. The Electrical Subcontractor shall indicate all electrical equipment and conduit provided by him or his Sub subcontractors on the coordination drawings. This equipment and conduit shall include, but not be limited to, the following:
- L. All electrical distribution equipment, drawn to scale with clearance requirements. (Substations, switchboards, busway and plug-ins, transformers, panelboards, motor control centers, fire alarm control panels and terminal cabinets, starters and VFDs, etc.)
1. All switchboard and panelboard feeder conduits.
 2. All conduits for all systems over 2" in diameter.
 3. Conduit routing and rack locations for all conduits regardless of conduit size when more than 4 conduits are grouped in a rack.
 4. All pull and splice boxes over 8" in size in any direction (height, width or length).
 5. Lighting fixture housings and supports that interfere with other system and furnishings.
- M. All costs associated with all aspects of coordination drawings, regardless as to how long they take to produce and how many times they have to be redrawn, shall be borne by the Electrical Subcontractor.

- N. The Electrical Subcontractor shall be responsible for coordinating the Electrical AutoCAD coordination drawings, including, but not limited to, the drawing lists, layering system, producing copies of the drawings for the Architect as directed, etc. Final coordination drawing shall be provided to owner on USB Drive.

1.11 REVIEW OF CONTRACT DOCUMENTS AND SITE

- A. With the submission of his bid, Contractor shall give written notice to the Owner of any materials or apparatus believed inadequate or unsuitable, in violation of laws, ordinances, rules or regulations of Authorities having jurisdiction, and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that the Contractor has included the cost of all required items in his proposal for a complete project.
- B. Contractor shall acknowledge that he has examined the Plans, Specifications and Site, and from his own investigations he has satisfied himself as to the nature and location of the work; the general and local conditions, particularly those bearing upon transportation, disposal, handling and storage of materials; availability of labor, water, electric power, roads and uncertainties of weather; the conformation and condition of the ground; the character, quality and quantity of surface and subsurface materials to be encountered; the character of equipment and facilities needed preliminary to and during the execution of the work; all federal, state, county, township and municipal laws, ordinances and regulations particularly those relating to employment of labor, rates of wages, and construction methods; and all other matters which can in any way affect work or the cost thereof under this Contract. Any failure by the Contractor to acquaint himself with the available information concerning these conditions will not relieve him from the responsibility for estimating properly the difficulty or cost of successfully performing the work.
- C. The location and elevation of the underground utilities, such as sewers, electrical power, water piping, steam and steam condensate return piping, conduit, etc., is as exact as can be determined from available information and its accuracy cannot be guaranteed. Exact location and elevation of these services shall be verified prior to excavation or installation of any portion of the work indicated. Exercise special care when excavating at or near the general location of underground utilities to avoid damage to the utility services. The Contractors is responsible to insure worker safety.
- D. The contractor shall also acknowledge having been to the site and examined conditions under which work must be performed including preparatory work done under other Sections or other Contracts or by the Owner. Report conditions to the Consultant. Do not proceed until defects have been corrected and conditions are satisfactory. Commencement of work shall be construed as complete acceptance of existing conditions and preparatory work.
- E. Owner assumes no responsibility for any understanding or representation made during or prior to the negotiation and execution of this Contract unless such understanding or representations are expressly stated in the Contract, and the Contract expressly provides that the responsibility, therefore, is assumed by the Owner.

1.12 DISCREPANCIES IN DOCUMENTS

- A. Where Drawings or Specifications conflict or are unclear, advise the Consultant in writing before award of Contract. Otherwise, Consultant's interpretation of the Contract documents shall be final, and no additional compensation shall be permitted due to discrepancies or ambiguousness thus resolved.
- B. Where Drawings or Specifications do not coincide with manufacturer's recommendations, or with applicable codes and standards, alert the Consultant in writing before installation. Otherwise, make changes in installed work as the Consultant requires within Contract Price.
- C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specification, this contractor shall provide material, installation, or work which is of higher standard.
- D. It is the requirement of these documents to have contractor provide systems and components that are fully complete and fully operational and fully suitable for intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of the component or its coordination with other building elements. In cases such as this, where the contractor has failed to notify the Consultant of the situation in accordance with paragraph (A) above, the contractor shall provide specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.
- E. In cases covered by paragraph (D) above, where the contractor believes he needs the engineering guidance, he shall submit a sketch identifying his proposed solution and the Consultant shall review, note if necessary, and approve the sketch.

1.13 MODIFICATION IN LAYOUT

- A. Electrical Drawings are diagrammatic. They indicate general arrangements of electrical systems and other work. They do not show all offsets required for coordination nor do they show exact routings and locations needed to coordinate with structure and other trades to meet the Consultant's requirements
- B. In order to obtain the Architect's desired aesthetics in spaces used by building occupants; prior to installation of visible materials, finishes and equipment (including access panels, review Consultant's Drawings for desired locations and where not definitely indicated, request information from the Architect/Consultant.
- C. Check Contract Drawings, as well as Shop Drawings, of all subcontractors to verify and coordinate spaces in which work of this section will be installed
- D. Maintain maximum headroom at all locations. All conduit and associated components to be as tight to underside of structure as possible.

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- E. Make reasonable modifications in layout and components to prevent conflict with work of other trades and to coordinate according to Paragraphs A,B,C,and D above. Systems shall be run in an organized and rectilinear fashion.
- F. Where conflicts or potential conflict exists and engineering guidance is desired, submit sketch of proposed resolution to the Consultant for review and approval

1.14 MEASUREMENTS

- A. Contractor shall base all his measurements, both horizontal and vertical from established benchmark. All work shall agree with these established lines and levels. He shall verify all measurements at site; and check the correctness of same as related to the work.

1.15 MATERIALS AND WORKMANSHIP

- A. Materials shall be new, meet detailed requirements of the Contract Documents and be identifiable as being specified or substitute products.
- B. Materials which do not conform to the requirements of the Contract Documents, are not equal to approved samples or are unsatisfactory or unsuited to the purpose for which they are intended, will be rejected.
- C. All work shall be performed in the best and most workmanlike manner by tradesmen skilled in their respective trades and properly licensed.
- D. All equipment shall be installed in accordance with the recommendation of the manufacturer.
- E. Defective work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or other cause shall be removed within ten (10) days after written notice is given by the Owner's Representative and the work shall be re-executed by the Contractor. The fact that the Owner's Representative may have previously overlooked such defective work shall not constitute total or partial acceptance of it.
- F. In no case shall a Bidder base his bid on a class of material or workmanship less than that required by the contract documents nor the governing codes and ordinances.

1.16 CHECKING AND TESTING EQUIPMENT BY CONTRACTORS AND MANUFACTURER'S REPRESENTATIVE

- A. All equipment shall be installed in strict accordance with manufacturer's instructions. During construction request supervisory assistance from equipment manufacturer's representatives so the equipment will be correctly installed. After installation, request the Owner's Representative to inspect and see the equipment is in proper working order.

- B. Manufacturer's representative shall review the overall system design relative to the proper application of his equipment in the particular system. He shall note conduit, wiring, control, location, and other relevant relationships, and furnish appurtenances necessary for satisfactory operation.
- C. Before final payment is issued the following shall be complete:
- D. The Contractor's representative shall submit to the CM a signed statement certifying:
 - 1. The equipment is properly installed and ready for operation
 - 2. The owners maintenance representatives have been thoroughly trained
 - 3. Maintenance and operation manuals issued and accepted by the Owner's Representative.

1.17 UL LISTING

- A. Furnish UL listed and labeled equipment, devices and materials. Where a UL listing is not available, submit the test reports of an independent testing engineer indicating that equipment is in conformance with local and state codes and provide in-filed UL Testing or equivalent for Listing of equipment. Contractor shall bear all costs for providing field UL Listing of equipment. Tests and inspections required for approval shall be performed at no additional cost to the Owner.

1.18 TEMPORARY FACILITIES

- A. Temporary Light and Power:
- B. All temporary facilities shall be removed at completion of project.

1.19 RFI'S

- A. If the RFI is a request to resolve a conflict or an un-clarity, or a request for additional detail, Contractor's RFI shall include a sketch or equivalent description of Contractor's proposed solution, in accordance with paragraph 1.11(E) above.

1.20 SUBMITTALS

- A. This paragraph supplements Division 1.
- B. Definitions:
 - 1. Shop Drawings are information prepared by the Contractor to illustrate portions of the work in more detail than shown in Contract Documents.

2. Coordination Drawings are detailed, large scale layout Shop Drawings showing Electrical, HVAC, Plumbing and Fire protection work superimposed in order to identify conflicts and ensure inter-coordination of Electrical, Mechanical, Plumbing, Fire Protection, Structural and other work.

C. Submittal Cover Sheet

1. Shop drawing submittal for each product shall include the copy of following cover sheet completely filled out. Incomplete or incorrect cover sheet submittal shall constitute reason for rejection.
2. Shop drawings shall be submitted according to specification section with a separate cover sheet completed for each product, rather than one cover sheet for multiple products, whether or not supplied by one manufacturer or vendor.
3. In order to maintain the shop drawing review schedule described hereafter, it is important that all submittals include a completed submittal cover sheet for each type of equipment submitted. This requirement will be enforced by the engineer.

SHOP DRAWING COVER SHEET		
PROJECT		CONTRACTOR
DIVISION NO:		SECTION NO:
DESCRIPTION:		
CONTRACT DRAWING REFERENCE NO:		
EQUIPMENT TAG:		
SUBMISSION (CIRCLE ONE): I II III IV		
DATE:		
INFORMATION AND CHECKLIST	REPLY	COMMENTS
Contractor's Log # ID		
Name, address, and phone number of supplier		
Are all specified or scheduled items included and exactly match scheduled/specified items.	Yes No	
Is this item a substitution?	Yes No	
Are deviations clearly identified?	Yes No	

Does this equipment fit space shown on construction documents, coordination drawings, and actual field conditions?	Yes	No	
Has support, erection, weights, and installation been coordinated with all trades?	Yes	No	
Does the proposed installation void warranties and/or violate UL or code requirements?	Yes	No	
Does this material/equipment add expense to any other trade or project costs?	Yes	No	
Does equipment require interface with other trades? Lists divisions and specifics requiring coordination?	Yes	No	
Is control interface coordinated?	Yes	No	
List electrical characteristics (V/Ph/A)	Yes	No	

D. Submittals procedure and format:

1. Identify each item by manufacturer, brand, trade name, number, size, rating, or whatever other data is necessary to properly identify and check materials and equipment.
2. Identify each submittal item by reference to Specification Section paragraph in which item is specified, or Drawing and Detail number, identify deviations, if any.
3. Organize submittals in same sequence as they appear in Specification Sections, articles or paragraphs.
4. Shop Drawings shall show physical arrangement, construction details and finishes:
5. Drawings shall be drawn to scale and dimensioned where applicable.
6. Catalog cuts and published material shall be included to supplement scale drawings.
7. Internal wiring diagrams of equipment shall show wiring as actually furnished for this project, with all optional items clearly identified as included or excluded. Clearly identify external wiring connections. Identify and obliterate superfluous material.
8. Submittal literature, drawings and wiring diagrams shall be specifically applicable to this Project and shall not contain extraneous material or optional choices. Clearly mark literature to indicate the proposed item. Submittals shall include, but not be limited to those items listed in individual Sections.
9. Include all physical and performance data, including materials, manufacturer's names, model numbers, weights, sizes, capacities, performance curves, finishes, colors, accessories, installation instructions, and all other data required to completely describe equipment and to indicate complete compliance with Specifications and Drawings.

10. Include with complete submittals above, complete, large scale, dimensioned Shop Drawings, certified by manufacturer, of all major equipment.
11. Time Schedules for Submission and Ordering: The Contractor shall prepare, review and coordinate his schedule of submissions carefully, determining the necessary lead time for preparing, submitting, checking, ordering and delivery of all materials and equipment for timely arrival. The Contractor shall be responsible for conformance with the overall construction schedule.
12. Submittals shall be reviewed for general compliance with Specifications only. The Contractor shall be responsible for deviations from the Drawings or Specifications and for errors or omissions of any sort in submittals.
13. The Contractor shall add and sign the following paragraph on all equipment and materials submitted for review:
14. "It is hereby certified that the equipment, material shown and marked in this submittal is that proposed to be incorporated into the project; is in compliance with the Contract Drawings and Specifications and can be installed in the allocated spaces."
15. Failure to add the above written statement for compliance shall result in return of submittals to be reviewed.
16. The Contractor shall verify dimensions of equipment and be satisfied per Applicable Code Requirements for fit prior to submitting Shop Drawings for approval.
17. Where current limiting devices are specified, submit technical data to substantiate adequate protection of equipment cascaded downstream. Submittals shall not be reviewed unless supporting calculations and data are submitted therewith.
18. For any material specified to meet Underwriters' Laboratories, Inc. (UL) or trade standards, furnish the manufacturer's or vendor's certification that the material furnished for the work does in fact equal or exceed such Specifications.
19. Submit on all materials and equipment even if they are as specified or shown on the Drawings.
20. Equipment Floor Plans: After approval of material is secured, prepare a floor plan of each electrical equipment closet enclosures and room drawn to, scale of 1/2 inch equals 1 foot, and submit for approval in the same manner as for Shop Drawings. The layout drawings shall be to exact scale, and indicate location of all electrical equipment.
21. Resubmittals shall include written response to each item in review of previous submittal.
22. Special Submissions:
23. Test reports for the following:
24. Ground fault devices, including ground fault interrupter (GFI) receptacles.
25. Megger Readings: Ground system, motors, feeders and switchgear.
26. Voltage Readings: Distribution, service and motors.
27. Emergency lighting systems.
28. Acceptance testing per NETA Specifications for all power system equipment. Include manufacturer's testing standards used to verify the test results.
29. Field inspection reports by manufacturer's engineer confirming that the respective equipment is installed correctly, and it meets the manufacturer's requirements.
30. Report indicating compliance with Contractor furnished "Overcurrent Protective Device Short-Circuit Study".
31. Report indicating compliance with Contractor furnished "Overcurrent Protective Device Coordination Study".

32. Report indicating compliance with Contractor furnished "Overcurrent Protective Device Arc-Flash Study".
 33. 1/2" scale equipment layout for each electrical, elevator, and mechanical equipment room, indicating all working clearance.
- E. Acceptable Manufacturers: The Consultant's mechanical/electrical design for each product is based on the single manufacturer listed in the schedule or shown on the drawings. In Part 2 of the specifications certain Alternate Manufacturers are listed as being acceptable. These are acceptable only if, as a minimum, they:
1. Meet all performance criteria listed in the schedules and outlined in the specifications. For example, to be acceptable, an air handling unit must deliver equal CFM against equal external static pressure using equal or less horsepower, equal or better coil thermal performance, equal or better acoustic performance as the air handler listed in schedules.
 2. Have identical operating characteristics to those called for in the specifications. For example, a two stroke diesel generator will not be acceptable if a four stroke is specified.
 3. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either space or product. Clearances to walls, ceilings and other equipment will be least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean that the Consultants has determined that the manufacturer's products will fit within the available space. This determination is solely the responsibility of the contractor.
 4. Products must adhere to all Consultant's considerations including, but not limited to: being of same color as the product scheduled or specified, fitting within Consultant's enclosures and details, and for diffusers, lighting and plumbing fixtures - being the same size and physical appearance as scheduled or specified products.
 5. The proposed substitution shall meet performance and quality of scheduled equipment, whether it requires additional accessories or not.
 6. There is no increase in Contract Sum and this Contractor shall pay for any additional work required by other trades as a result of the substitution.
 7. Submit all equipment sound power and pressure level for review and compliance.
- F. Required Use of Acceptable Manufacturers on his Project: Substitution of products other than those of the Acceptable Manufacturers specified herein shall not be made. Only the specified items or the comparable product by one of the specified Alternate Manufacturers shall be submitted. Products by other manufacturers shall not be used on this project.
- G. Deviations:
1. Concerning deviations other than substitutions, proposed deviations from Contract Documents shall be requested individually in writing whether deviations result from field conditions, standard shop practice or other cause. Submit letter with transmittal of shop drawings, which flags deviation to the attention of the Consultants.

2. Without letters flagging the deviation to the Consultants, it is possible that the Consultants may not notice such deviation or may not realize its ramifications. Therefore, if such letters are not submitted to the Consultants, the contractor shall hold the Consultants and his consultants harmless for any adverse consequences resulting from the deviations being implemented. This shall apply regardless of whether the Consultants has reviewed or approved shop drawings containing the deviation, and will be strictly enforced.
 3. Approval of proposed deviations, if any, will be made at discretion of Consultants.
 4. Any of the approved deviations shall be deemed acceptable to this Contractor with no change in contract sum, unless the Consultant also receives a written notice to the contrary.
- H. Submittal Notations: Submittals will be returned from the Consultants marked as illustrated below:
1. NO EXCEPTIONS TAKEN: "Reviewed and found generally acceptable. Minor deviations may be noted. No further submittal required if notations are complied with."
 2. INCORPORATE COMMENTS NOTED; REVISE AND RESUBMIT: "Submittal contains deviations which must be corrected and confirmed by a new submittal."
 3. REJECTED: "Submittal is incorrect to such an extent that the material is unacceptable, or in incomplete to such an extent that a review cannot be made. Resubmit in accordance with requirements of the Contract Documents."
 4. NOT REVIEWED: "Submittal does not pertain to trade"
- I. Responsibility:
1. Intent of Submittal review is to check for capacity, rating, and certain construction features. Contractor shall ensure that the work meets the requirements of Contract Documents regarding information that pertains to fabrication processes or means, methods, techniques, sequences and procedures of construction; and for coordination of work of this or other Sections. Work shall comply with submittals marked "NO EXCEPTIONS TAKEN" to the extent they agree with the Contract Documents. Submittal review shall not diminish responsibility under this Contract for dimensional coordination, quantities, installation, wiring, supports and access for service, nor shop drawing errors or deviations from requirements of Contract Documents. The Consultant's noting of some errors while overlooking the others will not excuse the contractor from proceeding in error. Contract Documents are not limited, waived nor superseded in any way by review.
 2. INFORM SUBCONTRACTORS, MANUFACTURERS, SUPPLIERS, ETC. OF SCOPE AND LIMITED NATURE OF REVIEW PROCESS AND ENFORCE COMPLIANCE WITH CONTRACT DOCUMENTS.

- J. Schedule: Incorporate shop drawing review period into construction schedule so that Work is not delayed. Contractor shall assume full responsibility for delays caused by not incorporating the following review time requirements into his project schedule. Working days listed reference the time in Engineer's office. It does not include transmittal time or review time of Contractor or the Consultant. Allow at least 10 working days, exclusive of transmittal time, for review each time shop drawing is submitted or resubmitted with the exception that 20 working days, exclusive of transmittal time, are required for the following:

1. Coordination Drawings: If more than five shop drawings of a single trade are received in one calendar week.

1.21 List of Proposed Equipment and Materials:

- A. Within four weeks of Award of Contract and before ordering materials or equipment, submit complete list of materials and equipment and indicate manufacturer's name, addresses and telephone numbers. No consideration will be given to partial lists submitted out of sequence.
- B. If the List of Materials and Equipment is not received within the prescribed time limit, provide the first-named manufacturer for all material and equipment on this project.

1.22 OPERATING AND MAINTENANCE MANUALS

- A. Obtain at time of purchase of equipment, three copies of operation and maintenance manuals for all items. Assemble literature in coordinated "D" ring notebooks. All information shall also be provided in electronic PDF format. Divide the manuals into three sections or books as follows:
- B. System General Description and Information. Section shall include a general description of the systems used and contain names and addresses of manufacturers and local representatives who stock or furnish or repair parts for items or equipment. List of all major equipment as installed and include model number, capacities, nameplate data and manufacturer's location and purchase order information. Include in the manuals, parts catalogs for each item of equipment furnished with the components identified by number for replacement ordering. This section shall also include:
 1. Letters from manufacturers certifying their supervision of equipment installation and startup procedures as required.
 2. Factory certification test certificates.
 3. Equipment test certificates.
- C. Operation, Start-up and Shutdown Procedures. Section shall include directions for and sequence of operation for each item of the Mechanical and Electrical systems. Include detailed approved electrical diagrams for each electrical system.

- D. Provide a step-by-step write-up and video of the operation, start-up and shut down procedures for all major equipment.
- E. Problems, Solutions and Troubleshooting. Section shall include detailed procedures to be followed in case of equipment or system malfunctions. Include manufacturer's printed troubleshooting procedures into the operating manual for reference.
- F. Preventative Maintenance. Section shall include preventative maintenance requirements and schedule for each piece of equipment.
- G. Furnish three copies of manuals to the Consultant for approval and distribution to Owner. Deliver manuals no less than 30 days prior to project close-out or 10 days prior to commissioning whichever is sooner.

1.23 RECORD DOCUMENTS (AS-BUILTS)

- A. As work progresses and for duration of Contract, maintain current complete and separate sets of prints of Contract drawings at job site. Record work completed and all changes from original Contract Drawings clearly and accurately including work installed as a modification or addition to original design. Include actual location of existing utilities if they differ from design documents.
- B. Underground utility services, both inside and outside of buildings, shall be dimensioned from permanent structures or benchmark. Utility services outside of buildings shall also show depth of burial with reference to the finished ground floor elevation.
- C. Drawings shall show record condition of details, sections, riser diagrams, control changes and correction to schedules. Schedules shall show actual manufacturer and make and model numbers of final equipment installation. All elements shall be dimensioned from grid lines or benchmarks and all elevations shall be noted. Construction notes (such as component numbers, conflict notes, etc.) shall be removed and the drawings shall clearly be noted in the title block as being as-built drawings.
- D. At the completion of the project, prepare a complete set of record drawings, showing all systems actually installed, as well as electronic files on latest CAD version.
- E. The design tracings will be made available for Contractor's copying, at his expense, into reproducible to serve as background drawings. The quantity of design tracings, which are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show required information. Contractor's professional draftsman shall transfer changes to record files and then submit the electronic files and three sets of prints to the Consultant for comments as to compliance with this section.

- F. The record set reproducible, as corrected and recorded by the Contractor, shall be submitted to the Owner's Representative for approval prior to authorization for final payment. Record drawings shall be certified as to their correctness by the signature of the Contractor, and shall be stamped or otherwise identified as record drawings. THE CONSULTANT WILL NOT CERTIFY THE ACCURACY OF THE RECORD DRAWINGS - THIS IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR.
- G. Each trade shall submit a record set for approval by the building department in a form acceptable to the department, when required by the jurisdiction. Such drawing format size changes, and supplemental information required for the submittal are the requirement of the contractor.

1.24 COOPERATION BETWEEN TRADES

- A. Cooperate with all other Divisions performing work on this project as necessary to achieve a complete neatly fitted installation for each condition. Consult the Drawings and Specifications to determine nature and extent of work specified in other Divisions that adjoins or attaches to the work of this Division. Confer with other Divisions at the site to coordinate this work with theirs in view of job conditions to the end that interferences may be eliminated and that maximum head room and clearance may be obtained. In the event that interferences develop, the Owner's Representative's decision will be final as to which Division shall relocate its work, and no additional compensation will be allowed for the moving of piping, ductwork, conduit, or equipment, to clear such interferences. Provide templates, information, and instructions to other divisions to properly locate holes and openings to be cut or provided
- B. The Electrical Subcontractor shall compare his drawings and specifications with those of other Trades as well as the Architectural drawings and specifications, and report any discrepancies between them to the Architect and obtain from the Architect written instructions for changes necessary in the electrical work.
- C. All work shall be installed in cooperation with other Trades installing interrelated work. Before installation, Electrical Subcontractor shall make proper provisions to avoid interferences in a manner approved by the Architect. All changes required in the work of the Electrical Subcontractor or that of any other trade caused by the Electrical Subcontractor's neglect, shall be made by him at his own expense, and to the Architect's satisfaction.
- D. The Electrical Subcontractor shall include in his bid sufficient dollar amounts to coordinate the work of this Contract. This project MAY require additional time to coordinate all Trades and allow implementation of the Owner's Standards and maintenance serviceability requirements. This requirement shall include, but not be limited to, producing the coordination drawings, as many times and as many drawings as required, to ensure serviceability of equipment, as approved by the Architect.

- E. The proposed routings on MEP drawings are diagrammatic only, the Electrical Subcontractor is responsible to coordinate the actual routing at field and make sure no foreign item such as duct or pipe run through the required working or dedicated space of the project electrical boards (switchgear, switchboard, distribution board, panelboard, sub-panel). Refer to NEC section 110 for additional information regarding to the requirements. The dedicated electrical space, which extends the footprint of the switchboard or panelboard from the floor to a height of 6 feet above the height of the equipment or to the structural ceiling (whichever is lower), is required to be clear of piping, ducts, leak protection apparatus, or equipment foreign to the electrical installation. Plumbing, heating, ventilation, and air-conditioning piping, ducts, and equipment must be installed outside the width and depth zone. A dropped, suspended, or similar ceiling that does not add strength to the building structure shall not be considered a structural ceiling. Foreign systems installed directly above the dedicated space reserved for electrical equipment (the space beyond the required 6 feet dedicated space) are required to include protective equipment that ensures that occurrences such as leaks, condensation, and even breaks do not damage the electrical equipment located below.
- F. Locations of conduits, boxes distribution equipment, systems, etc. shall be adjusted to accommodate the work with interferences anticipated and encountered. The Electrical Subcontractor shall determine the exact routing and location of his systems prior to fabrication or installation of any system component. Accurate measurements and coordination drawings shall be completed to verify dimensions and characteristics of the various systems installations.
- G. Lines which pitch shall have the right-of-way over those which do not pitch. For example, steam piping shall normally have the right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.
- H. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. The Electrical Subcontractor shall provide elbows, conduit bends, "LB" fittings, offsets in busway, etc. as required for his work to effect these offsets, transitions and changes in direction.
- I. All work shall be installed in a way to permit removal (without damage to other parts) of pull and junction box covers, wiring, lighting fixtures, and all other system components provided under this Contract requiring periodic replacement or maintenance. All pull and junction boxes shall be arranged in a manner to clear the openings of swinging overhead access doors as well as ceiling tiles. All work shall be done to allow easy access for maintaining equipment. The Owner and Engineer will require proof via the preparation of large scale sections and part plans that pull and junction boxes, etc. are accessible after the work is completed. Any items in the field discovered to be in non-compliance shall be removed and relocated, as required, and as directed by the Architect ad at no cost to the Owner.
- J. The Contract Drawings are diagrammatic only intending to show general runs and locations of conduits, distribution equipment, lighting fixtures, systems equipment, etc. and not necessarily showing all required offsets, details and accessories and equipment to be connected. All work shall be accurately laid out with other Trades to avoid conflicts and to obtain a neat and workmanlike installation which will afford maximum accessibility for operation, maintenance and headroom.

- K. Where discrepancies in scope of work as to what Trade provides items, such as starters, disconnects, flow switches, etc., exist, such conflicts shall be reported to the Architect during bidding and prior to signing of the Contract. If such action is not taken, the Electrical Subcontractor shall furnish such items as part of his work as necessary, for complete and operable systems and equipment, as determined by the Architect.
 - L. Where drawing details, plans, specification requirements and/or scheduled equipment capacities are in conflict and where feeders, branch circuits or equipment are shown to be different between plans and/or between plans and riser diagrams, details or specifications, the most stringent requirement will be included in the Contract. Electrical systems and equipment called for in the specification and/or shown on the drawings shall be provided under this Contract as if it were required by both the drawings and specifications. However, prior to ordering or installation of any portion of work which appears to be in conflict, such work shall be brought to Architect's attention for direction as to what is to be provided.
 - M. Final location of all lighting fixtures, receptacles, etc., shall be coordinated with the Architectural reflected ceiling plans, architectural elevations, and/or other Architectural details, as applicable and shall not be scaled from locations indicated on the electrical drawings. Obtain approval of locations of all devices from Architect in the field. The Owner/Architect reserves the right to relocate any receptacle, device, lighting fixture, etc. 10'-0" in any direction prior to installation at no additional cost to the Project.
 - N. The Electrical Subcontractor shall coordinate his work with other Trades' work so that all equipment and systems can be easily, safely and properly serviced and maintained. It is imperative that service personnel can safely access all equipment.
- 1.25 HOIST, RIGGING, TRANSPORTATION AND SCAFFOLDING
- A. Provide all scaffolding, staging, cribbing, tackle hoist and rigging necessary for placing all materials and equipment in their proper places in the Project. All temporary work shall be removed from the premises when its use is no longer required.
- 1.26 PRODUCT DELIVERY, STORAGE, AND HANDLING
- A. Store electrical equipment indoors in clean, dry space with uniform temperature to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.
 - B. Do not install indoor equipment until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above equipment is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - C. Identify materials and equipment delivered to Site to permit check against approved materials list, reviewed Shop Drawings.

- D. Cap all openings in conduit daily to protect against entry by foreign matter.
- E. Protect premises and Work of other Divisions from damage arising out of installation of Work of this Division.
- F. Perform Work in manner precluding unnecessary safety and hazard.
- G. Protect from loss or damage. Replace lost or damaged materials and equipment with new at no increase in Contract Sum. Protect from damage, water, dust, etc., material, equipment and apparatus provided under this Division, both in storage and installed, until Notice of Completion has been filed. Provide temporary storage facilities for material and equipment. Material, equipment or apparatus damaged because of improper storage or protection will be rejected. Remove from Site and provide new, duplicate material, equipment or apparatus in replacement of that rejected.
- H. All stock piled conduit shall be placed on dunnage, and protected from weather and from entry of foreign material. All stored materials and equipment shall be carefully inspected prior to installation and replaced with new material or equipment if found to be damaged, corroded, etc.

1.27 GUARANTEE AND 24 HOUR SERVICE

- A. Guarantee the Work of this section for one year following the date of Substantial Completion or successful system performance whichever requires later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the owner.
- B. The guarantee shall repair or replace defective materials, equipment, workmanship and installation that develop within this period, promptly and to the Consultant's satisfaction and correct damage caused in making necessary repairs and replacements under guarantee within Contract Price.
- C. In addition to guarantee requirements of Division 1 and of Paragraph A above, obtain written equipment and material warranties offered in manufacturer's published data without exclusion or limitation, in Owner's name.
- D. Replace material and equipment that require excessive service during guarantee period as defined and as directed by the Consultant.

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- E. Provide 24 hour service beginning on the date of substantial completion and lasting until the termination of guarantee period. Service shall be at no cost to Owner. Service can be provided by this Contractor or a separate service organization. Choice of service organization shall be subject to the Consultant and Owner approval. Submit name and phone number that will be answered on a 24 hour basis each day of the week, for the duration of the service.
- F. Submit copies of equipment and material warranties to Consultants before final payment.
- G. At end of guarantee period, transfer manufacturer's equipment and warranties still in force to Owner.
- H. This paragraph shall not be interpreted to limit Owner's rights under applicable codes and laws under this Contract.
- I. Part 2 Paragraphs of the Specification sections may specify warranty requirements that may exceed those of this Paragraph.
- J. Use of systems provided under this Section for temporary services and facilities shall not constitute Final Acceptance of work nor beneficial use by Owner, and shall not institute guarantee period.
- K. Provide manufacturer's engineering and technical staff at site to analyze and rectify problems that develop during guarantee period immediately. If problems cannot be rectified immediately to Owner's satisfaction, advise the Consultant in writing, describe efforts to rectify situation, and provide analysis of cause of problem. Consultants will suggest course of action.

1.28 WARRANTY

- A. Refer to provisions of the General Requirements in Division 01 regarding warranties for work under this Contract.
- B. All warranties shall begin on the Date of Substantial Completion of the entire project or the Owner's acceptance of the workmanship and/or material covered by the warranty, whichever is later. The warranty coverage shall continue for the specified period. Refer to individual specification sections for warranty period. If no specific warranty period is specified, the warranty shall extend for a minimum of 365 days.
- C. Manufacturers shall provide their standard warranties for work under the Electrical Trades. However, such warranties shall be in addition to, and not in lieu of, all other liabilities which the manufacturer and Electrical Subcontractor may have by law or by other provisions of the Contract Documents.

- D. All materials, items of equipment and workmanship furnished under the Electrical Section shall carry the standard warranty against all defects in material and workmanship. Any fault due to defective or improper material, equipment, workmanship or design which may develop shall be made good, forthwith, by and at the expense of the Electrical Subcontractor for the work under his Contract, including all other damage done to areas, materials and other systems resulting from this failure.
- E. The Electrical Subcontractor shall warranty that all elements of the systems which are to be provided under his Contract, are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.
- F. Upon receipt of notice from the Owner or Architect of failure of any part of the systems or equipment during the warranty period, the affected part or parts shall be replaced by the Electrical Subcontractor for their work or any other work affected by the failure(s).
- G. Electrical Subcontractor shall furnish, before the final payment is made, a written warranty covering the above requirements in accordance with the General Requirements.

1.29 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect, Construction Manager and Owner no fewer than five days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Construction Manager's and Owner's written permission.
 - 3. Comply with NFPA 70E.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Equipment and materials shall be as described in the respective Sections of Division 21, 22,23 and Division 26 and as shown.

2.2 MATERIALS

- A. Equipment specified by manufacturer's number shall include all accessories, controls, etc., listed in catalog as standard with equipment. Furnish optional or additional accessories as specified. And or/as required to provide a fully operational installation.
- B. Equipment, material damaged during transportation, installation, operation is considered as totally damaged. Replace with new. Payment for this equipment shall not be approved. Variance from this permitted only with written acceptance.
- C. All items of materials in each category of equipment shall be of one manufacturer.
- D. Material and Equipment General Requirements:
 - 1. All equipment and components shall be New.
 - 2. Testing agency labeled or with other identification wherever standards have been established.
 - 3. Owner's Representative reserves right to reject items not in accordance with Specification either before or after installation.
 - 4. Comprised to render complete and operable systems; provide additional items needed to complete installation to realized design.
 - 5. Compatible with space allocated. Modifications necessary to adjust items to space limitations at Contractor's expense.
 - 6. Installed fully operating and without objectionable noise or vibration.

PART 3 - EXECUTION

3.1 COMMISSIONING OF EQUIPMENT AND SYSTEMS

- A. General
 - 1. Completion of startup and commissioning shall be accomplished as a prerequisite for substantial completion and shall be completed for each phase of construction.
 - 2. Operate and maintain systems and equipment until final acceptance by Owner.
 - 3. All guarantees and warranties shall not begin until final acceptance of the systems and equipment by the Owner. Acceptance requires, at a minimum complete systems and commissioning.
 - 4. The Owner maintains the right to have access to the entire project site to develop his own operational procedures.
- B. Comprehensive Work Plan and Reporting
 - 1. Provide detailed, methodical, scheduled, start up and commissioning procedures and execution of same and every system and piece of equipment provided.

2. Attend start up and commissioning meetings on a regular basis, as directed by the General Contractor or Construction Manager.
3. Develop and provide a written work plan with detailed procedures for this work and submit, using shop drawing submittal procedure, within 6 weeks of the contract award. The work plan shall include provisions for an integrated start up plan and schedule. The plan and schedule shall identify tasks, start and completion dates, critical path items, interface requirements with other trades and major equipment start up, as minimum requirements of the plan. The plan and schedule shall clearly identify work in each construction phase, as well.
4. The purpose of this work plan is to provide for smooth, quick, and efficient start up and commissioning of systems and equipment and for a smooth transition to turn the complete, correctly operating building over to the Owner, at each phase of construction.
5. The Owner and the Consultant will have input to and be part of approval process for startup and commissioning plan.
6. Develop and submit for approval a specific start up, check out and sign off form for every piece of major equipment.
7. Develop and submit for approval a specific start up, check out and sign off form for every piece of major system.
8. Systems shall be operated under actual or simulated full load conditions. Identify the operating conditions in the work plan.
9. Work plan shall incorporate the below specified "Demonstration of Successful Operation"
10. The Consultant/Owner may check the completed and commissioned installation either sequentially as different parts are completed, and/or when the entire installation is complete, at sole option of the Consultant/Owner.
11. Each contractor shall arrange that an officer of his contracting company shall certify that each and every system has been tested. At the conclusion of the tests, this contractor shall submit a letter and enclosed commissioning forms signed by the officer stating:
 12. That he/she is the officer of the company.
 13. That he/she certifies that the specified testing of the systems has been performed by the company (give the name and dates of system testing).
 14. The results of testing as compared to specified performance, listing the name, title, and company affiliation of all those witnessing and performing these tests.

C. Commissioning

1. Commission equipment and systems in accordance with the approved work plan, completing the startup, check out and sign off forms for each piece of equipment and each system.
2. Provide qualified personnel, equipment, apparatus and services for startup and testing of equipment and systems, to obtain the performance shown in schedules, as specified or on commissioning forms, and as required by codes, standards, regulations and authorities having jurisdiction including Municipal Inspectors, Owners and Consultants.

3. Start up and testing procedures as may be outlined in various mechanical and electrical sections of the specifications are the minimum effort required for the project. Contractor shall use any additional procedures he feels will be necessary to properly start up and test the systems and equipment actually installed on the job at no additional cost to the Owner.
 4. Provide capacity and performance of equipment by field testing. Install thermowells and gauge connections and, at no additional cost to Owner, equipment and instruments required for testing.
 5. Qualified representative of equipment manufacturer shall be present at test.
 6. For each piece of equipment, copy nameplate data and include with the letter and start up, check out and sign off forms referred to above.
 7. Do not cover or conceal work before testing and inspection and obtaining approval.
 8. Leaks, damage and defects discovered or resulting from startup and testing shall be repaired or replaced by this contract to like-new condition with acceptable materials. Tests shall be continued until system operates without adjustments or repairs.
- D. Demonstration of Successful Operation: After all components and every system has been completely commissioned, provide a two week, 24 hour per day fully functional automatic operation period of all systems simultaneously. This shall be successfully concluded before systems are accepted by the Owner.

3.2 SPECIAL RESPONSIBILITIES:

- A. Cooperate and coordinate with work of other Sections in executing work of this Section.
1. Perform work such that progress of entire project including work of other Sections shall not be interfered with or delayed.
 2. Provide information as requested on items furnished under this Section which shall be installed under other Sections.
 3. Obtain detailed installation information from manufacturers of equipment provided under this section.
 4. Obtain final roughing dimensions or other information needed for complete installation of items furnished under other Sections or by Owner.
 5. Keep fully informed as to shape, size and position of openings required for material or equipment to be provided under this and other Sections. Give full information so that openings required by work of this Section may be coordinated with other work and other openings and may be provided for in advance. In case of failure to provide sufficient information on proper time, provide cutting and patching or have same done, at own expense and to full satisfaction of Consultants.
 6. Provide information as requested as to sizes, number and locations of pads necessary for floor mounted equipment provided under this Section.

7. Notify Consultants of location and extent of existing piping, conduit, ductwork and equipment that interferes with new construction. In coordination with and with approval of Consultants, relocate piping, ductwork and equipment to permit new work to be provided as required by Contract Documents. Remove non-functioning and abandoned piping, ductwork and equipment as directed by Consultants. Dispose of or store items as requested by Consultants.
- B. Installation Only Items
1. Where this contractor is required to install items which it does not purchase, it shall coordinate delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to time of installation. This trade shall be responsible for:
 2. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt to Consultant's and structural conditions.
 3. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.
 4. This contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted this contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.
- C. Maintenance of equipment and systems: Maintain equipment and systems until Final Acceptance. Ensure adequate protection of equipment and material during delivery, storage, installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions.
- D. Use of premises: Use of premises shall be restricted as directed by the Consultant and as required below:
1. Remove and dispose of dirt and debris, and keep premises clean. During progress of work, remove equipment and unused material. Put building and premises in neat and clean condition, and do cleaning and washing required to provide acceptable appearance and operation of equipment, to satisfaction of the Consultant.
 2. Store materials in a manner that will maintain an orderly clean appearance. If stored on-site in open or unprotected areas, all equipment and material shall be kept off the ground by means of pallets or racks and covered with tarpaulins.
 3. Do not interfere with function of existing sewers and water and gas mains, electrical or mechanical systems and services. Extreme care shall be observed to prevent debris from entering pipe, ductwork and equipment. Confer with the Consultant as to the disruption of services or other utilities due to testing, connection of new work to existing. Interruption of services shall be performed at time of day or night deemed by Owner to provide minimal interference with normal operation. Obtain Owner's approval of the method proposed for minimizing service interruption.

E. Surveys and Measurements:

1. Base measurements, both horizontal and vertical, on reference points established by Contractor and be responsible for correct laying out of work.
2. In event of discrepancy between actual measurements and those indicated, notify the Consultant in writing and do not proceed with work until written instructions have been issued by the Consultant.

F. Temporary Utilities:

1. Refer to Division 1 regarding requirements.
2. Furnish temporary equipment, and wiring, as needed during the construction phase. Remove temporary items after use.

3.3 MATERIAL AND WORKMANSHIP

- A. Work shall be neat and rectilinear. Conduit shall run concealed except in mechanical rooms and areas where no hung ceiling exists. Install material and equipment to comply with manufacturers. Recommended Requirements. Rough Work will be rejected. Work shall be properly and effectively protected, and conduit openings shall be temporarily closed to prevent obstruction and damage before completion.
- B. Except as specified otherwise, material and equipment shall be new. Provide supplies, appliances and connections necessary for complete and operational installation. Provide components required or recommended by OSHA and applicable NFPA documents.
- C. Finish of materials, components and equipment shall be as approved by the Consultant and shall be resistant to corrosion and weather as necessary.
- D. Owner will not be responsible for material and equipment before testing, commissioning, and acceptance.
- E. Equipment and materials shall be delivered to the site and stored in original sealed containers, suitably sheltered from the elements, but readily accessible for inspection by the Architect until installed. All items subject to moisture damage such as controls shall be stored in dry, heated spaces. Equipment such as switchgear with heater elements installed shall have the heater elements energized after the equipment is received by the Electrical Subcontractor.
- F. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical injury and theft. At the completion of the work, equipment and materials shall be cleaned and polished thoroughly and turned over to the Owner in a condition satisfactory to the Architect. Damage or defects that develop before acceptance of the work shall be made good at the Electrical Subcontractor's expense.

- G. The Electrical Subcontractor shall make necessary field measurements to ascertain space requirements, for equipment and connections to be provided under his respective Trade and shall furnish and install such sizes and shapes of equipment to allow for the final installation to conform to the drawings and specifications.
- H. Manufacturer's directions shall be followed completely in the delivery, storage, protection and installation. Promptly notify the Architect in writing of any conflict between any requirements of the Contract Documents and the manufacturer's directions. Obtain the Architect's written instructions before proceeding with the work. Should Electrical Subcontractor perform any work that does not comply with the manufacturer's directions or written instructions from the Architect, he shall bear all costs arising in correcting any deficiencies that should arise.
- I. All equipment of one type (such as distribution equipment, cable, wiring devices, fire alarm system, etc.) shall be the products of one manufacturer.
- J. Equipment pre-purchased by the General Contractor on behalf of the Owner or by the Owner himself, if assigned to the Electrical Subcontractor, shall be received, installed, tested, etc., as if the equipment was purchased by the Electrical Subcontractor. All guarantees, service contracts, etc., shall be the same as for all other equipment provided under this Contract.

3.4 CONTINUITY OF SERVICES

- A. Do not interrupt existing services without Owner's approval.
- B. Schedule interruptions in advance, according to Owner's instructions. Submit, in writing, with request for interruption, methods proposed to minimize length of interruption.
- C. Interruptions shall be scheduled at such times of day and work so that they have minimal impact to Owner's operations.
- D. Subcontractor shall coordinate any shutdowns of existing systems as follows:
 - 1. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days are required.
 - 2. Minimize shutdowns of any system.
 - 3. Provide temporary services where required and perform shutdown and tie-ins at a time convenient to Owner.
 - 4. Subcontractor shall be responsible for completing and filing Owner's shutdown notice questionnaire.
 - 5. Perform required survey and inspection work required by the notice for shutdown.
- E. Include premium time work associated with interruption of services and/or shutdown as necessary to avoid disruption to Owner's operations.

3.5 ANCHORS AND INSERTS:

- A. Inserts shall be iron or steel of type to receive machine bolt head or nut after installation. Insert shall permit adjustment of bolt in one horizontal direction and shall develop strength of bolt when installed in properly cured concrete.
- B. Provide anchors as necessary for attachment of equipment support and hangers.

3.6 WATERPROOF CONSTRUCTION:

- A. Maintain waterproof integrity of penetrations of materials intended to be waterproof. Provide flashing at exterior wall and roof penetrations. Caulk watertight penetrations of foundation walls and floors. Provide membrane clamps at penetrations of waterproof membranes.
- B. Provide galvanized sheet metal weather protection canopies, hoods or enclosures over all out-of-doors equipment, the operation or maintenance of which would be impaired by rainwater. This requirement applies to damper operators and bearing, damper motors, controls, and instruments. See other paragraphs in this Division for application of this requirement to panels, motors, and devices.

3.7 RESTORATION OF DAMAGE:

- A. Repair or replace, as directed by the Consultant and/or Owner's Representative, materials and parts of premises which become damaged as result of installation of Work of this Division. Remove replaced parts from premises.

3.8 TOOLS AND EQUIPMENT

- A. Furnish all tools and equipment necessary for the proper installation, protection and upkeep of the Work.

3.9 ADJUSTMENTS

- A. Preliminary Operation: Operate any portion of installation for Owner's convenience if so requested by Construction Manager. Such operation does not constitute acceptance of Work as complete. Cost of utilities, such as gas and electrical power, will be borne by Owner if Owner requests operation.
- B. Start-up Service: Prior to startup, ensure that systems are ready for their intended use.
- C. Start and operate all systems. Provide services of factory trained technicians for startup of major equipment and systems.
- D. Adjusting:

1. Adjust all equipment and system components as shown or as otherwise required to result in intended system operation.
2. Thereafter, as a result of system operation or as directed by Owner's Representative, make readjustments as necessary to refine performance and to effect complete system "tune-up".
3. After completion of testing and adjustment, operate the different systems and equipment under normal working conditions for 72 hours continuously and show specified performance.
4. If, in the opinion of the Consultant, performance of equipment or systems is not in accordance with specifications or submitted data, alter or replace equipment at no increase in Contract Sum. The Contractor, at his option, may order tests from an independent approved laboratory to prove compliance. All such tests shall be at no increase in Contract Sum. Repeat process as often as required. If the reason for unsatisfactory operation is design errors all additional cost for corrective measures will be reimbursed to the contractor.
5. At completion of Work, provide written certification that all systems are functioning properly without defects.

E. Noise:

1. Cooperate in reducing any objectionable noise or vibration caused by electrical systems to the extent of adjustments to specified and installed equipment and appurtenances.
2. Cooperate in adjustment of mechanical systems and terminal devices, as directed by Owner's Representative, to obtain specified acoustic properties.
3. Completely correct noise problems caused by failure to make installation in accordance with Contract Documents, including labor and materials required as a result of such failure, at no increase in Contract Sum. Includes refinish walls, floors etc.

3.10 INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate connection of electrical service with utility provider. Comply with utility provider requirements and local codes and regulations.
- C. Coordinate connection of branch circuits and feeders to equipment furnished under other Divisions.
- D. Assemble equipment required to be field assembled under the direct supervision of the manufacturers' agent. Prior to the final acceptance submit letters from the manufacturers that this has been done.
- E. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways, to the satisfaction of the Consultant and in accordance with code requirements. Installation shall permit clearance for access to equipment for repair, servicing and replacement.

- F. Install equipment so as to properly distribute equipment loads on building structural members provided for equipment support under other Sections. Roof mounted equipment shall be installed and supported on structural steel provided under other Sections.
- G. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs as necessary for floor, wall or ceiling mounting of equipment as required.
- H. Provide steel supports and hardware for proper installation of hangers, anchors, guides, etc.
- I. Provide cuts, weights, and other pertinent data required for proper coordination of equipment support provisions and installations.
- J. Structural steel and hardware shall conform to Standard specifications of ASTM; use of steel and hardware shall conform to requirements of Section V of Code of Practice of American Institute of Steel Construction.
- K. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly, which will void warrantee. Report in writing to the Consultant, prior to purchase or shipment of equipment involved, on conditions which may prevent proper installation.
- L. Measure indicated mounting heights to center of unit for suspended items and wall-mounted items, unless noted otherwise.
- M. If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- N. Sequence for efficient flow of installation and positioning prior to building closing-in. Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Provide for ease of disconnecting of equipment with minimum interference to other installations.
- O. Arrange raceways, cables, [wireways,] [cable trays,] [and busways]to be clear of obstructions and of the working and access space of other equipment.
- P. Give right of way to piping systems installed at a required slope.
- Q. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- R. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Refer to Division 08 Section "Access Doors and Frames."
- S. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Comply with Division 07 Section "Penetration Firestopping."

- T. Comply with Division 01 Section "Cutting and Patching" restoration of surfaces disturbed by electrical installation.

3.11 PAINTING

- A. Equipment installed shall have shop coat of non-lead paint. Hangers and supports shall have one coat of non-lead primer. Finish painting, including painting of various conduit or wire way systems, shall be done under other Sections.
- B. Paint all outside exposed equipment and equipment supports with two coats of weather resistant enamel.
- C. Properly prepare Work under this Division to be finish painted under Division 9.
- D. Refer to standard paint colors for all Electrical equipment inside the Building.
- E. Paint finished surfaces damaged during electrical installation, matching color and type of paint. Follow manufacturer's written instructions for surface preparation and application. Apply successive coats required to restore finish equal to the unblemished areas.

3.12 SELECTIVE DEMOLITION

- A. Refer to all drawings for general description of areas requiring demolition.
- B. Refer to General Contractor's/Construction Manager's Instructions for all existing equipment and materials that shall remain the property of the Owner.
- C. Items of value which are not directed to be returned to the Owner shall become the property of the Contractor. Storage or sale of items on the project site is prohibited.
- D. Protection: Ensure the safe passage of persons in and around building during demolition. Prevent injury to persons and damage to property. Provide adequate shoring and bracing to prevent collapse. Immediately repair damaged property to the condition before being damaged. Take effective measures to prevent windblown dust.
- E. Utilities: Maintain all utilities except those requiring removal or relocation. Keep utilities in service and protect from damage. Do not interrupt utilities serving used areas without first obtaining permission from the utility company and the Owner. Provide temporary services as required.

3.13 JOBSITE SAFETY

- A. Neither the professional activities of the Engineer, nor the presence of the Engineer or his or her employees and sub-consultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Engineer and the Engineer's consultants shall be indemnified and shall be made additional insured's under the Contractor's general liability insurance policy.

3.14 CLEANING

- A. This Section of the specifications shall include the cleaning of all equipment on a day-to-day basis and final cleaning of all electrical equipment prior to turning building over to the Owner. All necessary cleaning referred to herein shall be cleaned to the satisfaction of the Architect.
- B. Electrical Distribution Equipment
 - 1. All electrical distribution equipment shall be completely cleaned and dried inside and out prior to initial energizing.
 - 2. Cleaning shall consist of vacuuming all busses, windings, enclosures (inside and out), etc. After vacuuming is complete, all equipment shall be wiped down. If equipment is wet or contains moisture, it shall be thoroughly dried and inspected by the manufacturer's representative before energizing.
- C. Raceways and Junction Boxes
 - 1. All raceways and junction boxes shall be blown out and dried prior to installation of feeder conductors and branch circuit conductors.
- D. Low Tension Systems
 - 1. All cabinets and panels for low tension systems shall be thoroughly cleaned and dried prior to system start-up.
- E. Final Cleaning
 - 1. All lighting fixtures, devices, device plates, etc., shall be cleaned and left in "like new" condition to the satisfaction of the Architect, prior to occupancy.
 - 2. All rubbish and discarded materials shall be disposed of and removed from the site on a day-to-day basis.

3. All equipment, whether part of the Electrical Subcontractor's Contract or not, which must be cleaned due to the Electrical Subcontractor's work, shall be cleaned by the Electrical Subcontractor to the satisfaction of the Architect.

3.15 FINAL JOBSITE OBSERVATION

- A. As the work nears completion, the Contractor is to review the requirements of the Contract Documents, inspect the work and inform all parties involved of the work to be corrected or completed before the project can be deemed substantially complete.
- B. When the Project is substantially complete, In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation. Notify the Owner's Representative in writing of this fact, listing any items of Work remaining incomplete, the reason therefore, and the anticipated date that all remaining work will be completed. The Contractor shall inform the certification that the project is complete and ready for a final punch, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
- C. It is understood that if the Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Engineers additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- D. The Contractor shall carry out their own final inspection and satisfy the Work.
- E. The Owner's Representative reserves the right to cancel and reschedule the inspection in the event considerable more work remains to be completed or corrected than indicated in the written request for inspection.
- F. All items not completed or found not complying with drawings or specifications by the Owner's Representative will be identified in their inspection report.
- G. Correct all items on inspection report. Make the correction and initial and date each item on the report after corrections have been completed.
- H. Include the fee for all local inspections.

3.16 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

- C. The Owner has the option to video tape all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. The instructions shall include:
 - 1. Maintenance of equipment.
 - 2. Start-up procedures for all major equipment.
 - 3. Description of emergency system operation.

3.17 PROJECT CLOSE-OUT PROCEDURE

- A. General
 - 1. The requirements of this section are in addition to and supplement the requirements outlined in Division 1.
 - 2. It shall be each contractor's responsibility to personally hand-deliver all of the required project close-out checklist items and to obtain Owner's authorized representative(s) signed receipt on all items requiring Owner sign-off.
- B. The following documents shall be provided on to the Contractor's letterhead, filled out, Signed by the Licensed Permit Holder and sealed by an Authorized Officer of the Corporation then submitted to the Architect for Final Certificate of Occupancy:
 - 1. All Code related punch list items have been addressed and signed-off by contractor.
 - 2. Electrical/Fire Alarm Sub-Contractor Record of Completion.
 - 3. NFPA 72 Record of Completion Form completed by the installing contractor or by an independent third party testing company if it is a new project. For both new and renovation projects Fire Alarm final test reports reflecting PASS result for all required tests identified in NFPA-72 Chapter 14.
 - 4. Generator under-load test report including automatic transfer switches operated correctly and confirmation emergency lighting systems are functional.
 - 5. Emergency battery unit test report where applicable to the project.
 - 6. Exit sign battery testing report where applicable to the project.
 - 7. Letter from contractor stating that all fire safing is complete for all floor and wall penetrations.
 - 8. Letter from contractor stating that seismic restraints for all systems have been completed.
 - 9. Factory start-up reports and letters certifying that systems are online and operational:
 - a. Emergency system such as Generator and/or power backup systems where applicable to the project.
 - b. Fire Alarm System where applicable to the project.
- C. Project Close-Out Checklist

December 5, 2025

SKOWHEGAN RIVERFRONT WALKWAY
Skowhegan, Maine

1. Review requirements of each section of the specifications and submit for approval to Consultants the sign-off forms which shall become the project close-out checklist. These, at a minimum, shall include the following information shown in attached Project Closeout Checklist Example. The Consultants and/or Owner may incorporate additional specific items to the following checklist which shall become part of project requirements.
2. Close-Out Checklist Example:

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

In order to prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

3. Penetrations fire sealed and labeled in accordance with specifications.
4. Electrical panels have typed circuit identification.
5. Operation and Maintenance manuals have been submitted per Specification.
6. Factory startup and reports have been submitted as required.
7. Electric Panels and equipment have been properly labeled.

Accepted by:

Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Engineer so that the final observation can be scheduled.

It is understood that if the Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

SECTION 260519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoplastic-insulated wire.
2. Thermoset-insulated wire.
3. Nonmetallic underground conduit with conductors.
4. Connectors and splices.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260500 "Common Work Results for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
6. Section 260533.13 "Conduits for Electrical Systems" specifies installation of raceways referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.

1.2 DEFINITIONS

- A. NICET: National Institute for Certification in Engineering Technologies; a division of the National Society of Professional Engineers (NSPE).

1.3 ACTION SUBMITTALS

- A. Product Schedule: Indicate type, use, location, and termination locations.
- B. Product Data: For each type of product.

- C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's published instructions.
- B. Field Reports:
 - 1. Field reports for infrared scanning.

1.5 QUALIFICATIONS

- A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.
- B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.
- C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - 1. On-site electrical testing supervisors must possess active NICET EPT Technician [III] [IV] certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 THERMOPLASTIC-INSULATED WIRE

- A. Description: Thermoplastic-insulated wire for use in accordance with Article 310 of NFPA 70.
- B. UL ZLGR - Type THHW Insulated Wire:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.
 2. Standard Features:
 - a. Referenced Standard: Article 310 of NFPA 70.
 - b. Insulation Voltage Rating: 600 V.
 - c. Insulation Temperature Rating: 90 deg C.
 - d. Conductor Material: Copper.
 - e. Conductor Size: As indicated on the Drawings.
 - 1) Minimum Conductor Size: 12 AWG.
- C. UL ZLGR - Type THW Insulated Wire:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.
 2. Standard Features:
 - a. Referenced Standard: Article 310 of NFPA 70.
 - b. Insulation Voltage Rating: 600 V.
 - c. Insulation Temperature Rating: 90 deg C.
 - d. Conductor Material: Copper.
 - e. Conductor Size: As indicated on the Drawings.
 - 1) Minimum Conductor Size: 12 AWG.
- D. UL ZLGR - Type THW-2 Insulated Wire <Insert drawing designation>:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Thermoplastic-Insulated Wire: UL CCN ZLGR, including UL 83.
 2. Standard Features:
 - a. Referenced Standard: Article 310 of NFPA 70.
 - b. Insulation Voltage Rating: 600 V.
 - c. Insulation Temperature Rating: 90 deg C.

- d. Conductor Material: Copper
- e. Conductor Size: As indicated on the Drawings.

- 1) Minimum Conductor Size: 12 AWG.

2.3 THERMOSET-INSULATED WIRE

- A. Description: Thermoset-insulated wire for use in accordance with Article 310 of NFPA 70.
- B. UL ZKST - Type XHH Insulated Wire:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.
 - 2. Standard Features:
 - a. Referenced Standard: Article 310 of NFPA 70.
 - b. Insulation Voltage Rating: 600 V.
 - c. Insulation Temperature Rating: 90 deg C.
 - d. Conductor Material: Copper
 - e. Conductor Size: As indicated on the Drawings.
 - 1) Minimum Conductor Size: 12 AWG.
- C. UL ZKST - Type XHHW Insulated Wire:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.
 - 2. Standard Features:
 - a. Referenced Standard: Article 310 of NFPA 70.
 - b. Insulation Voltage Rating: 600 V.
 - c. Insulation Temperature Rating: 75 deg C for wet locations
 - d. Conductor Material: Copper.
 - e. Conductor Size: As indicated on the Drawings.
 - 1) Minimum Conductor Size: 12 AWG.
- D. UL ZKST - Type XHHW-2 Insulated Wire:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Thermoset-Insulated Wire: UL CCN ZKST, including UL 44.
 2. Standard Features:
 - a. Referenced Standard: Article 310 of NFPA 70.
 - b. Insulation Voltage Rating: 600 V.
 - c. Insulation Temperature Rating: 90 deg C.
 - d. Conductor Material: Copper.
 - e. Conductor Size: As indicated on the Drawings.
 - 1) Minimum Conductor Size: 12 AWG.
- E. UL YDUX - Underground Feeder and Branch-Circuit Cable, Type UF and Type UF-B:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Type UF and Type UF-B Cables: UL CCN YDUX, including UL 493.
 2. Standard Features:
 - a. Referenced Standard: Article 340 of NFPA 70.
 - b. Insulation Voltage Rating: 600 V.
 - c. Insulation Temperature Rating:
 - 1) Type UF: 60 deg C.
 - 2) Type UF-B: Individual conductors are rated 90 deg C for multiple conductor ampacity calculations; however, final cable ampacity rating must not exceed value for 60 deg C in Table 310.15(C)(1) of NFPA 70.
 - d. Conductor Material: Copper.
 - e. Conductor Size: As indicated on the Drawings]
 - 1) Minimum Conductor Size: 12 AWG.
 - f. Cable Covering: Flame retardant, moisture resistant, fungus resistant, corrosion resistant, and suitable for direct burial in the earth.
- F. UL TYLZ - Service-Entrance Cable, Type SE, Type USE, and Type USE-2:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Service-Entrance Cable: UL CCN TYLZ, including UL 854.
2. Standard Features:
 - a. Referenced Standard: Article 338 of NFPA 70.
 - b. Insulation Voltage Rating: 600 V.
 - c. Insulation Temperature Rating: Not in excess of rating for insulation type specified below:
 - 1) Type THWN: 75 deg C, dry and wet locations.
 - 2) Type THWN-2: 90 deg C, dry and wet locations.
 - 3) Type RHW: 75 deg C, dry and wet locations.
 - 4) Type XHHW: 90 deg C, dry and damp locations; 75 deg C, wet locations.
 - 5) Type RHW-2: 90 deg C, dry and wet locations.
 - 6) Type XHHW-2: 90 deg C, dry and wet locations.
 - d. Conductor Material: Copper.
 - e. Conductor Size: As indicated on the Drawings.
 - 1) Minimum Conductor Size: 12 AWG.

2.4 CONNECTORS AND SPLICES

A. UL ZMVV - Wire Connectors and Soldering Lugs <Insert drawing designation>:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Wire Connectors and Soldering Lugs: UL CCN ZMVV, including UL 486A-486B or UL 486C.
2. Standard Features:
 - a. One piece, seamless, designed to terminate conductors specified in this Section.
 - b. Material: Copper.
 - c. Type: One or two hole with standard barrels.
 - d. Termination: Compression or crimp.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Copper for feeders smaller than No. 4 AWG; copper, aluminum, or copper-clad aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Material: Copper.
 - a. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
 - b. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway, Type XHHW-2, single conductors in raceway, Multiconductor cable, Type SE.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway, Type XHHW-2, single conductors in raceway
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway, Type XHHW-2, single conductors in raceway, Underground feeder cable, Type UF.
- D. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway, Type XHHW-2, single conductors in raceway, Underground branch-circuit cable, Type UF.

3.3 INSTALLATION OF LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:
 1. Electrical Construction: ICC IBC, ICC IFB, NFPA 1, NFPA 70, and NECA NEIS 1.
 2. Electrical Maintenance: NFPA 70B.
 3. Electrical Safety: NFPA 70E.

4. Temporary Electric Power Work: NECA NEIS 200.
5. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
6. Work in Confined Spaces: NFPA 350.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Installation of Type AC and Type MC Cables: NECA NEIS 120.
9. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
2. Complete raceway installation between conductor and cable termination points prior to pulling conductors and cables.
3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
4. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
5. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
6. Provide support for cables.
7. Complete cable tray systems installation prior to installing conductors and cables.
8. Connections:
 - a. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
 - b. Make splices, terminations, and taps that are compatible with conductor material[and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors].
 - 1) Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
9. Wiring at Outlets: Install conductor at each outlet, with at least [6 inch (150 mm)] [12 inch (300 mm)] of slack.

D. Interfaces with Other Work:

1. Identification:
 - a. Identify and color-code conductors and cables.
 - b. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.
2. Sleeves and Sleeve Seals: Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3. Firestopping: Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. Owner will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections with assistance of factory-authorized service representative.

B. Field tests and inspections must be witnessed by Architect and authorities having jurisdiction.

C. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
3. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements:
4. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection in accordance with the single-line diagram.
 - b. Test bolted connections for high resistance using one or more of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.

D. Nonconforming Work:

1. Wire or cable assembly will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.5 MAINTENANCE

A. Infrared Scanning of Splices: Two months after Substantial Completion, perform infrared scan of splices, joints, and connections in conductors 3 AWG and larger. Remove covers so splices, joints, and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison. Correct deficiencies determined during the scan.

1. Follow-On Infrared Scanning: Perform follow-up infrared scan of splices at 11 months after Substantial Completion.
2. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
3. Field Reports for Infrared Scanning: Prepare certified report that identifies cables splices checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 260519

SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding connectors.
5. Grounding (earthing) electrodes.
6. Grounding electrode enclosures.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260500 "Common Work Results for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 264113 "Lightning Protection for Structures" specifies bonding of lightning protection grounding electrodes to facility grounding electrodes.
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
 - a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.

- b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
 - c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.
 - B. Shop Drawings: Prepare and submit the following:
 - 1. Plans showing dimensioned locations of grounding features described in "Field Quality Control for Grounding and Bonding" Article, including the following:
 - a. Grounding electrode access enclosures.
 - b. Grounding electrodes.
 - c. Grounding arrangements and connections for separately derived systems.
 - C. Field quality-control reports.
- 1.3 INFORMATIONAL SUBMITTALS
 - A. Manufacturer's published instructions.
- 1.4 CLOSEOUT SUBMITTALS
 - A. Operation and Maintenance Data:
 - 1. In addition to items specified in Section 260010 "Supplemental Requirements for Electrical," include the following:
 - a. Plans showing locations of grounding features described in "Field Quality Control for Grounding and Bonding" Article, including the following:
 - 1) Grounding electrode access enclosures.
 - 2) Grounding electrodes.
 - 3) Grounding arrangements and connections for separately derived systems.
 - b. Instructions for periodic testing and inspection of grounding features at test wells
 - 1) Tests must determine if ground-resistance or impedance values remain within specified maximums, and instructions must recommend corrective action if values do not.
 - 2) Include recommended testing intervals.

1.5 QUALIFICATIONS

- A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.
- B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems, evaluate tests, test equipment, test results, and power system performance, recommend actions to maintain or improve system performance, and lead multi-team projects.
- C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - 1. On-site electrical testing supervisors must possess active NICET EPT Technician certification.

1.6 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

- A. Soil Resistivity: Grounding (earthing) Work on the Project must account for soil resistivity conditions specified in Section 018116 "Facility Environmental Requirements."
- B. Electrical and ICT Equipment Grounding (Earthing): Do not exceed 25 Ω resistance to ground (earth).
 - 1. Contact Architect for resolution if 25 Ω specified resistance to ground (earth) is not attained after complying with prescriptive requirements in Article 250 of NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 GROUNDING AND BONDING CONDUCTORS

- A. Equipment Grounding Conductor:
 - 1. Standard Features: 600 V, THHN/THWN-2 or THWN-2, copper wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Isolated Equipment Grounding Conductor:

1. Standard Features: 600 V, THHN/THWN-2 or THWN-2, copper or tinned-copper wire or cable, green color with one or more yellow stripes, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. ASTM - Bare Copper Grounding and Bonding Conductor:

1. Standard Features: Complying with one or more of the following:
 - a. Soft or Annealed Copper Wire: ASTM B3.
 - b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
 - c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
 - d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

D. UL KDER - Armored Grounding Wire:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
2. Standard Features: Single corrosion-resistant copper, aluminum, or copper-clad aluminum conductor within helically formed steel armor.

E. UL KDSH - Protector Grounding Conductor:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
2. Standard Features:
 - a. Conductors intended to be used for grounding primary protector or metallic members of cable sheath in accordance with Chapters 7 and 8 of NFPA 70.
 - b. Color: green.

2.3 GROUNDING AND BONDING CLAMPS

- A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications.

B. UL KDER and KDSH - Hex-Fitting-Type Pipe and Rod Grounding and Bonding Clamp:

1. Source Limitations: Obtain products from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
3. Standard Features:
 - a. Two pieces with stainless steel bolts.
 - b. Clamp Material: Die-cast zinc alloy, Brass, or Tinned brass.
 - c. Listed for outdoor use.

C. UL KDER and KDSH - U-Bolt-Type Pipe and Rod Grounding and Bonding Clamp:

1. Source Limitations: Obtain products from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
3. Standard Features:
 - a. Clamp Material: Aluminum, Brass, or Tinned brass.
 - b. Listed for outdoor use.
4. Sustainable Design Features:

D. UL KDER and KDSH - Strap-Type Pipe and Rod Grounding and Bonding Clamp:

1. Source Limitations: Obtain products from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

3. Standard Features:

- a. Clamp Material: Copper or Galvanized steel.
- b. Listed for outdoor use.

E. UL KDER - Beam Grounding and Bonding Clamp:

- 1. Source Limitations: Obtain products from single manufacturer.
- 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
- 3. Standard Features: Mechanical-type, terminal, ground wire access from four directions; with dual, tin-plated or silicon bronze bolts.

F. UL KDER - Exothermically Welded Connection:

- 1. Source Limitations: Obtain products from single manufacturer.
- 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
- 3. Standard Features: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

G. UL KDER - Raised-Floor Signal Reference Grid Clamp:

- 1. Source Limitations: Obtain products from single manufacturer.
- 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

3. Standard Features: Mechanical-type, stamped-steel terminal with hex head screw.

2.4 GROUNDING AND BONDING BUSHINGS

- A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.
- B. UL KDER - Bonding Bushing:
 1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 3. Standard Features: Threaded bushing with insulated throat.
- C. UL KDER - Grounding Bushing:
 1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 3. Standard Features: Threaded bushing with insulated throat and mechanical-type wire terminal.
 4. Sustainable Design Features:

2.5 GROUNDING AND BONDING CONNECTORS

- A. UL KDER - Split-Bolt Pressure-Type Grounding and Bonding Cable Connector:
 1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
- 3. Standard Features: Bolts that surround cable and bond to cable under compression when nut is tightened.
 - a. Copper, Copper alloy, or Tinned copper.
- B. UL KDER - Signal Reference Grid Grounding and Bonding Connector:
 - 1. Source Limitations: Obtain products from single manufacturer.
 - 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 - 3. Standard Features: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

2.6 BRIDGE GROUNDING CONNECTORS

- A. Description: Devices that provide means for connecting communications systems grounding and bonding conductors at service equipment or at disconnecting means for buildings or structures.
- B. UL KDSH - One-Piece Intersystem Bonding Bridge Grounding Connector <Insert drawing designation>:

2.7 SIGNAL REFERENCE GRIDS

- A. Description: Means for providing low-impedance path to ground over a large area, approximating an equipotential plane, while simultaneously mitigating large current spikes from faults or lightning.
- B. UL KDER - Mesh-Type Signal Reference Grid:
 - 1. Source Limitations: Obtain products from single manufacturer.

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
3. Standard Features: Conductive metal wire mesh for field-fabrication of grid.
 - a. Wire Size: 4 AWG.
 - b. Wire Material: Copper.
 - c. Spacing: 24 inch (610 mm).
 - d. Welded or brazed intersections.

C. UL KDER - Tape-Type Signal Reference Grid:

1. Source Limitations: Obtain products from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
3. Standard Features: Conductive copper tape for field-fabrication of grid.
 - a. Copper Tape Dimensions: 16 mil (0.4 mm) (26 ga.) thick by 2 inch (51 mm) wide
 - b. Spacing: 24 inch (610 mm).
 - c. Welded or brazed fittings for intersections.

2.8 GROUNDING (EARTHING) ELECTRODES

A. UL KDER - Rod Electrode:

1. Source Limitations: Obtain products from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
3. Standard Features: Copper-clad, Zinc-coated; 5/8 inch by 8 ft (16 mm by 2.4 m).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.
- B. Inspect test results of grounding system measured at point of electrical service equipment connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS

- A. Grounding and Bonding Conductors:
 - 1. Provide solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.
 - 2. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
 - 3. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 4. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
 - 5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Underground Grounding Conductors: Install bare [tinned-]copper conductor, 2/0 AWG minimum.
- B. Grounding and Bonding Connectors:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.
- C. Grounding and Bonding Busbars: Provide in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated on the Drawings.
- D. Substation Signal Reference Grid:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with IEEE C2.
 - a. Install 6 AWG bonding conductors below grade in a grid pattern on 2 ft (600 mm) centers. Bond grid conductors with exothermic welds where they cross each other.
 - b. Grid must fill entire area inside equipment yard fence, and extend minimum 6.5 ft (2 m) outside fence, so someone walking or running outside yard may not touch fence or open gate without first stepping inside grid.
 - c. Bond each metal fence post and gate post to at least two grid conductors.
 - d. Inside grid, bond equipment reinforcing steel inside bases and sidewalks to at least two grid conductors.
 - e. Bond underground metal pipe and conduit passing under grid to nearest grid conductor at both ends.

E. Signal Reference Grid Tape Mesh:

1. Install tape mesh under floor finish with the following features:
 - a. Tape mesh, 2 inch (50 mm) by 16 mil (0.4 mm) solid copper, 24 inch (610 mm) spacing.

3.3 INSTALLATION OF GROUNDING AND BONDING

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Work in ITE Rooms: NFPA 75.
7. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
8. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
12. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Grounding and Bonding Conductors:
 - a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
 - b. Underground Grounding Conductors:
 - 1) Bury at least **30 inch (750 mm)** below grade.
 - 2) Duct-Bank Grounding Conductor: Bury **12 inch (300 mm)** above duct bank when indicated as part of duct-bank installation.
2. Grounding and Bonding Connectors: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
 - a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 - b. Make connections with clean, bare metal at points of contact.
 - c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
 - d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 - e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 - f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
 - 2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.
 - g. Grounding and Bonding for Piping:
 - 1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.

- 3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
 - h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
 - i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft (18 m) apart.
- 3. Electrodes:
 - a. Ground Rods: Drive rods until tops are 2 inch (50 mm) below finished floor or final grade unless otherwise indicated.
 - 1) Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2) Use exothermic welds for below-grade connections.
 - b. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to service grounding electrode conductor.
 - c. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and must be at least 12 inch (300 mm) deep, with cover.
 - 1) Install at least one test well for each service unless otherwise indicated. Install at ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- 4. Grounding at Service:
 - a. Equipment grounding conductors and grounding electrode conductors must be connected to ground busbar. Install main bonding jumper between neutral and ground buses.
- 5. Grounding Separately Derived Systems:
 - a. Permanent Generators: Install grounding electrode(s) at location of permanent generators having switched neutral connections. Electrode must be connected to equipment grounding conductor and to frame of generator.
- 6. Grounding Underground Distribution System Components:

- a. Duct-Bank Grounding Conductor: Bury 12 inch (300 mm) above duct bank when indicated as part of duct-bank installation.
 - b. Comply with IEEE C2 grounding requirements.
 - c. Grounding Manholes and Handholes: Install driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inch (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inch (50 mm) above to 6 inch (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
 - d. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields in accordance with manufacturer's published instructions with splicing and termination kits.
 - e. Pad-Mounted Transformers and Switches: Install two ground rods and ring electrode around pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than 2 AWG for ring electrode and for taps to equipment grounding terminals. Bury ring electrode not less than 6 inch (150 mm) from foundation.
7. Equipment Grounding and Bonding:
- a. Install insulated equipment grounding conductors with feeders and branch circuits.
 - b. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1) Feeders and branch circuits.
 - 2) Lighting circuits.
 - 3) Receptacle circuits.
 - 4) Single-phase motor and appliance branch circuits.
 - 5) Three-phase motor and appliance branch circuits.
 - 6) Flexible raceway runs.
 - 7) Armored and metal-clad cable runs.
 - 8) Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9) X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
 - c. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air

- cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- d. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
 - e. Isolated Grounding Receptacle Circuits: Install insulated equipment grounding conductor connected to receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.
 - f. Isolated Equipment Enclosure Circuits: For designated equipment supplied by branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.
 - g. Poles Supporting Outdoor Lighting Fixtures: Bond insulated equipment grounding conductor to equipment grounding terminal inside pole base.
 - h. Metallic Fences: Comply with requirements of IEEE C2.
 - 1) Grounding Conductor: Bare, tinned copper, not less than 8 AWG.
 - 2) Gates: Must be bonded to grounding conductor with flexible bonding jumper.
 - 3) Barbed Wire: Strands must be bonded to grounding conductor.

3.4 FIELD QUALITY CONTROL FOR GROUNDING AND BONDING

A. Administrant for Electrical Power Tests and Inspections:

- 1. [Owner] [Tenant] will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
- 2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
- 3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
- 4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

B. Field tests and inspections must be witnessed by authorities having jurisdiction.

C. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
 3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal[, at ground test wells][, and at individual ground rods]. Make tests at ground rods before conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
 - c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.
 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to record of tests and observations. Include number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- D. Nonconforming Work:
1. Grounding system will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective components and retest.
- E. Collect, assemble, and submit test and inspection reports.
1. Report measured ground resistances that exceed the following values:
 - a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 Ω .
 - b. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 Ω .
 - c. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 Ω .
 - d. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 Ω .
 - e. Substations and Pad-Mounted Equipment: 5 Ω .
 - f. Manhole Grounds: 10 Ω .

3.5 PROTECTION

- A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

December 5, 2025

SKOWHEGAN RIVERFRONT WALKWAY
Skowhegan, Maine

END OF SECTION 260526

SECTION 260529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Support systems.
2. Mounting, anchoring, and attachment components.
3. Installation of fabricated metal supports.
4. Installation of concrete bases.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260500 "Common Work Results for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 033000 "Cast-in-Place Concrete" specifies concrete materials, reinforcement, and placement requirements referenced by this Section.
5. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration controls, seismic restraints, and wind restraints referenced by this Section.

1.2 DELEGATED DESIGN SERVICES

- A. Delegated Design Professionals: Engage qualified structural professional engineer to design hangers and supports for electrical systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.

- d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
 - 2. Include rated capacities and furnished specialties and accessories.
 - B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.
 - 1. Hangers. Include product data for components.
 - 2. Slotted support systems.
 - 3. Equipment supports.
 - 4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - C. Delegated Design Submittals: For hangers and supports for electrical systems.
 - 1. Include design calculations and details of hangers.
 - 2. Include design calculations for seismic restraints.
- 1.4 INFORMATIONAL SUBMITTALS
- A. Welding certificates.
- 1.5 REGULATORY AGENCY APPROVALS
- A. Delegated design submittals and shop drawings requiring approval by authorities having jurisdiction must be signed by qualified structural professional engineer responsible for their preparation.
- 1.6 QUALIFICATIONS
- A. Structural Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic and wind controls, equipment hangers and supports, and concrete foundations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Prepare design calculations in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical" and Section 018123 "Facility Seismic and Wind Criteria."
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame Rating: Class 1.
 - 2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT SYSTEMS

- A. Steel Slotted Support Systems:
 - 1. Standard Features: Preformed steel channels and angles with minimum 13/32 inch (10 mm) diameter holes at a maximum of 8 inch (200 mm) on center in at least one surface.
 - a. Referenced Standard: MFMA-4 factory-fabricated components for field assembly.
 - b. Material for Channel, Fittings, and Accessories: Galvanized steel, Stainless steel, Type 304, Stainless steel, Type 316.
 - c. Channel Width: 1-5/8 inch (41.25 mm), 1-1/4 inch (31.75 mm), 13/16 inch (20.64 mm).
 - d. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - e. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - f. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - g. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Aluminum Slotted Support Systems:
 - 1. Standard Features: Extruded-aluminum channels and angles with minimum 13/32 inch (10 mm) diameter holes at a maximum of 8 inch (200 mm) on center in at least one surface.
 - a. Referenced Standard: MFMA-4 factory-fabricated components for field assembly.
 - b. Channel Material: 6063-T5 aluminum alloy.
 - c. Fittings and Accessories Material: 5052-H32 aluminum alloy.

- d. Channel Width: 1-5/8 inch (41.25 mm), 1-1/4 inch (31.75 mm), 13/16 inch (20.64 mm).
 - e. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - f. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - g. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Conduit and Cable Support Devices:
- 1. Standard Features: Stainless steel, Glass-fiber-resin hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit:
- 1. Standard Features: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints:
- 1. Standard Features: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.
- 2.3 MOUNTING, ANCHORING, AND ATTACHMENT COMPONENTS
- A. Powder-Actuated Fasteners:
- 1. Standard Features: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors:
- 1. Standard Features: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
- C. Concrete Inserts:
- 1. Standard Features: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
- D. Clamps for Attachment to Steel Structural Elements:

1. Standard Features: MSS SP-58 units are suitable for attached structural element.
- E. Through Bolts:
1. Standard Features: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, **Grade A325** (**Grade A325M**).
- F. Toggle Bolts:
1. Standard Features: Stainless steel springhead type.
- G. Hanger Rods:
1. Standard Features: Threaded steel.

PART 3 - EXECUTION

3.1 SELECTION OF HANGERS AND SUPPORTS

- A. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as required by NFPA 70. Minimum rod size must be **1/4 inch** (**6 mm**) in diameter.
- B. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted [or other] support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps.
- C. Spring-steel clamps designed for supporting single conduits without bolts may be used for **1-1/2 inch** (**38 mm**) and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:
1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
 2. Hot Work: NFPA 51B.
 3. Work in Confined Spaces: NFPA 350.
 4. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.

5. Installation of Steel Conduit: NECA NEIS 101.
6. Installation of Aluminum Conduit: NECA NEIS 102.
7. Installation of Metal Cable Tray Systems: NECA NEIS 105.
8. Installation of Nonmetallic Cable Tray Systems: NECA NEIS 111.
9. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Raceway Support Methods: In addition to methods described in NECA NEIS 1, EMT, IMC and ERMIC may be supported by openings through structure members, in accordance with NFPA 70.
2. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb (90 kg).
3. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - a. To Wood: Fasten with lag screws or through bolts.
 - b. To New Concrete: Bolt to concrete inserts.
 - c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - d. To Existing Concrete: Expansion anchor fasteners.
 - e. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inch (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inch (100 mm) thick.
 - f. To Light Steel: Sheet metal screws.
 - g. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate[by means that comply with seismic-restraint strength and anchorage requirements].
4. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

D. Interfaces with Other Work:

1. Provide vibration and seismic controls with hangers and supports.
2. Touchup Finishes:
 - a. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

- 1) Apply paint by brush or spray to provide minimum dry film thickness of **2.0 mils (0.05 mm)**.
 - b. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
 - c. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.
3. Installation of Fabricated Metal Supports:
 - a. Provide site-fabricated metal supports.
 - b. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
 - c. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.
4. Installation of Concrete Bases:
 - a. Provide concrete bases of dimensions indicated, but not less than **4 inch (100 mm)** larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
 - b. Use **3000 psi (20.7 MPa)**, 28-day compressive-strength concrete.
 - c. Anchor equipment to concrete base as follows:
 - 1) Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2) Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3) Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION 260529

SECTION 260533.13
CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EMT duct raceways and elbows.
2. Type ENT duct raceways and fittings.
3. Type HDPE and Type EPEC duct raceways and fittings.
4. Type ERMC duct raceways, elbows, couplings, and nipples.
5. Type IMC duct raceways.
6. Type LFMC duct raceways.
7. Type PVC duct raceways and fittings.
8. Fittings for conduit, tubing, and cable.
9. Joint compounds.
10. Solvent cements.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
3. Section 260500 "Common Work Results for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" specifies nonmetallic underground conduit with conductors (Type NUCC).
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies conduit hangers and supports referenced by this Section.
6. Section 260543 "Underground Ducts and Raceways for Electrical Systems" specifies exterior duct banks, manholes, and underground utility construction.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.

2. EMT-A: Aluminum electrical metallic tubing.
3. EMT-S: Steel electrical metallic tubing.
4. EMT-SS: Stainless steel electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. EPEC: Electrical HDPE underground conduit (thin wall).
7. EPEC-A: Type A electrical HDPE underground conduit.
8. EPEC-B: Type B electrical HDPE underground conduit.
9. ERM: Electrical rigid metal conduit.
10. ERM-A: Aluminum electrical rigid metal conduit.
11. ERM-S: Steel electrical rigid metal conduit.
12. ERM-S-G: Galvanized-steel electrical rigid metal conduit.
13. ERM-S-PVC: PVC-coated-steel electrical rigid metal conduit.
14. ERM-SS: Stainless steel electrical rigid metal conduit.
15. FMC: Flexible metal conduit.
16. FMC-A: Aluminum flexible metal conduit.
17. FMC-S: Steel flexible metal conduit.
18. FMT: Steel flexible metallic tubing.
19. FNMC: Flexible nonmetallic conduit. See "LFNC."
20. HDPE: HDPE underground conduit (thick wall).
21. HDPE-40: Schedule 40 HDPE underground conduit.
22. HDPE-80: Schedule 80 HDPE underground conduit.
23. IMC: Steel electrical intermediate metal conduit.
24. LFMC: Liquidtight flexible metal conduit.
25. LFMC-A: Aluminum liquidtight flexible metal conduit.
26. LFMC-S: Steel liquidtight flexible metal conduit.
27. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
28. LFNC: Liquidtight flexible nonmetallic conduit.
29. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
30. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
31. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
32. PVC: Rigid PVC conduit.
33. PVC-40: Schedule 40 rigid PVC conduit.
34. PVC-80: Schedule 80 rigid PVC Conduit.
35. PVC-A: Type A rigid PVC concrete-encased conduit.
36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
37. RGS: See ERM-S-G.
38. RMC: See ERM.
39. RTRC: Reinforced thermosetting resin conduit.
40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

B. Definitions:

1. Conduit: A structure containing one or more duct raceways.
2. Direct Buried: Installed underground without encasement in concrete or other protective material.
3. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.
4. Duct Raceway: A single enclosed raceway for conductors or cable.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's published instructions.

1.5 QUALIFICATIONS

- A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.
- B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.
- C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 1. On-site electrical testing supervisors must possess active NICET EPT Technician [III] [IV] certification.
- D. ERM-C-S-PVC Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by ERM-C-S-PVC manufacturer prior to starting installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 TYPE EMT DUCT RACEWAYS AND ELBOWS

- A. UL FJMX - Aluminum Electrical Metal Tubing (EMT-A) and Elbows:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN FJMX; including UL 797A.
- 2. Standard Features:
 - a. Material: Aluminum.
 - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- 3. Required by the Project:
 - a. Colors: As indicated on the Drawings.

- B. UL FJMX - Stainless Steel Electrical Metal Tubing (EMT-SS) and Elbows:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN FJMX; including UL 797A.
- 2. Standard Features:
 - a. Material: Stainless steel.
 - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- 3. Other Available Features Required by the Project:
 - a. Colors: As indicated on the Drawings.

C. UL FJMX - Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN FJMX; including UL 797.
2. Standard Features:
 - a. Material: Steel.
 - b. Exterior Coating: Zinc or Alternate corrosion-resistant coating.
 - c. Interior Coating: Zinc with organic top coating or Zinc.
 - d. Minimum Trade Size: Metric designator 21 (trade size 3/4).
3. Other Available Features Required by the Project:
 - a. Colors: As indicated on the Drawings.

2.3 TYPE ENT DUCT RACEWAYS AND FITTINGS

A. UL FKHU - Electrical Nonmetallic Tubing (ENT) and Fittings:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN FKHU; including UL 1653.
2. Other Available Features Required by the Project:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - b. Fittings:
 - 1) Mechanically Attached Fittings: UL 1653.
 - 2) Solvent-Attached Fittings: UL 651.

2.4 TYPE HDPE AND TYPE EPEC DUCT RACEWAYS AND FITTINGS

A. UL EAZX - Schedule 40 Electrical HDPE Underground Conduit (HDPE-40):

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN EAZX; including UL 651A.
 2. Standard Features:
 - a. Dimensional Specifications: Schedule 40.
 3. Other Available Features Required by the Project:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- B. UL EAZX - Schedule 80 Electrical HDPE Underground Conduit (HDPE-80):
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN EAZX; including UL 651A.
 2. Standard Features:
 - a. Dimensional Specifications: Schedule 80.
 3. Other Available Features Required by the Project:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- C. UL EAZX - Type A Electrical HDPE Underground Conduit (EPEC-A):
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN EAZX; including UL 651A.
 2. Standard Features:
 - a. Dimensional Specifications: Type A.
 3. Sustainable Design Features:
 4. Other Available Features Required by the Project:

- a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- D. UL EAZX - Type B Electrical HDPE Underground Conduit (EPEC-B):
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN EAZX; including UL 651A.
 - 2. Standard Features:
 - a. Dimensional Specifications: Type B.
 - 3. Other Available Features Required by the Project:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.5 TYPE ERM C DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

- A. UL DYWV - Aluminum Electrical Rigid Metal Conduit (ERM C-A), Elbows, Couplings, and Nipples:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DYWV; including UL 6A.
 - 2. Standard Features:
 - a. Material: Aluminum.
 - b. Protective Coating: Provide protective coating for use in concrete, direct burial or use in severely corrosive environment.
 - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - 3. Other Available Features Required by the Project:
 - a. Colors: As indicated on the Drawings.
- B. UL DYWV - Stainless Steel Electrical Rigid Metal Conduit (ERM C-SS), Elbows, Couplings, and Nipples:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DYWV; including UL 6A.
 2. Standard Features:
 - a. Material: Stainless steel.
 - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 3. Other Available Features Required by the Project:
 - a. Colors: As indicated on the Drawings.
- C. UL DYIX - Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DYIX; including UL 6.
 2. Standard Features:
 - a. Exterior Coating: Zinc.
 - b. Interior Coating: Zinc with organic top coating or Zinc.
 - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 3. Other Available Features Required by the Project:
 - a. Colors: As indicated on the Drawings.
- D. UL DYIX - PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DYIX; including UL 6.
 2. Standard Features:
 - a. Exterior Coating: PVC complying with NEMA RN 1.

- b. Interior Coating: Zinc with organic top coating or Zinc.
 - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- 3. Other Available Features Required by the Project:
 - a. Colors: As indicated on the Drawings.
 - b. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
 - c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

2.6 TYPE IMC DUCT RACEWAYS

A. UL DYBY - Steel Intermediate Metal Conduit (IMC):

- 1.
- 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DYBY; including UL 1242.
- 3. Standard Features:
 - a. Exterior Coating: Zinc or Alternative corrosion-resistant coating.
 - b. Interior Coating: Zinc with organic top coating or Zinc.
 - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- 4. Other Available Features Required by the Project:
 - a. Colors: As indicated on the Drawings.

2.7 TYPE LFMC DUCT RACEWAYS

A. UL DXHR - Steel Liquidtight Flexible Metal Conduit (LFMC-S):

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DXHR; including UL 360.
- 2. Standard Features:
 - a. Material: Steel.
 - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).

3. Other Available Features Required by the Project:

- a. Colors: As indicated on the Drawings.

B. UL DXHR - Stainless Steel Liquidtight Flexible Metal Conduit (LFMC-SS):

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. UL CCN DXHR; including UL 360.

2. Standard Features:

- a. Material: Stainless steel.
- b. Minimum Trade Size: Metric designator 21 (trade size 3/4).

3. Other Available Features Required by the Project:

- a. Colors: As indicated on the Drawings.

2.8 TYPE PVC DUCT RACEWAYS AND FITTINGS

A. UL DZYR - Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. UL CCN DZYR; including UL 651.

2. Standard Features:

- a. Dimensional Specifications: Schedule 40.
- b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- c. Markings: For use with maximum 90 deg C wire.

B. UL DZYR - Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. UL CCN DZYR; including UL 651.

2. Standard Features:

- a. Dimensional Specifications: Schedule 80.
- b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- c. Markings: For use with maximum 90 deg C wire.

C. UL DZYS - Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. UL CCN DZYS; including UL 651.

2. Standard Features:

- a. Dimensional Specifications: Type A.
- b. Minimum Trade Size: Metric designator 21 (trade size 3/4).

D. UL DZYS - Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. UL CCN DZYS; including UL 651.

2. Standard Features:

- a. Dimensional Specifications: Type EB.
- b. Minimum Trade Size: Metric designator 53 (trade size 2).

2.9 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. UL EBMB - Duct Fittings for Hazardous (Classified) Locations:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. UL CCN EBMB; including UL 1203.

B. UL DWTT - Fittings for Type ERM, Type IMC, Type PVC, Type HDPE, Type EPEC, and Type RTRC Duct Raceways:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DWTT; including UL 514B.
 2. Standard Features:
 - a. Material: Steel or Die cast.
 - b. Coupling Method: Compression coupling or Raintight compression coupling with distinctive color gland nut.
 - c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.
- C. UL FKA V - Fittings for Type EMT Duct Raceways:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN FKA V; including UL 514B.
 2. Standard Features:
 - a. Material: Steel or Die cast.
 - b. Coupling Method: Compression coupling or Raintight compression coupling with distinctive color gland nut.
 - c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.
- D. UL ILNR - Fittings for Type FMC Duct Raceways:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN ILNR; including UL 514B.
- E. UL DXAS - Fittings for Type LFMC and Type LFNC Duct Raceways:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN DXAS; including UL 514B.

2.10 JOINT COMPOUNDS

A. UL FOIZ - Electrically Conductive Corrosion-Resistant Compound for Threaded Conduit:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN FOIZ; including UL Subject 2419.

2.11 SOLVENT CEMENTS

A. UL VBEW - Solvent Cements for Nonmetallic Duct Raceways and Fittings:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Solvent Cements: UL CCN VBEW; including UL 340.
 - b. Solvent Cement Compatibility with PVC Conduit Fittings: UL CCN DWTT; including UL 514B. Follow solvent manufacturer's published instructions.
 - c. Solvent Cement Compatibility with Rigid PVC Conduit: UL CCN DZYR; including UL 651. Follow solvent manufacturer's published instructions.
 - d. Solvent Cement Compatibility with Rigid EPEC and HDPE Underground Conduit: UL CCN EAZX; including UL 651A. Follow solvent manufacturer's published instructions.

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

- A. Unless more stringent requirements are specified in the Contract Documents or manufacturer's published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.
- B. Special Instructions Regarding HDPE Conduits: Although Article 353 of NFPA 70 permits use of HDPE conduits where encased in concrete aboveground, UL CCN EAZX listing requirements state that HDPE and EPEC underground conduits are intended only for use where direct buried with or without being encased in concrete. Specified Type HDPE and Type EPEC underground conduits are not permitted to be used aboveground on the Project.
- C. Outdoors:

1. Exposed and Subject to Severe Physical Damage: ERM, IMC.
2. Exposed and Subject to Physical Damage: ERM, IMC, Corrosion-resistant EMT.
3. Exposed and Not Subject to Physical Damage: ERM, IMC, Corrosion-resistant EMT, PVC-80.
4. Direct Buried: PVC-80, PVC-40, HDPE-80, HDPE-40.
5. Concrete Encased Not in Trench: PVC-80, PVC-40, PVC-A.
6. Concrete Encased in Trench: PVC-80, PVC-40, PVC-A, PVC-EB, HDPE-80, HDPE-40.
7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

D. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

1. ERM and IMC: Provide threaded-type fittings unless otherwise indicated.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFB, NFPA 1, NFPA 70, and NFPA 70E.
2. Electrical Safety: NFPA 70E.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Grounding and Bonding: NFPA 70E and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NFPA 70E 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Type EMT-A: Article 358 of NFPA 70 and NFPA 70E 102.
11. Type EMT-SS: Article 358 of NFPA 70 and NFPA 70E 101.
12. Type EMT-S: Article 358 of NFPA 70 and NFPA 70E 101.
13. Type ENT: Article 362 of NFPA 70 and NFPA 70E 102.
14. Type HDPE and Type EPEC: Article 353 of NFPA 70 and NFPA 70E 111.
15. Type ERM-A: Article 344 of NFPA 70 and NFPA 70E 102.
16. Type ERM-SS: Article 344 of NFPA 70 and NFPA 70E 101.
17. Type ERM-S: Article 344 of NFPA 70 and NFPA 70E 101.
18. Type FMC-S: Article 348 of NFPA 70 and NFPA 70E 101.
19. Type FMC-A: Article 348 of NFPA 70 and NFPA 70E 102.
20. Type FMT: Article 360 of NFPA 70 and NFPA 70E 101.
21. Type IMC: Article 342 of NFPA 70 and NFPA 70E 101.
22. Type LFMC: Article 350 of NFPA 70 and NFPA 70E 101.
23. Type LFNC: Article 342 of NFPA 70 and NFPA 70E 111.
24. Type PVC: Article 356 of NFPA 70 and NFPA 70E 111.

25. Type RTRC: Article 355 of NFPA 70 and NECA NEIS 111.
26. Expansion Fittings: NEMA FB 2.40.
27. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. General Requirements for Installation of Duct Raceways:

- a. Complete duct raceway installation before starting conductor installation.
- b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of **2 ft (0.6 m)** above finished floor.
- c. Install no more than equivalent of three 90-degree bends in conduit run. Support within **12 inch (300 mm)** of changes in direction.
- d. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
- e. Support conduit within **12 inch (300 mm)** of enclosures to which attached.
- f. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.
- g. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways at the following points:
 - 1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2) Where an underground service duct raceway enters a building or structure.
 - 3) Conduit extending from interior to exterior of building.
 - 4) Conduit extending into pressurized duct raceway and equipment.
 - 5) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 - 6) Where otherwise required by NFPA 70.
- h. Do not install duct raceways or electrical items on "explosion-relief" walls or rotating equipment.
- i. Do not install conduits within **2 inch (50 mm)** of the bottom side of a metal deck roof.
- j. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
- k. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than **200 lb (90 kg)** tensile strength. Leave at least **12 inch (300 mm)** of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.

- l. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
 - 1) Termination fittings with shoulders do not require two locknuts.
 - m. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts.
2. Types EMT-A, ERM-C-A, and FMC-A: Do not install aluminum duct raceways or fittings in contact with concrete or earth.
3. Types ERM-C and IMC:
 - a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.
4. Type ERM-C-S-PVC:
 - a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
 - b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERM-C-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERM-C-S-PVC duct raceway.
 - c. Coat field-cut threads on PVC-coated duct raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.
5. Types PVC, HDPE, and EPEC:
 - a. Do not install Type PVC, Type HDPE, or Type EPEC conduit where ambient temperature exceeds 122 deg F (50 deg C). Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
 - b. Comply with manufacturer's published instructions for solvent welding and fittings.
 - c. Join joints with solvent cement in accordance with manufacturer's published instructions and allowed to cure before handling. Joints to be bent, pushed, or pulled must set for minimum 24 h after joining.
6. Duct Raceways Embedded in Slabs:

- a. Run duct raceways larger than metric designator 27 (trade size 1) below concrete slab [Run duct raceways larger than metric designator 27 (trade size 1) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place duct raceway close to slab support. Secure duct raceways to reinforcement at maximum 10 ft (3 m) intervals.
 - b. Arrange duct raceways to cross building expansion joints with expansion fittings at right angles to the joint.
 - c. Arrange duct raceways to ensure that each is surrounded by minimum of 1 inch (25 mm) of concrete without voids.
 - d. Do not embed threadless fittings in concrete unless locations have been specifically approved by Architect.
 - e. Change from ENT to PVC-80, PVC-40, ERM C or IMC before rising above floor.
7. Stub-ups to Above Recessed Ceilings:
- a. Provide EMT, IMC, or ERM C for duct raceways.
 - b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
8. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:
- a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG.
9. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
- a. ERM C-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 - b. EMT: Provide compression, steel or cast-metal fittings. Comply with NEMA FB 2.10.
 - c. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.
10. Expansion-Joint Fittings:
- a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg F (17 deg C) and that have straight-run length that exceeds 25 ft (7.6 m). Install in runs of aboveground ERM C and EMT conduit that are located where environmental temperature change may exceed 100 deg F (55 deg C) and that have straight-run length that exceeds 100 ft (30 m).
 - b. Install type and quantity of fittings that accommodate temperature change listed for the following locations:
 - 1) Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.

- 2) Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
- c. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
- d. Install expansion fittings at locations where conduits cross building or structure expansion joints.
- e. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
11. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.
 - a. Provide warning signs.

D. Interfaces with Other Work:

1. Provide conduit hangers and supports.

3.3 FIELD QUALITY CONTROL OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Administrant for Electrical Power Tests and Inspections:

1. Owner will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections with assistance of factory-authorized service representative.

B. Administrant for Communications Tests and Inspections:

1. Owner will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.

3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
 4. Administer and perform tests and inspections with assistance of factory-authorized service representative.
- C. Field tests and inspections must be witnessed by authorities having jurisdiction.
- D. Tests and Inspections:
1. Perform manufacturer's recommended tests and inspections.
 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum **12 inch (300 mm)** long mandrel equal to duct size minus **1/4 inch (6 mm)**. If obstructions are indicated, remove obstructions and retest.
 3. Conduit Placement:
 - a. Verify that center-line location and offsets are in accordance with the Drawings.
 - b. Verify that hangers and supports for conduits are attached to structure.
 - c. Verify that nuts on bolts or hanger rods are secure.
 - d. Verify that space between raceways and cored holes are filled with non-shrinking grout or other approved material indicated on the Drawings and the Specifications.
 - e. Verify that expansion devices are installed at locations indicated on the Drawings and the Specifications.
 - f. Verify that ends are cut square to provide flush-butting surfaces when spliced and inside edges are free of burrs that could impede installation of cables.
 - g. Verify minimum separation of utilities, or that approved mechanical protection has been provided to surrounding conduit(s) where minimum separation cannot be achieved.
 4. Document all changes on Record Drawings.
- E. Nonconforming Work:
1. Conduit will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective units and retest.
- F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLEANING

- A. Verify that bentonite or other drilling fluids are contained and removed, and site is restored to its original or improved condition.

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SKOWHEGAN RIVERFRONT WALKWAY
Skowhegan, Maine

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533.13

SECTION 260533.16
BOXES AND COVERS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Nonmetallic outlet boxes, device boxes, rings, and covers.
3. Junction boxes and pull boxes.
4. Cover plates for device boxes.
5. Hoods for outlet boxes.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
3. Section 260500 "Common Work Results for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
6. Section 260573 "Power System Studies" specifies arc-flash hazard analysis and warning labels referenced by this Section.

1.2 DEFINITIONS

- A. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
- B. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:

1. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
2. Concrete Box: A box intended for use in poured concrete.
3. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
4. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
5. Cover Plate: A cover designed for protecting wiring devices installed in flush-mounted device boxes while permitting their safe operation; also called a faceplate or wallplate.
6. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
7. Device Box: A box with provisions for mounting a wiring device directly to the box.
8. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
9. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
10. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
11. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
12. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
13. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
14. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
15. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
16. Raised-Floor Box: A floor box intended for use in raised floors.
17. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
18. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
19. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
20. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
21. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.

- 22. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
- 23. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each type of product requiring samples for source quality control.
- C. Shop Drawings: Prepare and submit the following:
 - 1. Shop Drawings for Floor Boxes: Show that floor boxes are located to avoid interferences and are structurally allowable. Indicate floor thickness [at location] where boxes are embedded in concrete floors and underfloor clearances where boxes are installed in raised floors.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's published instructions.

1.5 QUALIFICATIONS

- A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.
- B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.
- C. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician I: Possessing active NICET I&TFAS Level I certification. Able to perform periodic inspections and tests of basic fire-alarm systems and prepare related records and reports.
- D. Inspection and Testing of Fire-Alarm Systems (I&TFAS) Technician II: Possessing active NICET I&TFAS Level II certification. Able to plan, perform, and coordinate periodic inspections and tests of complex fire-alarm systems (including one or more of suppression interfaces, networked control units, smoke control interfaces, air sampling systems, multi-zone voice evacuation systems, or high-rise applications) and prepare related records and reports.

- E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - 1. On-site electrical testing supervisors must possess active NICET EPT Technician [III] [IV] certification.
- F. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - 1. On-site communications testing supervisor must have BICSI Technician (TECH) certification and documented training, and be experienced with testing communications equipment in accordance with BICSI testing standards.
- G. Security Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - 1. On-site security testing supervisor must have ASIS certification and documented training and experience with testing security equipment in accordance with ASIS testing standards.
- H. Fire-Alarm Testing Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - 1. On-site fire-alarm testing supervisor must possess active NICET I&TFAS Technician [I] [II] certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

- A. Source Quality Control:
 - 1. Samples:
 - a. Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.

- b. Raised Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
- c. Recessed Access-Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
- d. Concrete Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.

B. UL QCIT - Metallic Outlet Boxes and Covers:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCIT; including UL 514A.
- 2. Standard Features:
 - a. Box having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
 - b. Material: Sheet steel, Sheet aluminum or Cast metal.
 - c. Sheet Metal Depth: Minimum 1.5 inch (38 mm).
 - d. Cast-Metal Depth: Minimum 1.8 inch (44.5 mm).
- 3. Other Available Features Required by the Project:
 - a. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing up to 50 lb (23 kg).
 - b. Paddle Fan Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to 70 lb (32 kg).

C. UL QCIT - Metallic Conduit Bodies:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCIT; including UL 514A.

2. Standard Features: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
- D. UL QCIT - Metallic Device Boxes:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCIT; including UL 514A.
 2. Standard Features:
 - a. Box with provisions for mounting wiring device directly to box.
 - b. Material: Sheet steel, Sheet aluminum or Cast metal.
 - c. Sheet Metal Depth: minimum 1.5 inch (38 mm).
 - d. Cast-Metal Depth: minimum 1.8 inch (44.5 mm).
- E. UL QCIT - Metallic Extension Rings:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCIT; including UL 514A.
 2. Standard Features: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.
- F. UL QCIT - Metallic Floor Boxes and Floor Box Covers:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCIT; including UL 514A.
 2. Standard Features: Box mounted in floor with floor box cover and other components to complete floor box enclosure.
- G. UL QCIT - Metallic Raised-Floor Boxes and Floor Box Covers:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCIT; including UL 514A.
2. Standard Features: Box mounted in raised-floor with floor box cover and other components to complete floor box enclosure.

H. UL QCIT - Metallic Recessed Access-Floor Boxes and Recessed Floor Box Covers:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCIT; including UL 514A.
2. Standard Features: Floor box with provisions for mounting wiring devices below floor surface and floor box cover with provisions for passage of cords to recessed wiring devices mounted within floor box.

I. UL QCIT - Metallic Concrete Boxes and Covers:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCIT; including UL 514A.
2. Standard Features: Box intended for use in poured concrete.

2.3 NONMETALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Source Quality Control:

1. Samples:
 - a. Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
 - b. Raised Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.

- c. Recessed Access-Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
 - d. Concrete Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
- B. UL QCMZ - Nonmetallic Outlet Boxes and Covers:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCMZ; including UL 514C.
 - 2. Standard Features: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
- C. UL QCMZ - Nonmetallic Conduit Bodies:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCMZ; including UL 514C.
 - 2. Standard Features: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
- D. UL QCMZ - Nonmetallic Device Boxes:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCMZ; including UL 514C.
 - 2. Standard Features: Box with provisions for mounting wiring device directly to box.
 - 3. Sustainable Design Features:
- E. UL QCMZ - Nonmetallic Extension Rings:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCMZ; including UL 514C.
 2. Standard Features: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.
- F. UL QCMZ - Nonmetallic Floor Boxes and Floor Box Covers:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCMZ; including UL 514C.
 2. Standard Features: Box mounted in floor with floor box cover and other components to complete floor box enclosure.
- G. UL QCMZ - Nonmetallic Raised-Floor Boxes and Floor Box Covers:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCMZ; including UL 514C.
 2. Standard Features: Box mounted in raised-floor with floor box cover and other components to complete floor box enclosure.
- H. UL QCMZ - Nonmetallic Recessed Access-Floor Boxes and Recessed Floor Box Covers:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCMZ; including UL 514C.
 2. Standard Features: Floor box with provisions for mounting wiring devices below floor surface and floor box cover with provisions for passage of cords to recessed wiring devices mounted within floor box.
- I. UL QCMZ - Nonmetallic Floor Nozzles:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCMZ; including UL 514C.
2. Standard Features: Enclosure intended primarily as housing for receptacle, provided with means, such as collar, for surface-mounting on floor, which may or may not include stem to support it above floor level, and is sealed against the entrance of scrub water at floor level.

J. UL QCMZ - Nonmetallic Concrete Boxes and Covers:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCMZ; including UL 514C.
2. Standard Features: Box intended for use in poured concrete.

2.4 JUNCTION BOXES AND PULL BOXES

A. UL BGUZ - Outdoor Sheet Metal Junction and Pull Boxes:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN BGUZ; including UL 50 and UL 50E.
2. Standard Features:
 - a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
 - b. Degree of Protection: Type 4X.

B. UL BGUZ - Outdoor Cast-Metal Junction and Pull Boxes:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

- a. UL CCN BGUZ; including UL 50 and UL 50E.
 - 2. Standard Features:
 - a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
 - b. Degree of Protection: Type 4X.
 - C. UL BGUZ - Outdoor Polymeric Junction and Pull Boxes:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN BGUZ; including UL 50 and UL 50E.
 - 2. Standard Features:
 - a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
 - b. Degree of Protection: Type 4X.
- 2.5 COVER PLATES FOR DEVICE BOXES
- A. UL QCIT or QCMZ - Metallic Cover Plates for Device Boxes:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
 - 2. Standard Features:
 - a. Cover plate-Securing Screws: Metal with head color to match cover plate finish.
 - b. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
 - c. Cover Plate Material: 0.032 inch (0.8 mm) thick, Type 302/304 non-magnetic stainless steel with brushed finish 0.040 inch (1.0 mm) thick aluminum, anodized or lacquered to prevent corrosion 0.04 inch (1 mm) thick, brushed brass with factory polymer finish, Galvanized steel, Cast aluminum or As indicated on architectural Drawings.
 - B. UL QCIT or QCMZ - Nonmetallic Cover Plates for Device Boxes:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
 2. Standard Features:
 - a. Cover Plate-Securing Screws: Metal with head color to match cover plate finish.
 - b. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
 - c. Cover Plate Material: **[0.060 inch (1.5 mm)]** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device or As indicated on architectural Drawings.
 - d. Color: indicated on architectural Drawings.
- C. UL QCIT or QCMZ - Illuminating Cover Plates for Device Boxes:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
 2. Standard Features:
 - a. Cover Plate-Securing Screws: Metal with head color to match cover plate finish.
 - b. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
 - c. Cover Plate Material: **[0.060 inch (1.5 mm)]** thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device or As indicated on architectural Drawings.
 - d. Color: As indicated on architectural Drawings.

2.6 HOODS FOR OUTLET BOXES

- A. UL QCIT or QCMZ - Extra-Duty, While-in-Use Hoods for Outlet Boxes:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.

- b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.
- 2. Standard Features:
 - a. Mounts to box using fasteners different from wiring device.
 - b. Marked "Extra-Duty" in accordance with UL 514D.
 - c. Provides clear, weatherproof, "while-in-use" cover.
 - d. Manufacturer may combine nonmetallic device box with hood as extra-duty rated assembly.

PART 3 - EXECUTION

3.1 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.
- B. Degree of Protection:
 - 1. Outdoors:
 - a. Type 3R unless otherwise indicated.
 - b. Locations Exposed to Hosedown: Type 4X.
 - c. Locations Subject to Potential Flooding: Type 6P.
 - d. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.
 - e. Locations in-Ground or Exposed to Corrosive Agents: Type 4X].
 - f. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.
- C. Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:
 - 1. Provide cast-metal boxes, Boxes with knockouts or unprotected openings are prohibited.
 - 2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.2 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
11. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
2. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
3. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
4. Locate boxes so that cover or plate will not span different building finishes.
5. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
6. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
7. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
8. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
9. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:
 - a. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
 - b. Provide gaskets for cover plates and covers.

D. Interfaces with Other Work:

1. Identification: Provide labels for boxes and associated electrical equipment.
 - a. Identify field-installed conductors, interconnecting wiring, and components.
 - b. Label each enclosure with engraved metal or laminated-plastic nameplate.
 - c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
2. Coordinate installation of new products for with existing conditions.

3.3 FIELD QUALITY CONTROL OF BOXES AND COVERS

- A. Administrant for Electrical Power Tests and Inspections:
 - 1. Owner will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
 - 2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
 - 3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
 - 4. Administer and perform tests and inspections with assistance of factory-authorized service representative.
- B. Field tests and inspections must be witnessed by authorities having jurisdiction.
- C. Tests and Inspections:
 - 1. Perform manufacturer's recommended tests and inspections.
 - 2. Perform tests and inspections recommended by standards listed in "Reference Standards for Installation" Paragraph.
- D. Nonconforming Work:
 - 1. Boxes and covers will be considered defective if they do not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLEANING

- A. Remove construction dust and debris from boxes before installing cover plates, covers, and hoods.

3.5 PROTECTION

- A. After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260533.16

SECTION 260533.23
SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Surface metal raceways and fittings.
2. Surface nonmetallic raceways.
3. Strut-type channel raceways and fittings.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, and other structural design conditions applicable to the Work specified in this Section.
3. Section 260500 "Common Work Results for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260553 "Identification for Electrical Systems" specifies warning signs referenced by this Section.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each type of product requiring samples for source quality control.
- C. Manufacturer's published instructions.

1.3 QUALIFICATIONS

- A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

- B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.
- C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - 1. On-site electrical testing supervisors must possess active NICET EPT Technician [III] [IV] certification.
- D. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - 1. On-site communications testing supervisor must have BICSI Technician (TECH) certification and documented training, and be experienced with testing communications equipment in accordance with BICSI] testing standards.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 SURFACE METAL RACEWAYS AND FITTINGS

- A. Source Quality Control:
 - 1. Samples:
 - a. Surface Metallic Raceway Nonmetallic Cover Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, 12 inch (300 mm) long.
- B. UL RJBT - Surface Metal Raceways and Fittings with Metal Covers:
 - 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN RJBT; including UL 5.

2. Standard Features:

- a. Galvanized steel, Aluminum base with snap-on covers.
- b. Manufacturer's standard enamel finish in color selected by Architect.

C. UL RJBT - Surface Metal Raceways and Fittings with Nonmetallic Covers:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN RJBT; including UL 5.
- 2. Standard Features:
 - a. UL 94, V-0 requirements for self-extinguishing characteristics.
 - b. Galvanized steel, Aluminum base with snap-on covers.
 - c. Provide texture and color selected by Architect from manufacturer's standard colors.

2.3 SURFACE NONMETALLIC RACEWAYS

A. Source Quality Control:

- 1. Samples:
 - a. Surface Nonmetallic Raceway Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, 12 inch (300 mm) long.

B. UL RJTX - Surface Nonmetallic Raceways and Fittings with Nonmetallic Covers:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN RJTX; including UL 5A.
 - b. UL 94, V-0 requirements for self-extinguishing characteristics.
- 2. Standard Features:
 - a. Provide texture and color selected by Architect from manufacturer's standard colors.

C. UL RJTX - Surface Nonmetallic Raceways and Fittings with Metallic Covers:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN RJTX; including UL 5A.
 - b. UL 94, V-0 requirements for self-extinguishing characteristics.
2. Standard Features:
 - a. Manufacturer's standard enamel finish in color selected by Architect.

2.4 STRUT-TYPE CHANNEL RACEWAYS AND FITTINGS

A. Source Quality Control:

1. Samples:
 - a. Strut-Type Channel Raceway Nonmetallic Covers for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, 12 inch (300 mm) long.

B. UL RIUU - Strut-Type Channel Raceways and Fittings with Metallic Covers:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN RIUU; including UL 5B.
2. Standard Features:
 - a. Manufacturer's standard enamel finish in color selected by Architect.

C. UL RIUU - Strut-Type Channel Raceways and Fittings with Nonmetallic Covers:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. UL CCN RIUU; including UL 5B.
 - b. UL 94, V-0 requirements for self-extinguishing characteristics.

2. Standard Features:

- a. UL 94, V-0 requirements for self-extinguishing characteristics.
- b. Provide texture and color selected by Architect from manufacturer's standard colors.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFB, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Communications Work: BICSI N1.
5. Work in Confined Spaces: NFPA 350.
6. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
7. Auxiliary Gutters: Article 366 of NFPA 70.
8. Surface Metal Raceway: Article 386 of NFPA 70.
9. Surface Nonmetallic Raceway: Article 388 of NFPA 70.
10. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Install surface raceways only where indicated on Drawings.
2. Install surface raceway with a minimum 2 inch (50 mm) radius control at bend points.
3. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inch (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway in accordance with manufacturer's published instructions. Tape and glue are unacceptable support methods.

D. Interfaces with Other Work:

1. Identification: Provide labels for surface raceways and associated electrical equipment.
 - a. Identify field-installed conductors, interconnecting wiring, and components.
 - b. Provide warning signs.

3.2 FIELD QUALITY CONTROL OF SURFACE RACEWAYS

A. Administrant for Electrical Power Tests and Inspections:

1. Owner will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

B. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform tests and inspections recommended by standards listed in "Reference Standards for Installation" Paragraph.

C. Nonconforming Work:

1. Boxes and covers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.3 CLEANING

- #### A. Remove construction dust and debris from surface raceways before installing covers.

3.4 PROTECTION

- #### A. After installation, protect surface raceways from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260533.23

SECTION 260543
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EPEC raceways and fittings.
2. Type ERMCS raceways, elbows, couplings, and nipples.
3. Type ERMCS raceways, elbows, couplings, and nipples.
4. Type IMC raceways.
5. Type PVC raceways and fittings.
6. Type RTRC-BG raceways and fittings.
7. Fittings for conduit, tubing, and cable.
8. Electrically conductive corrosion-resistant compounds for threaded conduit.
9. Solvent cements.
10. Duct accessories.
11. Handholes and boxes for exterior underground wiring.
12. Manholes for exterior underground wiring.
13. Utility structure accessories.
14. Duct sealing.

B. Related Requirements:

1. Section 260500 "Common Work Results for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" specifies nonmetallic underground conduit with conductors (Type NUCC).
3. Section 260553 "Identification for Electrical Systems" specifies underground-line warning tape and concrete cable routing markers (warning planks).

1.2 ALLOWANCES

- A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1.3 UNIT PRICES

- A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

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1.4 ALTERNATES

- A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.5 DEFINITIONS

- A. Duct: A single raceway or multiple raceways, installed singly or as components of a duct bank.
- B. Duct Bank: Two or more ducts installed in parallel, direct buried or with additional casing materials such as concrete.
- C. Handhole: An underground chamber containing electrical cables, sized such that personnel are not required to enter in order to access the cables.
- D. Manhole: An underground chamber containing electrical cables and equipment, sized to provide access with working space clearances.
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.6 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.
- B. Preinstallation Coordination Meeting(s): For underground ducts and raceways. Conduct meeting(s) as videoconference.
 - 1. Attendees: Installers, fabricators, representatives of manufacturers, and administrators for field tests and inspections. Notify Architect, Construction Manager, and Owner's Commissioning Authority of scheduled meeting dates.

1.7 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For concrete and steel used in precast concrete manholes and handholes, also include product certificates as required by ASTM C858.
- B. Shop Drawings:
 - 1. Electric Utility Duct Banks and Structures:
 - a. Include plans, elevations, sections, and details, including attachments to other Work.
 - b. Indicate locations of private property boundaries and utility easements.

- c. Include information required for approval by electric utility and for obtaining public space utility work permits.
 - 2. Precast or Factory-Fabricated Concrete Structures:
 - a. Include plans, elevations, sections, and details, including attachments to other Work.
 - b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
 - c. Include reinforcement details.
 - d. Include frame and cover design and manhole chimneys.
 - e. Include ladder details.
 - f. Include grounding details.
 - g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, sumps, and other accessories.
 - h. Include joint details.
 - 3. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
 - a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
 - b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
 - c. Include cover design.
 - d. Include grounding details.
 - e. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and other accessories.
 - C. Field quality-control reports.
- 1.8 INFORMATIONAL SUBMITTALS
- A. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
 - B. Field Reports:
 - 1. Factory Test Reports: For handholes and boxes.
 - 2. Manufacturer's field reports for field quality-control support.
- 1.9 MAINTENANCE MATERIAL SUBMITTALS
- A. Spare Parts: Furnish to Owner spare parts necessary for repairing or adding more cables to manholes or handholes that are packaged with protective covering for storage and identified with labels describing contents.

1. Cable-Support Stanchions, Arms, and Associated Fasteners: Five percent of quantity of each item installed.
2. Insulators: Five percent of quantity of each item installed.

1.10 REGULATORY AGENCY APPROVALS

- A. Shop Drawing submittals for electric utility duct banks and structures must be signed and sealed by qualified electrical professional engineer responsible for their preparation. Obtain approval by electric utility prior to submitting for action by Architect.
- B. Submit Shop Drawings for electric utility duct banks and structures for action by Architect prior to submitting for approval by electric utility.

PART 2 - PRODUCTS

2.1 TYPE EPEC RACEWAYS AND FITTINGS

- A. Performance Criteria:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics: UL 651A and UL CCN EAZX.
- B. Schedule 40 Electrical HDPE Underground Conduit (EPEC-40):
 1. Dimensional Specifications: Schedule 40.
 2. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- C. Schedule 80 Electrical HDPE Underground Conduit (EPEC-80):
 1. Dimensional Specifications: Schedule 80.
 2. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- D. Type A Electrical HDPE Underground Conduit (EPEC-A):
 1. Dimensional Specifications: Type A.
 2. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

E. Type B Electrical HDPE Underground Conduit (EPEC-B):

1. Dimensional Specifications: Type B.
2. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.2 TYPE ERM-C-SS RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 6A and UL CCN DYWV.

B. Stainless Steel Electrical Rigid Metal Conduit (ERM-C-SS), Elbows, Couplings, and Nipples:

1. Material: Stainless steel.
2. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - b. Colors: As indicated on Drawings.

2.3 TYPE ERM-C-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 6 and UL CCN DYIX.

B. Galvanized-Steel Electrical Rigid Metal Conduit (ERM-C-S-G), Elbows, Couplings, and Nipples:

1. Exterior Coating: Zinc.
2. Options:
 - a. Interior Coating: Zinc with organic top coating or Zinc.
 - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - c. Colors: As indicated on Drawings.

C. PVC-Coated-Steel Electrical Rigid Metal Conduit (ERM-C-S-PVC), Elbows, Couplings, and Nipples:

1. Additional Characteristics:

2. Fittings for PVC-Coated Conduit:

- a. Minimum coating thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- b. Conduit bodies must be Form 8 with effective seal and positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig (positive) and 25 inch Hg (vacuum) for 72 hours must be available. Conduit bodies must be supplied with plastic-encapsulated stainless steel cover screws.
- c. Form 2 inch (51 mm) long or one pipe diameter long, whichever is less, PVC sleeve at openings of female fittings, except unions. Inside sleeve diameter must be matched to outside diameter of metal conduit.
- d. PVC coating on outside of conduit couplings must be protected from tool damage during installation.
- e. Female threads on fittings and couplings must be protected by urethane coating.
- f. Fittings must be from same manufacturer as conduit.
- g. Beam clamps and U bolts must be formed and sized to fit outside diameter of coated conduit. Plastic-encapsulated nuts must cover exposed portions of threads.

3. Options:

- a. Exterior Coating: PVC complying with NEMA RN 1 and marked ETL Verified PVC-001.
- b. Interior Coating: Zinc with organic top coating or Zinc.
- c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- d. Colors: As indicated on Drawings.
- e. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
- f. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

2.4 TYPE IMC RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 1242 and UL CCN DYBY.

B. Steel Electrical Intermediate Metal Conduit (IMC):

1. Options:

- a. Exterior Coating: Zinc or Alternative corrosion-resistant coating.
- b. Interior Coating: Zinc with organic top coating or Zinc.
- c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- d. Colors: As indicated on Drawings.

2.5 TYPE PVC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 651 and UL CCN DZYR.

B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Dimensional Specifications: Schedule 40.
2. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - b. Markings: For use with maximum 90 deg C wire.

C. Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:

1. Dimensional Specifications: Schedule 80.
2. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - b. Markings: For use with maximum 90 deg C wire.

D. Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:

1. Dimensional Specifications: Type A.
2. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

E. Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:

1. Dimensional Specifications: Type EB.
2. Options:
 - a. Minimum Trade Size: Metric designator 53 (trade size 2).

2.6 TYPE RTRC-BG RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 2420 and UL CCN DZKT, for Type BG.

B. Low-Halogen, Belowground Reinforced Thermosetting Resin Conduit (RTRC-BG) and Fittings:

1. Options:

a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.7 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

B. Metallic Fittings for Type ERM, Type IMC, Type PVC, Type EPEC, and Type RTRC Raceways:

1. General Characteristics: UL 514B and UL CCN DWTT.

2. Options:

a. Material: Steel or Die cast.

b. Coupling Method: Raintight compression coupling with distinctive color gland nut.

c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.

d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

2.8 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL Subject 2419 and UL CCN FOIZ.

2.9 SOLVENT CEMENTS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL CCN DWTT.

2.10 DUCT ACCESSORIES

- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

2.11 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- 2. General Characteristics:
 - a. ASTM C858 for design and manufacturing processes.
 - b. SCTE 77.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover:

- 1. Description: Molded of sand, concrete, and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or combination.
- 2. Configuration: Units must be designed for flush burial and have open bottom unless otherwise indicated.
- 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and installed location.
 - a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
 - b. Cover Legend: Molded lettering, "ELECTRIC".
- 4. Conduit Entrance Provisions: Conduit-terminating fittings must mate with entering ducts for secure, fixed installation in enclosure wall.
- 5. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- 6. Duct Entrance Provisions: Duct-terminating fittings must mate with entering duct for secure, fixed installation in enclosure wall.
- 7. Handholes **12 inch wide by 24 inch long** (300 mm wide by 600 mm long) and larger must have factory-installed inserts for cable racks and pulling-in irons.
- 8. Options:
 - a. Color: Gray.

C. Fiberglass Handholes and Boxes:

- 1. Description: Molded of fiberglass-reinforced polyester resin, with covers made of reinforced fiberglass.

2. Configuration: Units must be designed for flush burial and have open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
 - b. Cover Legend: Molded lettering, "ELECTRIC".
4. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
5. Duct Entrance Provisions: Duct-terminating fittings must mate with entering duct for secure, fixed installation in enclosure wall.
6. Handholes 12 inch wide by 24 inch long (300 mm wide by 600 mm long and larger must have factory-installed inserts for cable racks and pulling-in irons.
7. Options:
 - a. Color: Green.

D. High-Density Polyethylene (HDPE) Boxes:

1. Description: Injection molded of HDPE or copolymer-polypropylene. Cover must be made of plastic.
2. Configuration: Units must be designed for flush burial and have open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
 - b. Cover Legend: Molded lettering, "ELECTRIC".
4. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
5. Duct Entrance Provisions: Duct-terminating fittings must be installed perpendicular to box wall and mate with entering duct for secure, fixed installation in enclosure wall without putting stress on box wall or fitting.
6. Options:
 - a. Color: Green.

2.12 MANHOLES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics:
 - a. ASTM C858 for design and manufacturing processes.
 - b. SCTE 77.
- B. Precast Concrete Manholes:
1. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.
 2. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus additional **12 inch (300 mm)** vertically and horizontally to accommodate alignment variations.
 - a. Center window location.
 - b. Knockout panels must be located no less than **6 inch (150 mm)** from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - c. Knockout panel opening must have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
 - d. Knockout panel must be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 - e. Knockout panels must be **1-1/2 to 2 inch (38 to 50 mm)** thick.
 3. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size: Match fittings to duct to be terminated.
 - b. Fittings must align with elevations of approaching duct and be located near interior corners of manholes to facilitate racking of cable.
 - c. Provide minimum of one] cast end-bell or duct-terminating fitting of each size provided in each wall.
 4. Ground Rod Sleeve: Provide **3 inch (75 mm)** PVC sleeve in manhole floors **2 inch (50 mm)** from wall adjacent to, but not underneath, duct entering structure.
 5. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at installation location with ground-water level at grade.
 6. Source Quality Control: Test and inspect in accordance with ASTM C1037.
- C. Cast-in-Place Concrete Manholes:
1. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for duct entrance and sleeve for ground rod.
 2. Additional Criteria: Comply with Section 033000 "Cast-in-Place Concrete."

2.13 DUCT SEALING

- A. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Compound must be capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals. Duct sealing compound must be removable without damaging ducts or cables.
- B. Inflatable Duct-Sealing System: Wraparound inflatable bladder that seals ducts that are empty or containing conductors against air and water infiltration. System is suitable for use in steel, plastic, or concrete ducts and penetrations.

2.14 SOURCE QUALITY CONTROL

- A. Factory Tests for Handholes and Boxes:
 - 1. Testing Administrant: Owner will engage qualified structural testing agency to evaluate handholes and boxes.
 - a. Tests of materials must be performed by independent testing agency.
 - b. Strength tests of complete boxes and covers must be by independent testing agency or manufacturer. Qualified registered professional engineer must certify tests by manufacturer.
 - 2. Factory Tests and Inspections: Perform the following tests and inspections on handholes and boxes, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.
 - a. Precast Concrete Utility Structures: Test and inspect in accordance with ASTM C1037.
 - b. Polymer Concrete and Nonconcrete Handhole and Pull-Box Prototypes: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests must be for specified tier ratings of products supplied. Testing machine pressure gages must have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.
 - 3. Nonconforming Work:
 - a. Equipment that does not pass tests and inspections will be considered defective.
 - 4. Factory Test Reports: Prepare and submit factory test and inspection reports.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in field. Notify Architect if there is conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.
- C. Clear and grub vegetation to be removed, and protect vegetation to remain in accordance with Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication in accordance with Section 311000 "Site Clearing."

3.2 SELECTION OF UNDERGROUND DUCTS

- A. Duct for Electrical Feeders 600 V and Less: PVC-80 or EPEC-80, direct buried unless otherwise indicated.
- B. Duct for Electrical Branch Circuits: PVC-80 or EPEC-80, direct buried unless otherwise indicated.
- C. Underground Ducts Crossing Paved Paths Walks and Driveways: PVC-80 direct buried.
- D. Underground Ducts Crossing Roadways and Railroads: PVC-80, encased in reinforced concrete.
- E. Stub-ups: Concrete encased, PVC-80, ERM-C-S, ERM-C-S-PVC, IMC.

3.3 SELECTION OF UNDERGROUND ENCLOSURES

- A. Handholes and Boxes:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, H-10 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-10] structural load rating.
 - 3. Units in Sidewalk and Similar Applications with Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested in accordance with SCTE 77 with 3000 lbf (13 345 N) vertical loading.

5. Cover design load must not exceed load rating of handhole or box.

B. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating in accordance with AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating in accordance with AASHTO HB 17.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Restore area after construction vehicle traffic in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- E. Cut and patch existing pavement in path of underground duct, duct bank, and underground structures in accordance with "Cutting and Patching" Article in Section 017300 "Execution."

3.5 INSTALLATION OF DUCTS AND DUCT BANKS

A. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA TCB 2 for installation of underground ducts and duct banks.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Where indicated on Drawings, install duct, spacers, and accessories into duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
2. Steel raceway, bends, and fittings in single duct run or duct bank must be of same type.
3. Slope: Pitch duct minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from high point between two manholes to drain in both directions.
4. Expansion and Deflection Fittings: Install expansion and deflection fitting in each duct in area of disturbed earth adjacent to manhole or handhole.

5. Install expansion fitting near center of straight line duct with calculated expansion of more than **3/4 inch (19 mm)**.
6. Curves and Bends:
 - a. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with minimum radius of **48 inch (1200 mm)**, both horizontally and vertically, at other locations unless otherwise indicated.
 - b. Field bending must be in accordance with NFPA 70 minimum radii requirements, except bends over 45 degrees must be made with minimum radius of **48 inch (1200 mm)**. Use only equipment specifically designed for material and size involved. Use PVC heating bender for bending PVC conduit.
 - c. Duct must have maximum of 180 degrees of bends between pull points.
7. Joints: Use solvent-cemented joints in nonmetallic duct and fittings and make watertight in accordance with manufacturer's published instructions. Stagger couplings so those of adjacent duct do not lie in same plane. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with minimum **3 inch (75 mm)** of concrete for minimum of **12 inch (300 mm)** on each side of coupling.
 - a. Install insulated grounding bushings on steel raceway terminations that are less than **12 inch (300 mm)** below grade or floor level and do not terminate in hubs.
8. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing duct will not be subject to environmental temperatures above **104 deg F (40 deg C)**. Where environmental temperatures are calculated to rise above **104 deg F (40 deg C)**, and anywhere duct crosses above underground steam line, install insulation blankets listed for direct burial to isolate duct bank from steam line to maintain maximum environmental temperature of **104 deg F (40 deg C)**.
9. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately **10 inch (250 mm)** o.c. for **5 inch (125 mm)** duct, and vary proportionately for other duct sizes.
 - a. Begin change from regular spacing to end-bell spacing **10 ft (3 m)** from end bell, without reducing duct slope and without forming trap in line.
 - b. Grout end bells into structure walls from both sides to provide watertight entrances.
10. Duct Terminators for Entrances to Cast-in-Place Manholes and Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately **6 inch (150 mm)** o.c. for **4 inch (100 mm)** duct, and vary proportionately for other duct sizes.
 - a. Begin change from regular spacing to terminator spacing **10 ft (3 m)** from terminator, without reducing duct line slope and without forming trap in line.
11. Install manufactured steel raceway elbows for stub-ups at poles unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

- a. Couple steel elbows to ducts with adapters designed for this purpose, and encase coupling with minimum **3 inch (75 mm)** of concrete for minimum of **12 inch (300 mm)** on each side of coupling.
12. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least **15 psig (1.03 MPa)** hydrostatic pressure.
13. Pulling Cord: Install **200 lbf (1000 N)** test nylon cord in empty ducts.
14. Concrete-Encased Ducts and Duct Bank:
 - a. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes **6 inch (150 mm)** or less in nominal diameter.
 - b. Width: Excavate trench [**3 inch (75 mm)**] [**12 inch (300 mm)**] wider than duct on each side.
 - c. Depth: Install so top of duct envelope is at least **24 inch (600 mm)** below finished grade in areas not subject to deliberate traffic, and at least **30 inch (750 mm)** below finished grade in deliberate traffic paths for vehicles unless otherwise indicated. Install so top of duct envelope is below local frost line.
 - d. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 - e. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than [four] [five] spacers per **20 ft (6 m)** of duct. Place spacers within **24 inch (600 mm)** of duct ends. Stagger spacers approximately **6 inch (150 mm)** between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - f. Minimum Space between Ducts: **3 inch (75 mm)** between edge of duct and exterior envelope wall, **2 inch (50 mm)** between ducts for like services, and **4 inch (100 mm)** between power and communications ducts.
 - g. Elbows:
 - 1) Use manufactured duct elbows for stub-ups and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
 - 2) Use manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct run.
 - h. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 - i. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

- j. Concrete Cover: Install minimum of 3 inch (75 mm) of concrete cover between edge of duct to exterior envelope wall, 2 inch (50 mm) between duct of like services, and 4 inch (100 mm) between power and communications ducts.
 - k. Place minimum 6 inch (150 mm) of engineered fill above concrete encasement of duct.
 - l. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - 1) Start at one end and finish at other, allowing for expansion and contraction of duct as its temperature changes during and after pour. Use expansion fittings installed in accordance with manufacturer's published instructions, or use other specific measures to prevent expansion-contraction damage.
 - 2) If more than one pour is necessary, terminate each pour in vertical plane and install 3/4 inch (15 mm) reinforcing-rod dowels extending minimum of 18 inch (450 mm) into concrete on both sides of joint near corners of envelope.
 - m. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.
15. Direct-Buried Duct and Duct Bank:
- a. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inch (150 mm) in nominal diameter.
 - b. Width: Excavate trench 3 inch (75 mm) wider than duct on each side.
 - c. Depth: Install top of duct at least 36 inch (900 mm) below finished grade unless otherwise indicated.
 - d. Set elevation of top of duct bank below frost line.
 - e. Place minimum 3 inch (75 mm) of sand as bed for duct. Place sand to minimum of 6 inch (150 mm) above top level of duct.
 - f. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 - g. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 ft (6 m) of duct. Place spacers within 24 inch (600 mm) of duct ends. Stagger spacers approximately 6 inch (150 mm) between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - h. Install duct with minimum of 3 inch (75 mm) between ducts for like services and 6 inch (150 mm) between power and communications duct.

- i. Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 - j. Install manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct.
 - 1) Couple RNC duct to steel raceway with adapters designed for this purpose, and encase coupling with minimum 3 inch (75 mm) of concrete.
 - 2) Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
 - a) Stub-ups must terminate in coupling installed flush with finished base and minimum 3 inch (75 mm) from conduit side to edge of base.
 - k. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inch (100 mm) over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
16. Warning Planks: Bury warning planks approximately 12 inch (300 mm) above direct-buried duct, placing them 36 inch (900 mm) o.c. Align planks along width and along centerline of duct or duct bank. Provide additional plank for each 12 inch (300 mm) increment of duct-bank width over nominal 18 inch (450 mm). Space additional planks 12 inch (300 mm) apart, horizontally across width of ducts.
17. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inch (300 mm) above concrete-encased duct and duct banks and approximately 12 inch (300 mm) below grade. Align tape parallel to and within 3 inch (75 mm) of centerline of duct bank. Provide additional warning tape for each 12 inch (300 mm) increment of duct-bank width over nominal 18 inch (450 mm). Space additional tapes 12 inch (300 mm) apart, horizontally across width of ducts.
18. Ground ducts and duct banks in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Reference Standards:

- 1. Precast Concrete Handholes: Comply with ASTM C891 unless otherwise indicated.
- 2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Cast-in-Place Manholes:
 - a. Finish interior surfaces with smooth-troweled finish.
 - b. Knockouts for Future Duct Connections: Form and pour concrete knockout panels **1-1/2 to 2 inch (38 to 50 mm)** thick, arranged as indicated.
 - c. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.
2. Precast Concrete Handholes and Manholes:
 - a. Install units level and plumb and with orientation and depth coordinated with connecting duct to minimize bends and deflections required for proper entrances.
 - b. Unless otherwise indicated, support units on level bed of crushed stone or gravel graded from **1 inch (25 mm)** sieve to **No. 4 (4.75 mm)** sieve and compacted to same density as adjacent undisturbed earth.
 - c. Field-cut openings for conduits in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
3. Elevations:
 - a. Manhole Roof: Install with rooftop at least **15 inch (375 mm)** below finished grade.
 - b. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames **1 inch (25 mm)** above finished grade.
 - c. Install handholes with bottom below frost line.
 - d. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes **1 inch (25 mm)** above finished grade.
 - e. Where indicated, cast handhole cover frame integrally with handhole structure.
4. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
5. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 - a. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 - b. Install chimney, constructed of precast concrete collars and rings, and cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight joints and waterproof grouting for frame and chimney.
6. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Section 071353 "Elastomeric Sheet Waterproofing" and Section 071354 "Thermoplastic Sheet Waterproofing". After duct has been connected and grouted, and

- before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
7. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
 8. Hardware: Install removable hardware, including pulling eyes, cable stanchions, [and]cable arms, [and insulators,]as required for installation and support of cables and conductors and as indicated.
 9. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
 10. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inch (97 mm) for manholes and 2 inch (50 mm) for handholes, for anchor bolts installed in field. Use minimum of two anchors for each cable stanchion.
 11. Ground manholes, handholes, and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Reference Standards:

1. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
2. Unless otherwise indicated, support units on level bed of crushed stone or gravel, graded from 1/2 inch (12.5 mm) sieve to No. 4 (4.75 mm) sieve and compacted to same density as adjacent undisturbed earth.
3. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
4. Install handholes and boxes with bottom below frost line, <Insert depth of frost line below grade at Project site> below grade.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
6. Field cut openings for duct in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
7. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour concrete ring encircling, and in contact with enclosure

entry, and with top surface screeded to top of box cover frame. Bottom of ring must rest on compacted earth.

- a. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with troweled finish.
 - b. Dimensions: 10 inch wide by 12 inch deep (250 mm wide by 300 mm deep).
8. Ground handholes and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum 12 inch (300 mm) long mandrel equal to duct size minus 1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.
 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Nonconforming Work:
 1. Underground ducts, raceways, and structures will be considered defective if they do not pass tests and inspections.
 2. Correct deficiencies and retest as specified above to demonstrate compliance.
- D. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.
- E. Manufacturer Services: Engage factory-authorized service representative to support field tests and inspections.
 1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

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- B. Clean internal surfaces of manholes, including sump, and building interiors affected by Work.
 - 1. Sweep floor, removing dirt and debris.
 - 2. Remove foreign material.

END OF SECTION 260543

SECTION 260546
POLES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Utility poles.
 - 2. Utility pole accessories.
- B. Related Requirements:
 - 1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
 - 2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural design conditions applicable to the Work specified in this Section.
 - 3. Section 260500 "Common Work Results for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work.
 - 4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding components referenced by this Section.
 - 5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.
 - 6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
 - 7. Section 260573 "Power System Studies" specifies arc-flash hazard analysis and warning labels referenced by this Section.

1.2 DEFINITIONS

- A. Bonding: The electrical interconnecting of conductive parts, designed to maintain a common electrical potential.
- B. EPA: Equivalent projected area.
- C. Grounding (Earthing): Electrically connecting, whether intentional or accidental, an electrical circuit or equipment to the earth, or to some conducting body that serves in place of the earth.
- D. Guy: A tension member having one end securely anchored and the other end attached to a pole or other structure that it supports against overturning.
- E. Lighting Standard: An upright pole or beam used to support luminaires and used as a raceway to enclose supply conductors. Lighting standards frequently include provisions for supporting and supplying decorative items such as holiday decorations, flags, or banners.

- F. Pole: A column of wood or steel, or some other material, supporting overhead conductors, usually by means of arms or brackets.

1.3 DELEGATED DESIGN SERVICES

- A. Delegated Design Professionals:
 - 1. Engage qualified electrical professional engineer to design power distribution for lighting standards.
 - 2. Engage qualified structural professional engineer to design lighting standards, poles, foundations, hangers, and supports.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
 - 2. Include finishes for lighting poles and luminaire-supporting devices.
 - 3. Anchor bolts.
 - 4. Manufactured pole foundations.
 - 5. Product Certificates: Include product certificate, signed by manufacturers of poles, certifying that products are designed for indicated load requirements in accordance with AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification must be based on design calculations signed and sealed by a professional engineer.
 - 6. Include manufacturer's sample extended warranty language.
- B. Samples: Submit finish samples for each exposed lighting pole, standard, and luminaire-supporting device and for each color and texture specified.
- C. Shop Drawings: Prepare and submit the following:
 - 1. Plans, elevations, sections, and mounting details.
 - 2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Details of fabrication and assembly of poles and pole accessories.
 - 4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
 - 5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
 - 6. Method and procedure of pole installation. Include manufacturer's published installations.
- D. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Material Test Reports:

1. For each foundation component, by qualified testing laboratory.
2. For each pole, by qualified testing laboratory.

B. Soil test reports.

C. Manufacturer's published instructions.

D. Field Reports:

1. Manufacturer's field reports for field quality-control support.

1.6 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

1.8 REGULATORY AGENCY APPROVALS

- A. Submittals for poles requiring approval by authorities having jurisdiction must be signed by qualified structural professional engineer responsible for their preparation. [Obtain approval by authorities having jurisdiction prior to submitting for action by Architect] [Submit for action by Architect prior to submitting for approval by authorities having jurisdiction].

1.9 QUALIFICATIONS

- A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.
- B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

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- C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - 1. On-site electrical testing supervisors must possess active NICET EPT Technician III certification.
- D. Electrical Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in electrical engineering, including electrical power system modeling and analysis of electrical safety in accordance with NFPA 70E.
- E. Structural Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic-load and wind-load controls, utility poles, equipment hangers and supports, and concrete foundations.
- F. Outdoor Pole Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience in accordance with ASTM C1093 for foundation testing and inspections.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping in accordance with ASTM B660.
- B. Store poles on decay-resistant skids at least **12 inch (300 mm)** above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than **1/4 inch (6 mm)** deep. Do not apply tools to section of pole installed below finished grade.
- D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
- E. Retain factory-applied pole wrappings on metal poles until immediately before pole installation. Handle poles with web fabric straps.

1.11 WARRANTY

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed [pole(s)] [and luminaire-lowering device(s)] perform in accordance with specified requirements and agrees to repair or replace products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.
 - 1. Extended-Warranty Period: Four years from date of Substantial Completion; full coverage for labor, materials, and equipment.

- B. Special Manufacturer Extended Warranty: Manufacturer warrants that pole(s) perform in accordance with specified requirements and agrees to provide repair or replacement of products that fail to perform as specified within extended-warranty period, including materials that corrode, fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period. Warranty must convey to Owner upon acceptance of the Work.
1. Extended-Warranty Period: Five years from date of Substantial Completion; full coverage for labor, materials, and equipment.
 2. Warranty Period for Corrosion Resistance: Five years from date of Substantial Completion; full coverage for labor, materials, and equipment.
 3. Warranty Period for Color Retention: Five years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Description: Utility Pole
- B. Performance Criteria:
1. Regulatory Requirements:
 - a. Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 2. Utility Approval: Comply with CMU requirements.
 3. General Characteristics:
 - a. Structural Characteristics: Comply with AASHTO LTS-6-M.
 - b. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied in accordance with AASHTO LTS-6-M.
 - c. Live Load: Single load of 500 lb (2200 N) distributed in accordance with AASHTO LTS-6-M.
 - d. Ice Load: Load of 3 lb/ft² (145 Pa), applied in accordance with AASHTO LTS-6-M for applicable areas on the Ice Load Map.
 - e. Wind Load for Poles Exceeding 50 ft (15 m) Height:
 - 1) Basic Wind Speed: 100 mile/h (45 m/s)
 - 2) Wind Importance Factor: 1.0.
 - 3) Minimum Design Life: 50 years.
 - 4) Velocity Conversion Factor: 1.0.

- f. Wind Load for Poles Not Exceeding 50 ft (15 m) Height:
 - 1) Basic Wind Speed: 100 mile/h (45 m/s).
 - 2) Wind Importance Factor: 1.0.
 - 3) Minimum Design Life: 25 years
 - 4) Velocity Conversion Factor: 1.0
- g. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA used in pole selection strength analysis.
- h. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.
- i. General Finish Requirements:
 - 1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - 2) Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.2 UTILITY POLES

A. Wood Utility Pole:

- 1. Source Limitations: Obtain poles from single manufacturer or producer
- 2. Standard Features:
 - a. Comply with ATIS O5.1 and RUS Bulletin 1728F-700 and CMU standards, for wood poles.
 - b. Wood Species: Per CMU standards.
 - c. Pole Marking:
 - 1) Manufacturer's Mark: Comply with ATIS O5.1; locate 10 ft (3 m) from the pole butt for poles 50 ft (15 m) long or less.
 - 2) Pole Number: Machine-embossed aluminum, alphanumeric characters not less than 2-1/2 inch (65 mm) high, with aluminum nails.
 - d. Factory Operations: Machine trim poles by turning smooth, full length. Roof, gain, and bore poles before pressure treatment.

2.3 UTILITY POLE ACCESSORIES

A. Crossarms:

1. Description: Solid-wood distribution type, complying with RUS Bulletin 1728H-701 for specified construction grade and complying with IEEE C2 for required climbing space and wire clearances.
2. Braces: Galvanized, flat, ferrous-metal units; **1/4 inch (6 mm)** thick by **1-1/4 inch (30 mm)** wide, minimum, with length to suit crossarm dimensions.

B. Guys and Anchors:

1. Guy Strand Assemblies: Cable and attachment assemblies must have uniform minimum breaking strength of the cable.
 - a. Cable: Seven strands. Zinc-coated steel, complying with ASTM A475, Aluminum-clad steel, complying with ASTM B416, or Copper-clad steel, complying with ASTM B228. Breaking strength must be not less than **10,000 lb (45 kN)**.
 - b. Cable Termination:
 - 1) Thimble eye.
 - 2) Hooks and guy strain plates, complying with IEEE C135.1.
 - 3) Preformed galvanized-steel guy grips, matching material, galvanizing, and strength of the guy strand assembly.
2. Anchor and Anchor-Rod Assemblies: Hot-dip galvanized steel.
 - a. Power-installed, screw-type anchors.
 - 1) **15 inch (380 mm)** screw; with rod **8 ft (2.4 m)** long by **1-1/2 inch (38 mm)** in diameter. Rated at **10,000 lb (45 kN)** when installed.
 - 2) Guy anchors must have strength and holding area as required for anchor load and soil conditions at location of that anchor.
3. Strain Insulators: Epoxy-bonded fiberglass of length to meet clearance requirements specified in "Installation of Guys and Anchors" Subparagraph in "Installation of Utility Poles" Article.
4. Guy Markers: Round, of vinyl or PVC material, yellow color, **8 ft (2.4 m)** long. Shatter resistant at temperatures below **0 deg F (minus 18 deg C)**.

2.4 MAINTENANCE MATERIAL ITEMS

- A. Spare Parts: Furnish to Owner spare parts, for repairing lighting standards and poles, that are packaged with protective covering for storage on-site and identified with labels describing contents.
- B. Special Tools: Furnish to Owner proprietary equipment and keys required to operate, maintain, repair, adjust, or implement future changes to lighting standards and poles, that are packaged with protective covering for storage on-site and identified with labels describing contents.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine poles, luminaire-mounting devices, lowering devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.
- C. Examine roughing-in for foundation and conduit to verify actual locations of installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FOUNDATIONS FOR POLES AND LIGHTING STANDARDS

- A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A36/A36M and hot-dip galvanized in accordance with ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
- B. Precast Foundations: Factory fabricated, with structural steel complying with ASTM A36/A36M and hot-dip galvanized in accordance with ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
- C. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A36/A36M and hot-dip galvanized in accordance with ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories.
 - 1. Baseplate: Stamped with manufacturer's name, date of production, and cable entry.
- D. Direct-Buried Foundations: Install to depth indicated on the Drawings, but not less than one-sixth of pole height. Add backfill in 6 to 9 inch (150 to 230 mm) layers, tamping each layer before adding the next. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.
- E. Direct-Buried Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on the Drawings, but not less than one-sixth of pole height. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.
 - 1. Make holes 6 inch (150 mm) in diameter larger than pole diameter.

2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi (20 MPa) at 28 days and finish in a dome above finished grade.
 3. Use a short piece of 1/2 inch (13 mm) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
 4. Cure concrete a minimum of 72 hours before performing work on pole.
- F. Anchor Bolts: Install plumb using manufacturer-supplied steel template, uniformly spaced.

3.3 INSTALLATION OF UTILITY POLES

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturers' published instructions, comply with the following:
1. Electrical Construction: IEEE C2, NFPA 70 and NECA NEIS 1.
 2. Electrical Safety: NFPA 70E.
 3. Hot Work: NFPA 51B.
 4. Grounding and Bonding: IEEE C2, NECA NEIS 331 and Article 250 of NFPA 70.
 5. Communications Work: BICSI N1.
 6. Consult Architect for resolution of conflicting requirements.
- C. Special Installation Techniques:
1. Engage the services of a licensed surveyor to verify dimensions by field measurement, to identify locations of poles, anchors, and other features, and to verify all clearances. The survey document must also identify locations of connections to new and existing supply lines and to primary and secondary services. Notify Architect of discrepancies and field conditions that are not indicated and that will affect installation.
 2. Pole Orientation: Align curve of curved wood poles with straight-line runs of three or more poles. Align gained surfaces perpendicular to runs.
 3. Elevation of Line above Grade: Install poles with top at same elevation, unless grade changes dictate elevation change in poles, and in accordance with the following:
 - a. On level ground, set poles so tops of consecutive poles vary not more than 60 inch (1500 mm) in elevation.
 - b. Shorten wood poles by cutting off the top and make cuts to shed water. Apply preservative to cuts.
 4. Set poles in accordance with the following:
 - a. Make pole holes vertical, uniform in diameter, and large enough to permit effective use of tamping bars all around. Bore or excavate holes with an average diameter at grade less than twice the diameter of the pole at the same grade.

- b. Use minimum depths indicated, except at locations where hole is partly or entirely in rock and if hole is not vertical or has a diameter at grade more than two times the pole diameter at the same level; in these conditions, increase the depth of the hole by the following increments before setting the pole:
 - 1) Poles up to 35 ft (10.6 m) Long: 24 inch (600 mm).
 - 2) Poles 36 to 60 ft (11 to 18.3 m) Long: 30 inch (760 mm).
 - 3) Poles 61 to 75 ft (18.6 to 22.9 m) Long: 36 inch (900 mm).
 - c. For poles on slopes, indicated hole depth is from finished grade at lowest side of hole.
 - d. Set poles in alignment and plumb except at dead ends, angles, and points of extra strain; rake poles against conductor strain 1 inch (25 mm) minimum, 2 inch (51 mm) maximum, (after conductors are installed at required tension) for each 10 ft (3 m) of pole length. Rake poles so they will not lean or bend in direction of strain when loaded.
 - e. Backfill holes in 6 inch (150 mm) maximum lifts, and thoroughly tamp each layer before starting the next.
 - f. Place surplus earth around pole in a conical shape, and tamp thoroughly to provide drainage away from pole.
 - g. Set poles so alternate crossarm gains face in alternate directions, except at terminals and dead ends; place gains on last two poles on side facing terminal or dead end.
 - h. Poles Set in Concrete Paved Areas: Install poles with minimum of 6 inch (150 mm) wide, unpaved gap between the pole and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.
5. Field treat factory-treated poles and crossarms as follows:
- a. Poles Treated More Than One Year before Installation: Treat portion from 24 inch (600 mm) above ground line to butt.
 - b. Field-Bored Holes and Field-Cut Gains and Pole Tops: Treat cut portions.
 - c. Unused Holes: Treat and plug with treated-wood-dowel drive pins.
 - d. Engage the services of qualified wood pole and crossarm treatment technician to apply treatment. Comply with requirements in AWWPA standards that govern original factory treatment for field-applied treatment and application of chemicals.
6. Installation of Crossarms: Set line crossarms at right angle to line for straight runs and for angles 45 degrees and more. Bisect angles less than 45 degrees.
- a. Buck Arms: Install at corners and junction poles unless otherwise indicated.
 - b. Double Crossarms: Install at dead ends, corners, angles, and line crossings.
 - c. Equipment Arms: Locate below lines and set parallel or at right angles to them, whichever provides best climbing space.
 - d. Gains: Install factory-cut or metal-pole gains only. Do not cut gains in field without specific written approval.

7. Installation of Guys and Anchors:

- a. Install guys to resist unbalanced loads, including those developed at angles, corners, and dead ends. Install two or more guys if a single guy will not provide adequate strength. Install separate guys if unbalanced loads are separated by **36 inch (900 mm)** or more. Comply with IEEE C2.
 - 1) Unless a thimble eye is used, at the pole end, install a minimum of two guy hooks and two guy strain plates.
 - 2) At the anchor end, attach guy strand assembly with preformed grips.
- b. Protect guy strands from damage. Replace damaged guy strands. Install guy insulators where required to comply with IEEE C2 clearance requirements.
- c. Install guys with a lead-to-height ratio of 1 to 1 unless otherwise indicated. The minimum lead-to-height ratio must be 1/2 to 1. When less than 1 to 1, increase guy strength by the ratio of the sine of the lead angle indicated to the sine of the lead angle provided.
- d. Install screw-type guy anchors aligned in soil with guy. Set with anchor rod pointing at guy attachment on pole and rod projecting **6 to 9 inch (150 to 230 mm)** from ground.
- e. Install strain insulators to provide a minimum of **12 inch (300 mm)** of clearance between the nearest energized surface and the strain insulator fitting farthest from the pole. When loaded to the tension indicated, fiberglass strain insulators must be loaded to not more than two-thirds of manufacturer's published rating.

8. Guy Markers: Install at anchor end of guys to visually mark the guy wire at all accessible locations. Clamp to guy strand or anchor at top and bottom of marker.

D. Interfaces with Other Work:

1. Grounding and Bonding:

- a. Comply with IEEE C2 and NFPA 70 grounding and bonding requirements.
- b. Ground Rods: Copper-clad; **5/8 inch by 8 ft (16 mm by 2.4 m)**.
 - 1) Install [two] parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 Ω .
 - 2) Drive ground rods until tops are **12 inch (300 mm)** below finished grade in undisturbed earth.
- c. Grounding (Earthing) Conductors:
 - 1) 4 AWG minimum, soft-drawn copper.
 - 2) Conductor Protectors for Wood Poles: Half-round PVC or wood molding; if wood, use pressure-treated fir, cypress, or cedar. Protect grounding conductors running on surface of wood poles with molding extended from

- grade level up to and through communications service and transformer spaces.
 - 3) Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.
 - 4) Lightning Arrester Grounding Conductors: Separate from other grounding conductors.
- d. Bonding Conductors: Provide equipment grounding conductors with supply feeders for bonding pole-mounted electrical and electronic equipment to ground terminals of their supplying power sources in accordance with Article 250 of NFPA 70.
- 2. Identification: Provide labels for poles, components, wiring, cabling, terminals, and associated electrical equipment.
 - a. Identify field-installed conductors, interconnecting wiring, and components.
 - b. Label each enclosure with engraved metal or laminated-plastic nameplate.
 - c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
 - d. Locate pole numbers to provide maximum visibility from the road or patrol route.

3.4 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

- 1. [Owner will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
- 2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
- 3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
- 4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].

B. Field tests and inspections must be witnessed by authorities having jurisdiction.

C. Tests and Inspections:

- 1. Inspect poles for nicks, mars, dents, scratches, and other damage.
- 2. System function tests.
- 3. Guy Anchors: Test one of each type and capacity installed, plus additional units specifically indicated for testing. Apply rated pull-out force in the same pull direction applied by the guy at the test location.

- a. Acceptable Test Results: Denoted by movement of less than **3/8 inch (10 mm)** by the holding component of the anchor in the earth or other medium in which it is installed.
 - b. Replace or reinstall, at Architect's option, all anchors of same type and capacity as anchor type that fails this test.
4. Pole Ground Resistance: Measure resistance of each separate grounding electrode, including pole grounds. Also measure resistance of separate grounding electrode systems before bonding together.
 - a. Perform tests and obtain acceptable results before energizing any portion of overhead electrical distribution system.
 - b. Results and Follow-up: If ground resistance for a single ground electrode or pole ground, tested individually, exceeds 25 Ω , add a ground electrode not less than **10 ft (3 m)** away and interconnect with 2 AWG, minimum, bare conductor buried at least **12 inch (300 mm)** below furnished grade.
5. <Insert special inspections>.
- D. Nonconforming Work:
 1. Unit will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective units and retest.
- E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.
- F. Manufacturer Services: Engage factory-authorized service representative to support field tests and inspections.
 1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

END OF SECTION 260546

SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Extruded insulating tubing.
3. Bands.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260500 "Common Work Results for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 LABELS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN PGDQ2 for components; including UL 969.

B. UL PGDQ2 - Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

C. UL PGDQ2 - Self-Adhesive Wraparound Labels: [Preprinted] [Write-on], 3 mil (0.08 mm) thick, vinyl flexible label with acrylic pressure-sensitive adhesive.

1. Self-Lamination: Clear; UV-, weather-, and chemical-resistant; self-laminating, with protective shield over legend. Size labels such that clear shield overlaps entire printed legend.
2. Marker for Labels:
 - a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - b. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. UL PGDQ2 - Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3 mil (0.08 mm) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inch (37 by 150 mm) for raceway and conductors.
 - b. 3-1/2 by 5 inch (76 by 127 mm) for equipment.
 - c. As required by authorities having jurisdiction.

2.2 EXTRUDED INSULATING TUBING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria: UL CCN YDPU2 for components; including UL 224.

- B. UL YDPU2 - Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of 200 deg F (93 deg C).

2.3 BANDS

- A. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
- B. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inch (50 mm) long, with diameters sized to suit diameters and that stay in place by gripping action.

2.4 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mil (0.08 mm) thick by 1 to 2 inch (25 to 50 mm) wide; compounded for outdoor use.
- C. Tape and Stencil: 4 inch (100 mm) wide black stripes on 10 inch (250 mm) centers placed diagonally over orange background and are 12 inch (300 mm) wide. Stop stripes at legends.
- D. Floor Marking Tape: 2 inch (50 mm) wide, 5 mil (0.125 mm) pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
- E. Underground-Line Warning Tape:

1. Tape:

- a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical utility lines.
- b. Printing on tape must be permanent and may not be damaged by burial operations.
- c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2. Color and Printing:

- a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
- b. Inscriptions for Red Tapes: "CAUTION BURIED ELECTRIC LINE BELOW".

3. Nonconducting Line-Warning Tape:
 - a. Pigmented polyolefin, bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
 - b. Width: 3 inch (75 mm).
 - c. Thickness: 4 mil (0.1 mm).
 - d. Weight: 18.5 lb/1000 sq. ft (9.0 kg/100 sq. m).
 - e. Tensile in accordance with ASTM D882: 30 lbf (133.4 N) and 2500 psi (17.2 MPa).
4. Reinforced Nonconducting Line-Warning Tape:
 - a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
 - b. Width: 3 inch (75 mm).
 - c. Thickness: 12 mil (0.3 mm).
 - d. Weight: 36.1 lb/1000 sq. ft (17.6 kg/100 sq. m).
 - e. Tensile in accordance with ASTM D882: 400 lbf (1780 N) and 11,500 psi (79.2 MPa).
5. Detectable Line-Warning Tape:
 - a. Detectable three-layer laminate, consisting of printed pigmented polyolefin film, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
 - b. Width: 3 inch (75 mm).
 - c. Overall Thickness: 5 mil (0.125 mm).
 - d. Foil Core Thickness: 0.35 mil (8.9 m).
 - e. Weight: 28 lb/1000 sq. ft (13.7 kg/100 sq. m).
 - f. Tensile in accordance with ASTM D882: 70 lbf (311.3 N) and 4600 psi (31.7 MPa).
6. Reinforced Detectable Line-Warning Tape Insert drawing designation:
 - a. Reinforced, detectable three-layer laminate, consisting of printed pigmented woven scrim, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright-colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
 - b. Width: 3 inch (75 mm).
 - c. Overall Thickness: 8 mil (0.2 mm).
 - d. Foil Core Thickness: 0.35 mil (8.9 m).
 - e. Weight: 34 lb/1000 sq. ft (16.6 kg/100 sq. m).
 - f. Tensile in accordance with ASTM D882: 300 lbf (1334 N) and 12,500 psi (86.1 MPa).

F. Concrete Cable Route Markers:

1. Description: Concrete markers visually aid tracing the route of electrical cables. Monument markers are typically installed at grade. Protective cover markers are typically installed above the cables at grade or below grade.
2. Product Characteristics:
 - a. Material: Precast reinforced concrete.
 - b. Marker Type:
 - 1) Above-Ground Monument Post:
 - a) Nominal Dimensions (Height, Width, Depth): 30 inch (760 mm), 6 inch (150 mm), 3 inch (75 mm).
 - 2) Above-Ground Monument Block:
 - a) Nominal Dimensions (Height, Width, Depth): 12 inch (300 mm), 12 inch (300 mm), 6 inch (150 mm).
 - 3) In-Ground Protective Cover (Plank or Slab):
 - a) Nominal Dimensions (Length, Width, Depth): 36 inch (914 mm), 6 inch (150 mm), 2 inch (50 mm).
 - c. Legend: "DANGER - ELECTRIC CABLES" or "ELECTRIC SPLICE".
 - d. Lettering: Approximately 1/8 inch (3 mm) deep, not less than 1 inch (25 mm) high, symmetrically spaced; marked on both sides to allow for reversal.
3. Required Product Options:
 - a. Color: Red dye added to concrete during batching.
 - b. Attach metal medallion or sign stamped with feeder number.

- G. Stenciled Legend: In nonfading, waterproof, black] ink or paint. Minimum letter height must be 1 inch (25 mm).

2.5 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- B. Nonmetallic Preprinted Tags: Polyethylene tags, [0.015 inch (0.38 mm)] [0.023 inch (0.58 mm)] thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.
- C. Write-on Tags:

1. Polyester Tags: 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment.
2. Marker for Tags:
 - a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - b. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.6 SIGNS

A. Baked-Enamel Signs:

1. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4 inch (6.4 mm) grommets in corners for mounting.
3. Nominal Size: 7 by 10 inch (180 by 250 mm).

B. Metal-Backed Butyrate Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396 inch (1 mm) galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
2. 1/4 inch (6.4 mm) grommets in corners for mounting.
3. Nominal Size: 10 by 14 inch (250 by 360 mm).

C. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:
 - a. For signs up to 20 sq. inch (129 sq. cm), minimum 1/16 inch (1.6 mm) thick.
 - b. For signs larger than 20 sq. inch (129 sq. cm), 1/8 inch (3.2 mm) thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with 1/4 inch (6.4 mm) grommets in corners for mounting] [Self-adhesive.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 CABLE TIES

- A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 2. Listing Criteria: UL CCN ZODZ; including UL 1565 or UL 62275.
- B. UL ZODZ - General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C) in accordance with ASTM D638: 12,000 psi (82.7 MPa).
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black, except where used for color-coding.
- C. UL ZODZ - UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C) in accordance with ASTM D638: 12,000 psi (82.7 MPa).
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black.
- D. UL ZODZ - Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C) in accordance with ASTM D638: 7000 psi (48.2 MPa).
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 5. Color: Black.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

- A. Comply with 29 CFR 1910.144 for color identification of hazards, and the following:
- B. Pipe and Conduit Labeling: Comply with ASME A13.1.
- C. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - 1. Color must be factory applied or field applied for sizes larger than 6 AWG when permitted by authorities having jurisdiction.
 - 2. Colors for 240 V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - 3. Color for Neutral (Grounded Conductor): White.
 - 4. Color for Equipment Ground: Bare copper or Green.
 - 5. Color for Isolated Ground: Green with two or more yellow stripes.
- D. Color-Coding Raceways, Cable Trays, Junction Boxes, and Conductors for Intrinsically-Safe Circuits: Light blue. When used to identify intrinsically-safe circuits, Article 504 of NFPA 70 requires that the color light blue not be used for any other purpose.
- E. Color-Coding Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.
- F. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- G. Locations of Underground Lines: Underground-line warning tape for power and lighting.
- H. Vaults, Manholes, Handholes, and Pull and Junction Boxes, More Than 1000 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and separate tag with circuit designation.
- I. Concealed Raceways, Duct Banks, More Than 1000 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3 inch (75 mm) high, black letters on 20 inch (500 mm) centers.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, and at [10 ft (3 m)] [30 ft (9 m)] maximum intervals.
 - 2. Identify system voltage and system or service type with black letters on orange field.
 - 3. Apply floor marking tape to the following finished surfaces:
 - a. Floor surface directly above conduits running beneath and within 12 inch (300 mm) of floor that is in contact with earth or is framed above unexcavated space.

- b. Wall surfaces directly external to raceways concealed within wall.
 - c. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in building, or concealed above suspended ceilings.
- J. Accessible Raceways, Armored and Metal-Clad Cables, More Than 1000 V: Vinyl wraparound labels.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.
 - 2. Identify system voltage and system or service type with black letters on orange field.
- K. Vaults, Manholes, Handholes, and Pull and Junction Boxes, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify phase.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.
 - 2. Identify system voltage and system or service type] with black letters on orange field.
- L. Accessible Raceways and Metal-Clad Cables, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.
 - 2. Identify system voltage and system or service type with black letters on orange field.
- M. Conductors to Be Extended in Future: Attach marker tape to conductors and list source.
- N. Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Label cover plate with the following information, in the order listed:
 - 1. Panelboard designation.
 - 2. Colon or dash.
 - 3. Branch circuit number.
- O. Equipment Identification Labels:
 - 1. Black letters on white field.
 - 2. Outdoor Equipment: Laminated acrylic or melamine sign.
 - 3. Equipment to Be Labeled:
 - a. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.

- b. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of self-adhesive, engraved, laminated acrylic or melamine label.
 - c. Enclosures and electrical cabinets.
- P. Cable Ties: General purpose, for attaching tags, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.

3.3 SELECTION OF SIGNS AND HAZARD MARKINGS

- A. Comply with 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs.
- B. Signs, labels, and tags required for personnel safety must comply with the following standards:
 - 1. Safety Colors: NEMA Z535.1.
 - 2. Facility Safety Signs: NEMA Z535.2.
 - 3. Safety Symbols: NEMA Z535.3.
 - 4. Product Safety Signs and Labels: NEMA Z535.4.
 - 5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.
- C. Electrical Hazard Warnings:
 - 1. Arc-Flash Hazard Warning: Self-adhesive labels. Comply with NFPA 70E and Section 260573 "Power System Studies" requirements for arc-flash hazard warning labels.
 - 2. Raceways and Cables Carrying Circuits at More Than 1000 V:
 - a. Black letters on orange field.
 - b. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
 - 3. Multiple Power Sources Warning Legend: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 4. OSHA Workspace Clearance Warning Legend: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."
- D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
 - 1. Apply to exterior of door, cover, or other access.
 - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.
 - c. <Insert items>.

- E. Operating Instruction Signs: Self-adhesive labels.

3.4 SELECTION OF IDENTIFICATION PRODUCTS FOR COMMUNICATIONS, CONTROL, AUXILIARY, AND LIFE SAFETY SYSTEMS

- A. Comply with Section 270528 "Pathways for Communications Systems" and Section 271100 "Communications Equipment Room Fittings."

3.5 INSTALLATION

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes typical for electrical equipment environments specified in Section 018116 "Facility Environmental Requirements" and Section 260010 "Supplemental Requirements for Electrical."
- C. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- D. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.
- E. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- F. Install identifying devices before installing acoustical ceilings and similar concealment.
- G. Verify identity of item before installing identification products.
- H. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- I. Apply identification devices to surfaces that require finish after completing finish work.
- J. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.
- L. Vinyl Wraparound Labels:

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1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.
- M. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.
- N. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.
- O. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.
- P. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.
- Q. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.
- R. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.
1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of **6 inch (150 mm)** where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- S. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- T. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.
- U. Underground Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape not less than **12 inch (300 mm)** directly above cables or raceways buried **18 inch (450 mm)** or more below grade. Use multiple tapes where width of multiple lines installed in common trench or concrete envelope exceeds **16 inch (400 mm)** overall.
 2. Limit use of underground-line warning tape to direct-buried cables.
 3. Install underground-line warning tape for direct-buried cables and cables in raceways.
- V. Concrete Cable Route Markers:
- W. Metal Tags:
1. Place in location with high visibility and accessibility.
 2. Secure using UV-stabilized cable ties.
- X. Nonmetallic Preprinted Tags:
1. Place in location with high visibility and accessibility.
 2. Secure using UV-stabilized cable ties.

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- Y. Write-on Tags:
 - 1. Place in location with high visibility and accessibility.
 - 2. Secure using UV-stabilized cable ties.
- Z. Baked-Enamel Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
- AA. Metal-Backed Butyrate Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
- BB. Laminated Acrylic or Melamine Plastic Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

END OF SECTION 260553

SECTION 260573
POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Short-circuit study.
2. Overcurrent protective device coordination study.
3. Load-flow and voltage-drop study.
4. Motor-starting study.
5. Arc-flash hazard study.
6. Digital-twin modeling.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 DEFINITIONS

- A. Digital Twin: The digital representation of a real-world entity, concept, or notion, either physical or perceived.

1.3 ACTION SUBMITTALS

A. Product Data: For power system analysis software to be used for studies.

1. Product Certificates: For power system study software applications, include certificate stating compliance with specified requirements, signed by software manufacturer.

B. Power System Study Reports:

1. Submit reports after approval of system protective devices submittals. Submittals must be in digital form.
2. Submit short-circuit study input data, including completed computer-program input data sheets.
3. Submit coordination study input data, including completed computer-program input data sheets.

- a. Submit load-flow, voltage-drop, and motor-starting data with coordination study.
- 4. Submit arc-flash study input data, including completed computer-program input data sheets.
- 5. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
- 6. Submit revised one-line diagram, reflecting field investigation results and results of short-circuit study.
- C. Data files for studies in format compatible with Owner's power system analysis software.
- D. Digital-twin models.

1.4 QUALITY ASSURANCE

- A. Submittals for power system studies must be signed and sealed by qualified electrical professional engineer responsible for their preparation.
- B. Studies must be performed using commercially developed and distributed software designed specifically for power system analysis.
- C. Software algorithms must comply with requirements of standards and guides specified in this Section.
- D. Manual calculations are unacceptable.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE

- A. Standard Features:
 - 1. Power System Analysis:
 - a. Power-systems-analysis software applications must have analytical capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 3002 series standards.
 - b. Computer software application must be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program must report device settings and ratings of overcurrent protective devices and must demonstrate selective coordination by computer-generated, time-current coordination plots.

- c. Computer software application must be designed to perform arc-flash analysis or have function, component, or add-on module designed to perform arc-flash analysis.
- 2. Analysis Standards:
 - a. Short-Circuit Current Analysis: In accordance with IEEE 3002.3.
 - b. Device Coordination Analysis: In accordance with IEEE 3004.3 and IEEE 3004.5.
 - c. Load-Flow Analysis: In accordance with IEEE 3002.2.
 - d. Motor-Starting Analysis: In accordance with IEEE 3002.7.
 - e. Harmonic Analysis: In accordance with IEEE 3002.8.
 - f. Transient Stability Analysis: In accordance with IEEE P3002.9.
 - g. Arc-Flash Hazard Analysis: In accordance with IEEE 1584.
- 3. Capable of printing arc-flash hazard warnings for equipment on vinyl, weather- and UV-resistant, pressure-sensitive adhesive labels complying with NFPA 70E.
 - a. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard study:
 - 1) Equipment designation.
 - 2) Nominal voltage.
 - 3) Protection boundaries.
 - a) Arc-flash boundary.
 - b) Restricted approach boundary.
 - c) Limited approach boundary.
 - 4) Arc-flash PPE category.
 - 5) Required minimum arc rating of PPE in Cal/cm squared.
 - 6) Available incident energy.
 - 7) Working distance.
 - 8) Engineering report number, revision number, and issue date.
- B. Other Available Features Required by the Project:
 - 1. Simultaneous faults.
 - 2. Explicit negative sequence.
 - 3. Mutual coupling in zero sequence.
 - 4. Digital-Twin Model: Ability to create a digital-twin model for life-cycle operation and maintenance of the facility's electrical power system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Collect and analyze data for power system studies.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call discrepancies to Architect's attention.
2. For equipment included as Work on the Project, use characteristics submitted under provisions of action submittals and information submittals for the Project.
3. Gather and tabulate required input data to support power system studies. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on Record Document copy of one-line diagram. Comply with recommendations in IEEE 3002 series standards as to amount of detail that is required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:
 - a. Product data for the Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - b. Electrical power utility impedance at service.
 - c. Power sources and ties.
 - d. Short-circuit current at each system bus (three phase and line to ground).
 - e. Full-load current of loads.
 - f. Voltage level at each bus.
 - g. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 - h. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 - i. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 - j. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 - k. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
 - l. Maximum demands from service meters.
 - m. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
 - n. Motor horsepower and NEMA MG 1 code letter designation.
 - o. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).

- p. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).
- q. Derating factors.

3.2 PREPARATION

A. Preparation of Data for Short-Circuit Study:

1. Verify completeness of data supplied on one-line diagram. Call discrepancies to Architect's attention.
2. For equipment included as Work on the Project, use characteristics submitted under provisions of action submittals and information submittals for the Project.
3. Prepare one-line diagram of modeled power system, showing the following:
 - a. Protective device designations and ampere ratings.
 - b. Conductor types, sizes, and lengths.
 - c. Transformer kVA and voltage ratings.
 - d. Motor and generator designations and kVA ratings.
 - e. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
 - f. Derating factors and environmental conditions.
 - g. Revisions to electrical equipment required by study.

B. Preparation of Data for Overcurrent Protective Device Coordination Study:

1. Prepare data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, indicating the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

- j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.
 - k. Identify series-rated interrupting devices for condition where available fault current is greater than interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.
 - 2. Examine the Project's overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.
 - 3. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.
- C. Preparation of Data for Arc-Flash Hazard Study:
- 1. Assemble data from short-circuit study and overcurrent protective device coordination study.
 - 2. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.3 SHORT-CIRCUIT STUDY

- A. Base study on device characteristics supplied by device manufacturer.
- B. Extent of electrical power system to be studied is indicated on Drawings.
- C. Begin short-circuit current analysis at service, extending down to system overcurrent protective devices as follows:
 - 1. To normal system low-voltage load buses where fault current is 5 kA or less.
 - 2. Exclude equipment supplied by single transformer smaller than 75 kVA.
- D. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for the Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- E. Include AC fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase AC systems. Also account for fault-current DC decrement to address asymmetrical requirements of interrupting equipment.
- F. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.
 - G. Include in report identification of protective device applied outside its capacity.
- 3.4 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY
- A. Base study on device characteristics supplied by device manufacturer.
 - B. Extent of electrical power system to be studied is indicated on Drawings.
 - C. Begin analysis at service, extending down to system overcurrent protective devices as follows:
 1. To normal system low-voltage load buses where fault current is 5 kA or less.
 - D. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for the Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
 - E. Transformer Primary Overcurrent Protective Devices:
 1. Device must not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads in accordance with IEEE C57.96 if required by unusual loading or emergency conditions.
 2. Device settings must protect transformers in accordance with IEEE C57.12.00, for fault currents.
 - F. Motor Protection:
 1. Select protection for low-voltage motors in accordance with IEEE 3004.8 and NFPA 70.
 2. Select protection for motors served at voltages more than 600 V in accordance with IEEE 620.
 - G. Conductor Protection: Protect cables against damage from fault currents in accordance with ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 3004.7. Demonstrate that equipment withstands maximum short-circuit current for time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
 - H. Generator Protection: Select protection in accordance with manufacturer's published instructions and IEEE C37.102.

- I. Include AC fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase AC systems. Also account for fault-current DC decrement, to address asymmetrical requirements of interrupting equipment.
- J. Include coordination of ground-fault protection devices.
- K. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at equipment indicated on one-line diagram.
 - 1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.
- L. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 - 2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
 - 3. Application of series-rated devices must be recertified, complying with requirements in NFPA 70.
 - 4. Include in report identification of protective device applied outside its capacity.

3.5 LOAD-FLOW AND VOLTAGE-DROP STUDY

- A. Perform load-flow and voltage-drop study to determine steady-state loading profile of system. Analyze power system performance two times as follows:
 - 1. Determine load flow and voltage drop based on full-load currents.
 - 2. Determine load flow and voltage drop based on 80 percent of design capacity of load buses.
 - 3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.6 MOTOR-STARTING STUDY

- A. Perform motor-starting study to analyze transient effect of system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze effects of motor starting on power system stability.
- B. Prepare motor-starting study report, noting light flicker for limits proposed by IEEE 1453, and, and voltage sags so as not to affect operation of other utilization equipment on system supplying motor.

3.7 ARC-FLASH HAZARD STUDY

- A. Comply with NFPA 70E, including Annex D, for arc-flash hazard study.
- B. Preparatory Studies: Obtain short-circuit study and overcurrent protective device coordination study results prior to starting arc-flash hazard study.
- C. Calculate maximum and minimum contributions of fault-current size.
 - 1. Maximum calculation must assume maximum contribution from utility and must assume motors to be operating under full-load conditions.
 - 2. Calculate arc-flash energy at 85 percent of maximum short-circuit current in accordance with IEEE 1584 recommendations.
 - 3. Calculate arc-flash energy at 38 percent of maximum short-circuit current in accordance with NFPA 70E recommendations.
 - 4. Calculate arc-flash energy with utility contribution at minimum and assume no motor contribution.
- D. Calculate arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations.
- F. Calculate limited, restricted, and prohibited approach boundaries for each location.
- G. Incident energy calculations must consider accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations must account for changing current contributions, as sources are interrupted or decremented with time. Fault contribution from motors and generators must be decremented as follows:
 - 1. Fault contribution from induction motors must not be considered beyond three to five cycles.
 - 2. Fault contribution from synchronous motors and generators must be decayed to match actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 p.u. to 3 p.u. after 10 cycles).
- H. Arc-flash energy must generally be reported for maximum of line or load side of circuit breaker. However, arc-flash computation must be performed and reported for both line and load side of circuit breaker as follows:
 - 1. When circuit breaker is in separate enclosure.
 - 2. When line terminals of circuit breaker are separate from work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.8 POWER SYSTEM STUDY REPORTS

A. Preparation of Power System Study Reports: Prepare and submit the following:

1. Short-Circuit Study Report Contents:

- a. Executive summary of study findings.
- b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- c. One-line diagram of modeled power system, showing the following:
 - 1) Protective device designations and ampere ratings.
 - 2) Conductor types, sizes, and lengths.
 - 3) Transformer kVA and voltage ratings.
 - 4) Motor and generator designations and kVA ratings.
 - 5) Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
 - 6) Derating factors and environmental conditions.
 - 7) Revisions to electrical equipment required by study.
- d. Comments and recommendations for system improvements or revisions in written document, separate from one-line diagram.
- e. Short-Circuit Study Input Data:
 - 1) One-line diagram of system being studied.
 - 2) Power sources available.
 - 3) Manufacturer, model, and interrupting rating of protective devices.
 - 4) Conductors.
 - 5) Transformer data.
- f. Protective Device Evaluation:
 - 1) Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
 - 2) Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 - 3) For 600 V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 4) For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
 - 5) Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

g. Short-Circuit Study Output Reports:

- 1) Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a) Voltage.
 - b) Calculated fault-current magnitude and angle.
 - c) Fault-point X/R ratio.
 - d) Equivalent impedance.
- 2) Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a) Voltage.
 - b) Calculated symmetrical fault-current magnitude and angle.
 - c) Fault-point X/R ratio.
 - d) Calculated asymmetrical fault currents based on fault-point X/R ratio; based on calculated symmetrical value multiplied by 1.6; and based on calculated symmetrical value multiplied by 2.7.
- 3) Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a) Voltage.
 - b) Calculated symmetrical fault-current magnitude and angle.
 - c) Fault-point X/R ratio.
 - d) No AC Decrement (NACD) ratio.
 - e) Equivalent impedance.
 - f) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
 - g) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

2. Overcurrent Protection Device Coordination Study Report Contents:

- a. Executive summary of study findings.
- b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- c. One-line diagram of modeled power system, showing the following:
 - 1) Protective device designations and ampere ratings.
 - 2) Conductor types, sizes, and lengths.
 - 3) Transformer kVA and voltage ratings.
 - 4) Motor and generator designations and kVA ratings.
 - 5) Switchgear, switchboard, motor-control center, and panelboard designations.
 - 6) Revisions to electrical equipment required by study.

- d. Report recommended settings of protective devices, ready to be applied in field. Use manufacturer's data sheets for recording recommended setting of overcurrent protective devices when available.
- 1) Phase and Ground Relays:
 - a) Device tag.
 - b) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - c) Recommendations on improved relaying systems, if applicable.
 - 2) Circuit Breakers:
 - a) Adjustable pickups and time delays (long time, short time, and ground).
 - b) Adjustable time-current characteristic.
 - c) Adjustable instantaneous pickup.
 - d) Recommendations on improved trip systems, if applicable.
 - 3) Fuses: Show current rating, voltage, and class.
- e. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for switching schemes and for emergency periods where power source is local generation. Show the following information:
- 1) Device tag and title, one-line diagram with legend identifying portion of system covered.
 - 2) Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
 - 3) Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
 - 4) Plot the following listed characteristic curves, as applicable:
 - a) Power utility's overcurrent protective device.
 - b) Medium-voltage equipment overcurrent relays.
 - c) Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - d) Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - e) Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - f) Cables and conductors damage curves.
 - g) Ground-fault protective devices.
 - h) Motor-starting characteristics and motor damage points.

- i) Generator short-circuit decrement curve and generator damage point.
 - j) Largest feeder circuit breaker in each motor-control center and panelboard.
 - 5) Maintain selectivity for tripping currents caused by overloads.
 - 6) Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
 - 7) Provide adequate time margins between device characteristics such that selective operation is achieved.
 - 8) Comments and recommendations for system improvements.
3. Arc-Flash Hazard Study Report Contents:
- a. Executive summary of study findings.
 - b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
 - c. One-line diagram, showing the following:
 - 1) Protective device designations and ampere ratings.
 - 2) Conductor types, sizes, and lengths.
 - 3) Transformer kVA and voltage ratings, including derating factors and environmental conditions.
 - 4) Motor and generator designations and kVA ratings.
 - 5) Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
 - d. Short-circuit study output data.
 - e. Overcurrent protective device coordination study report contents.
 - f. Arc-Flash Study Output Reports:
 - 1) Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in report:
 - a) Voltage.
 - b) Calculated symmetrical fault-current magnitude and angle.
 - c) Fault-point X/R ratio.
 - d) No AC Decrement (NACD) ratio.
 - e) Equivalent impedance.
 - f) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
 - g) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.
 - g. Incident Energy and Flash Protection Boundary Calculations:
 - 1) Arcing fault magnitude.
 - 2) Protective device clearing time.

- 3) Duration of arc.
- 4) Arc-flash boundary.
- 5) Restricted approach boundary.
- 6) Limited approach boundary.
- 7) Working distance.
- 8) Incident energy.
- 9) Hazard risk category.
- 10) Recommendations for arc-flash energy reduction.

- h. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

3.9 DIGITAL-TWIN MODELING

- A. Create digital-twin model of as-constructed facility's electrical power system.

3.10 FIELD ADJUSTMENT FOR DEVICE COORDINATION

- A. Adjust relay and protective device settings in accordance with recommended settings provided by coordination study. Field adjustments must be completed by engineering service division of equipment manufacturer under "Startup and Acceptance Testing" contract portion.
- B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.
- C. Testing and adjusting must be by qualified medium-voltage and low-voltage electrical testing and inspecting agency.
 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for adjustable overcurrent protective devices.

3.11 WARNING LABELING OF ARC-FLASH HAZARDS

- A. Apply one arc-flash label on front cover of each section of equipment for each equipment included in study, including each piece of equipment listed below:
 1. Medium voltage transformers.
 2. Low-voltage switchgear.
 3. Panelboards.
 4. Low voltage transformers.
- B. Base arc-flash label data on highest values calculated at each location.
- C. Machine print warning labels with no handwritten or field-applied markings.

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- D. Install arc-flash warning labels under direct supervision and control of qualified electrical professional engineer.
- E. Indicate on record Drawings location of equipment where personnel could be exposed to arc-flash hazard during their work.
 - 1. Indicate arc-flash energy.
 - 2. Indicate protection level required.

END OF SECTION 260573

SECTION 262416
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Panelboards.
2. Disconnecting and overcurrent protective devices.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural design conditions applicable to the Work specified in this Section.
3. Section 260500 "Common Work Results for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other requirements applicable to the Work for electrical, communications, and electronic safety and security systems on Project, including wiring methods.
4. Section 260529 "Hangers and Supports for Electrical Systems" specifies concrete bases and supports for panelboards installed by this Section.
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
6. Section 260573 "Power System Studies" specifies short-circuit current studies, overcurrent protective device coordination studies, and arc-flash hazard analysis studies.

1.2 DEFINITIONS

A. MCCB: Molded-case circuit breaker.

B. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. In addition to information identified in Section 013300 "Submittal Procedures," submit the following:

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
2. Include manufacturer's sample extended warranty language.

B. Shop Drawings: For each panelboard and related equipment:

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include Internet link for electronic access to downloadable PDF of coordination curves.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards.

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for voltage monitoring and adjusting.
3. Field reports for infrared scanning.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

1.7 QUALIFICATIONS

- A. Low-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - 1. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation in accordance with [NECA 407] [NEMA PB 1].

1.9 WARRANTY

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed panelboards perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.
 - 1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.
- B. Special Manufacturer Extended Warranty: Manufacturer warrants that panelboards perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.
 - 1. Initial Extended-Warranty Period: Four years from date of Substantial Completion; full coverage for labor, materials, and equipment.
 - 2. Follow-On Extended-Warranty Period: Five years from date of Substantial Completion; full coverage for materials that failed because of transient voltage surges only, free on board origin, freight prepaid.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- B. Fabricate and test panelboards in accordance with IEEE 344 to withstand seismic forces specified in Section 018123 "Facility Seismic and Wind Criteria."

- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Comply with NEMA PB 1.
- E. Enclosures: Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Outdoor Locations: UL 50E, Type 4X.
 - b. Kitchen and Wash-Down Areas: UL 50E, Type 4X.
 - c. Other Wet or Damp Indoor Locations: UL 50E, Type 4X.
 - 2. Height: 7 ft (2.13 m) maximum.
 - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims must cover live parts and may have no exposed hardware.
 - 4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
 - 5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 7. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Same finish as panels and trim.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- F. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating must run entire length of bus.
 - b. Bus must be fully rated for entire length.
 - 2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
 - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
- G. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.

2. Terminations must allow use of 75 deg C rated conductors without derating.
 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 4. Main and Neutral Lugs: Compression type, with lug on neutral bar for each pole in panelboard.
 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with lug on bar for each pole in panelboard.
- H. Quality-Control Label: Panelboards or load centers must be labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers must have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- I. Future Devices: Panelboards or load centers must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Percentage of Future Space Capacity: 20 percent.
- J. Panelboard Short-Circuit Current Rating:
1. Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction. Include label or manual with size and type of allowable upstream and branch devices listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series-connected short-circuit rating.
 - a. Panelboards rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
 - b. Panelboards rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.
 2. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.
 - a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
 - b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2.2 PANELBOARDS

- A. UL QEUY - Lighting and Appliance Branch-Circuit Panelboard:

1. Source Limitations: Obtain products from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Lighting and Appliance Branch-Circuit Type Panelboards: UL CCN QEUY; including UL 67 and NEMA PB 1.
3. Standard Features:
 - a. Mains: Circuit breaker or lugs only.
 - 1) Location: Bottom.
 - 2) Main Breaker: Main lug interiors up to 400 A must be field convertible to main breaker.
 - b. Branch Overcurrent Protective Devices: Plug-in or Bolt-on circuit breakers, replaceable without disturbing adjacent units.
4. Other Available Features Required by Project:
 - a. Surge Suppression: Factory installed as integral part of indicated panelboards, complying with UL 1449 SPD Type 1.
 - b. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
 - c. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
 - d. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors must be sized for double-sized or parallel conductors as indicated on Drawings.
 - e. Do not mount neutral bus in gutter.
 - f. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - g. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 - h. Gutter-Tap Lugs: Compression type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
 - i. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
 - j. Split Bus: Vertical buses divided into individual vertical sections.
 - 1) Contactors in Main Bus: NEMA ICS 2, Class A, [electrically] [mechanically] held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

- a) Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
- k. Doors: Door-in-door construction with concealed hinges; secured with flush or multipoint latch with tumbler lock; keyed alike. Outer door must permit full access to panel interior. Inner door must permit access to breaker operating handles and labeling, but current carrying terminals and bus must remain concealed.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event must be recorded with type, phase, and magnitude of fault that caused trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long- and short-time adjustments.
 - 4) Ground-fault pickup level, time delay, and $I^2 T$ response.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).
 - 6. GFPE Circuit Breakers: Class B ground-fault protection (30 mA trip).
 - 7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240 V, single-pole configuration.

8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: [Compression] [Mechanical] style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
 - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
 - h. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
 - i. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - j. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 A must have interchangeable rating plugs or electronic adjustable trip units.
- B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
 1. Provide fuses and spare fuse cabinet.
 2. Fused Switch Features and Accessories:
 - a. Standard ampere ratings and number of poles.
 - b. Mechanical cover interlock with manual interlock override, to prevent opening of cover when switch is in on position. Interlock must prevent switch from being turned on with cover open. Operating handle must have lock-off means with provisions for three padlocks.
 - c. Auxiliary Contacts: [One] [Two] normally open and normally closed contact(s) that operate with switch handle operation.

2.4 MAINTENANCE MATERIAL ITEMS

- A. Spare Parts: Furnish to Owner spare parts, for repairing panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
 1. Keys: Two spares for each type of panelboard cabinet lock.
 2. Circuit Breakers Including GFCI and GFPE Types: Two spares for each panelboard.
 3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

- B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
 - 1. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
 - 2. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards in accordance with NECA 407 and NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 - 1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NECA 407 and NEMA PB 1.1.
 - 2. Consult Architect for resolution of conflicting requirements.
- C. Special Techniques:
 - 1. Equipment Mounting:
 - a. Install floor-mounted panelboards on cast-in-place concrete equipment base(s).
 - b. Attach panelboard to vertical finished or structural surface behind panelboard.

- c. Mount surface-mounted panelboards to steel slotted supports [5/8 inch (16 mm) in depth. Orient steel slotted supports vertically.
 - d. Provide seismic control devices.
 - 2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
 - 3. Provide mounting and anchoring devices.
 - 4. Mount top of trim 7.5 ft (2.3 m) above finished floor unless otherwise indicated.
 - 5. Mount panelboard cabinet plumb and rigid without distortion of box.
 - 6. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
 - 7. Install overcurrent protective devices and controllers not already factory installed.
 - a. Set field-adjustable, circuit-breaker trip ranges.
 - b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.
 - 8. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
 - 9. Install filler plates in unused spaces.
 - 10. Stub four 1 inch (25 mm) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in future. Stub four 1 inch (25 mm) empty conduits into raised floor space or below slab not on grade.
 - 11. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
 - 12. Mount spare fuse cabinet in accessible location.
- D. Interfaces with Other Work:
- 1. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components.
- B. Install warning signs.
- C. Panelboard Nameplates: Label each panelboard with nameplate.
- D. Device Nameplates: Label each branch circuit device in power panelboards with nameplate.

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- E. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.
- F. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.
- G. Circuit Directory:
 - 1. Provide directory card inside panelboard door, mounted in metal frame with transparent protective cover.
 - a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.
 - 2. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.
 - 3. Create directory to indicate installed circuit loads[after balancing panelboard loads]; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.4 FIELD QUALITY CONTROL

- A. Adminstrant for Low-Voltage Electrical Tests and Inspections:
 - 1. Owner will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
 - 2. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
 - 3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
 - 4. Administer and perform tests and inspections[with assistance of factory-authorized service representative].
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Field tests and inspections must be witnessed by authorities having jurisdiction.
- D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Nonconforming Work:

1. Panelboards will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

1. Include certified report that identifies panelboards included and that describes scanning results, with comparisons of two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

G. Manufacturer Services: Engage factory-authorized service representative to [support] [supervise] field tests and inspections.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
 1. Measure loads during period of normal facility operations.

2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within panelboard, may not exceed 20 percent.

3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature in accordance with manufacturer's published instructions.

END OF SECTION 262416

SECTION 262726
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General-grade duplex straight-blade receptacles.
2. Receptacles with arc-fault and ground-fault protective devices.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
3. Section 260500 "Common Work Results for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260533.16 "Boxes and Covers for Electrical Systems" specifies covers and cover plates referenced by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.

1.2 DEFINITIONS

A. AFCI: Arc-Fault Circuit Interrupter.

B. Commercial/Industrial-Use Cord Reel: A cord reel subject to severe use in factories, commercial garages, construction sites, and similar locations requiring a harder service-type cord.

C. GFCI: Ground-Fault Circuit Interrupter.

D. UL 1472 Type I Dimmer: Dimmer in which air-gap switch is used to energize preset lighting levels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference virtually.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
 - a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
 - b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
 - c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are not acceptable for submitted product.
2. Include manufacturer's sample extended warranty language.

B. Samples:

1. One for each kind of duplex straight-blade receptacle and cover plate accessory specified, in each finish and color specified.
2. One for each kind of receptacle with GFCI device and cover plate accessory specified, in each finish and color specified.

C. Shop Drawings:

1. Wiring diagrams for duplex straight-blade receptacles with integral switching means.

D. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Manufacturer's field reports for field quality-control support.

1.6 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra stock material.
- B. Special tools.

1.8 QUALIFICATIONS

- A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.
- B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.
- C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - 1. On-site electrical testing supervisors must possess active NICET EPT Technician [III] [IV] certification.

1.9 WARRANTY FOR DEVICES

- A. Special Installer Extended Warranty: Installer warrants that installed devices perform in accordance with specified requirements and agrees to repair or replace products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.
 - 1. Extended-Warranty Period: Four years from date of Substantial Completion; full coverage for labor, materials, and equipment.
- B. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.
 - 1. Initial Extended Warranty Period: Five years from date of Substantial Completion; full coverage for labor, materials, and equipment.
 - 2. Follow-On Extended Warranty Period: Eight years from date of Substantial Completion; full coverage for materials only, free on board origin, freight prepaid.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

- A. Duplex Straight-Blade Receptacle:

- 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
 - b. Surge Protective Devices: UL 1449, Type 3.
- 2. Standard Features:
 - a. Device Color: White in accordance with NEMA WD 1.
 - b. Configuration:
 - 1) General-duty, NEMA 5-20R.
 - 2) General-duty, smooth face, NEMA 5-20R.
 - 3) Heavy-duty, NEMA 5-20R.
 - 4) Heavy-duty, smooth face, NEMA 5-20R.
 - 5) Extra-heavy-duty, NEMA 5-20R.
 - 6) Extra-heavy-duty, smooth face, NEMA 5-20R.
- 3. Other Available Features Required by the Project:
 - a. Has factory-terminated connectors on wiring device pigtails for quick installation.
- 4. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

- B. Tamper-Resistant Duplex Straight-Blade Receptacle:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Receptacles for Plugs and Attachment Plugs: UL CCN RTRT and UL 498.
 - b. Surge Protective Devices: UL 1449, Type 3.
2. Standard Features:
 - a. Device Color: White in accordance with NEMA WD 1.
 - b. Configuration:
 - 1) General-duty, NEMA 5-20R.
 - 2) General-duty, smooth face, NEMA 5-20R.
 - 3) Heavy-duty, NEMA 5-20R.
 - 4) Heavy-duty, smooth face, NEMA 5-20R.
 - 5) Extra-heavy-duty, NEMA 5-20R.
3. Other Available Features Required by the Project:
 - a. Has factory-terminated connectors on wiring device pigtails for quick installation.
4. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.3 RECEPTACLES WITH ARC-FAULT AND GROUND-FAULT PROTECTIVE DEVICES

A. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Receptacle GFCIs: UL CCN KCXS, UL 498, and UL 943.
2. Standard Features:
 - a. Device Color: White in accordance with NEMA WD 1.
 - b. Configuration: Heavy-duty, NEMA 5-20R.
3. Other Available Features Required by the Project:

- a. Has factory-terminated connectors on wiring device pigtails for quick installation.
- 4. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) thick, lockable, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.4 MAINTENANCE MATERIAL ITEMS FOR STRAIGHT-BLADE RECEPTACLES

- A. Extra Stock Material: Furnish to Owner extra materials, from same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Include the following:
 - 1. GFCI Receptacles: Equal to 10 percent of quantity installed for each kind specified, but no fewer than two units.
- B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to controlled receptacles, that are packaged with protective covering for storage on-site and identified with labels describing contents.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receptacles:
 - 1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.2 SELECTION OF GFCI RECEPTACLES

- A. Healthcare Facilities: Unless protection of downstream branch-circuit wiring, cord sets, and power-supply cords is required by NFPA 70 or NFPA 99, provide non-feed-through GFCI receptacles.

3.3 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

- A. Comply with manufacturer's published instructions.

- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFB, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Installing and Maintaining Wiring Devices: NECA NEIS 130.
5. Mounting Heights: Unless otherwise indicated in the Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
6. Receptacle Orientation: Unless otherwise indicated in the Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
 - a. Hospital-Grade Receptacle Orientation: Orient receptacle with ground pin or neutral pin at top.
7. Consult Architect for resolution of conflicting requirements.

- C. Interfaces with Other Work:

1. Identification: Provide labels for receptacles and associated electrical equipment.
 - a. Identify field-installed conductors, interconnecting wiring, and components.
 - b. Label each enclosure with engraved metal or laminated-plastic nameplate.
 - 1) Identify cover or cover plate for device with panelboard identification and circuit number.
 - 2) Mark cover or cover plate using hot, stamped, or engraved machine printing with [black] [white] [red]-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
 - c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.
 - d. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.
2. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.
3. performed at the Project site.

3.4 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

- A. Administrant for Electrical Power Tests and Inspections:

1. Owner will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
 2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
 3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
 4. Administer and perform tests and inspections with assistance of factory-authorized service representative.
- B. Acceptance Testing Preparation:
- C. Field tests and inspections must be witnessed by authorities having jurisdiction.
- D. Tests and Inspections:
1. Insert and remove test plug to verify that device is securely mounted.
 2. Verify polarity of hot and neutral pins.
 3. Measure line voltage.
 4. Measure percent voltage drop.
 5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
 6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).
 7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' published instructions.
- E. Nonconforming Work:
1. Device will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective units and retest.
- F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.
- G. Manufacturer Services: Engage factory-authorized service representative to [support] [supervise] field tests and inspections.
1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.
- 3.5 ADJUSTING
- A. Occupancy Adjustments for Controlled Receptacles: When requested within 12] months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual

occupied conditions. Provide up to two visits to the Project during other-than-normal occupancy hours for this purpose.

- B. Cord Reels and Fittings: Adjust spring mechanisms and moving parts of cord reels and fittings to function smoothly, and lubricate as recommended in writing by manufacturer.

3.6 PROTECTION

- A. Devices:

- 1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
 - 2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

- B. Cord Reels and Fittings:

- 1. After installation, protect cord reels and fittings from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

- C. Connectors, Cords, and Plugs:

- 1. After installation, protect connectors, cords, and plugs from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262726

SECTION 262816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Molded-case circuit breakers (MCCBs).
3. Enclosures.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. GFEP: Ground-fault circuit-interrupter for equipment protection.
- B. GFLS: Ground-fault circuit-interrupter for life safety.
- C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Enclosure types and details for types other than UL 50E, Type 1.
3. Current and voltage ratings.
4. Short-circuit current ratings (interrupting and withstand, as appropriate).
5. Include evidence of qualified electrical testing laboratory listing for series rating of installed devices.

6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 7. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in [PDF] [and] <Insert calculation program format> electronic format.
- B. Shop Drawings: For enclosed switches and circuit breakers.
1. Include plans, elevations, sections, details, and attachments to other work.
 2. Include wiring diagrams for power, signal, and control wiring.
- C. Field Quality-Control Submittals:
1. Field quality-control reports.
- 1.4 INFORMATIONAL SUBMITTALS
- A. Sample warranties.
- 1.5 CLOSEOUT SUBMITTALS
- A. Warranty documentation.
- 1.6 MAINTENANCE MATERIAL SUBMITTALS
- A. Spare Parts: Furnish to Owner spare parts, for repairing enclosed switches and circuit breakers, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 2. Fuse Pullers: Two for each size and type.
- 1.7 WARRANTY
- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed enclosed switches and circuit breakers perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.
1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

- B. Special Manufacturer Extended Warranty: Manufacturer warrants that enclosed switches and circuit breakers perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.
 - 1. Extended-Warranty Period: Three years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain products from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 MOLDED-CASE CIRCUIT BREAKERS

- A. Circuit breakers must be constructed using glass-reinforced insulating material. Current carrying components must be completely isolated from handle and accessory mounting area.
- B. Circuit breakers must have toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. Circuit-breaker handle must be over center, be trip free, and reside in tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon must be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with push-to-trip button, located on face of circuit breaker to mechanically operate circuit-breaker tripping mechanism for maintenance and testing purposes.
- C. Maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings must be clearly marked on face of circuit breaker. Circuit breakers must be 100 percent rated. Circuit breaker/circuit breaker combinations for series connected interrupting ratings must be listed by UL as recognized component combinations. Series rated combination used must be marked on end-use equipment along with statement "Caution - Series Rated System. ____ Amps Available. Identical Replacement Component Required."
- D. MCCBs must be equipped with device for locking in isolated position.

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- E. Lugs must be suitable for 90 deg C rated wire, sized in accordance with 75 deg C temperature rating in NFPA 70.
- F. Standard: Comply with UL 489 with required interrupting capacity for available fault currents.
- G. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- H. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- I. Electronic Trip Circuit Breakers: Field-replaceable rating plug, RMS sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I-squared t response.
- J. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- K. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- L. GFLS Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6 mA trip).
- M. GFEP Circuit Breakers: With Class B ground-fault protection (30 mA trip).
- N. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 4. Alarm Switch: One [NO] [NC] contact that operates only when circuit breaker has tripped.
 - 5. Auxiliary Contacts: [One SPDT switch] [Two SPDT switches] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 6. Lugs: [Mechanical] [Compression] type, suitable for number, size, trip ratings, and conductor material.
 - 7. Ground-Fault Protection: Comply with UL 1053; [integrally mounted, self-powered] [remote-mounted and powered] type with mechanical ground-fault indicator; relay with

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- adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
8. Communication Capability: [Circuit-breaker-mounted] [Universal-mounted] [Integral] [Din-rail-mounted] communication module with functions and features compatible with power monitoring and control system, specified in Section 260913 "Electrical Power Monitoring and Control."
 9. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 10. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
 11. Zone-Selective Interlocking: Integral with [electronic] [ground-fault] trip unit; for interlocking ground-fault protection function.
 12. Electrical Operator: Provide remote control for on, off, and reset operations.
 13. Accessory Control Power: [Integrally mounted, self-powered] [Remote mounted and powered]; [24 V(ac)] [120 V(ac)] [208 V(ac)] [240 V(ac)] [12 V(dc)] [24 V(dc)] [120 V(dc)].

2.3 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: Enclosure must be a brush finish on Type 304 stainless steel (UL 50E Type 4-4X stainless steel).
- C. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: Circuit-breaker operating handle must be externally operable with operating mechanism being integral part of box, not cover. Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.
- E. Enclosures designated as UL 50E Type 4, 4X stainless steel, 12, or 12K must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.
- F. UL 50E Type 7/9 enclosures must be furnished with breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

3.2 SELECTION OF ENCLOSURES

- A. Outdoor Locations: UL 50E, Type 4X.
- B. Wash-Down Areas: UL 50E, Type 4X.
- C. Other Wet or Damp, Indoor Locations: UL 50E, Type 4X.

3.3 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Special Techniques:
 - 1. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
 - 2. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
 - 3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
 - 4. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
 - 5. Install fuses in fusible devices.

3.4 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the following methods:
 - 1) Use low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on Drawings.
 - i. Verify correct phase barrier installation.
 - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
 - 2. Electrical Tests:
 - a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
 - b. Measure contact resistance across each switchblade fuseholder. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

- c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- e. Perform ground fault test in accordance with NETA ATS Section 7.14 "Ground Fault Protection Systems, Low-Voltage."

C. Tests and Inspections for Molded-Case Circuit Breakers:

1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data are as described in the Specifications and shown on Drawings.
- b. Inspect physical and mechanical condition.
- c. Inspect anchorage, alignment, grounding, and clearances.
- d. Verify that unit is clean.
- e. Operate circuit breaker to ensure smooth operation.
- f. Inspect bolted electrical connections for high resistance using one of the following methods:
 - 1) Use low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
- g. Inspect operating mechanism, contacts, and chutes in unsealed units.
- h. Perform adjustments for final protective device settings in accordance with coordination study.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar

connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

- b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - c. Perform contact/pole resistance test. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
 - d. Perform insulation resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values may be no less than 2 M Ω .
 - e. Determine the following by primary current injection:
 - 1) Long-time pickup and delay. Pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 2) Short-time pickup and delay. Short-time pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 3) Ground-fault pickup and time delay. Ground-fault pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 4) Instantaneous pickup. Instantaneous pickup values must be as specified and within manufacturer's published tolerances.
 - f. Test functionality of trip unit by means of primary current injection. Pickup values and trip characteristics must be as specified and within manufacturer's published tolerances.
 - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must be as indicated by manufacturer.
 - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset trip logs and indicators. Investigate units that do not function as designed.
 - i. Verify operation of charging mechanism. Investigate units that do not function as designed.
3. Test and adjust controls, remote monitoring, and safeties.

D. Nonconforming Work:

1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
 2. Remove and replace defective units and retest.
- E. Collect, assemble, and submit test and inspection reports.
1. Test procedures used.
 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 3. List deficiencies detected, remedial action taken, and observations after remedial action.
- F. Manufacturer Services:
1. Engage factory-authorized service representative to [support] [supervise] field tests and inspections.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges values indicated on Drawings.

3.7 PROTECTION

- A. After installation, protect enclosed switches and circuit breakers from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

- A. Infrared Scanning of Enclosed Switches and Breakers: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.
1. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 2. Follow-up Infrared Scanning: Perform two follow-up infrared scans of enclosed switches and breakers, one at four months and another at 11 months after Substantial Completion.
 3. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.

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4. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 262816

SECTION 310000
EARTHWORK

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the work specified in this section, and as shown on the Drawings.
- B. Work performed under this Section of the Specifications shall be subject to the General Conditions, Supplementary Conditions and Division 01 General Requirements of the Contract Documents.
- C. The work of this section includes but is not necessarily limited to:
 - 1. Excavation, fill, and backfill, as indicated or required, including compaction
 - 2. Excavation, as required, to the lines and grades indicated on the Drawings
 - 3. Excavation and offsite disposal of unsuitable or excess materials unless on-site locations are designated. Excavation shall include removal and satisfactory disposal of all unclassified material encountered throughout the site.
 - 4. Rough grading, including placement, moisture conditioning, and compaction of fills and backfill
 - 5. Placement of base and subbase course materials under structures, pavements, slabs, and footings, including compaction
 - 6. Trench excavation, bedding, and backfill for structures, foundations, and utilities, including compaction
 - 7. The removal, hauling and stockpiling of suitable excavated materials for subsequent use in the work. Stockpiling shall include protection to maintain materials in a workable condition
 - 8. Rehandling, hauling, and placing of stockpiled materials for use in refilling, filling, backfilling, grading, and such other operations
 - 9. Protection and preservation of all existing buildings, pavements, and utilities to remain
 - 10. Furnishing and installing all sheeting, shoring, and bracing of structural and trench excavations and its satisfactory removal, unless otherwise directed to have it remain in place
 - 11. Environmental controls
 - 12. Providing products in sufficient quantities to meet the project requirements
 - 13. Providing adequate pumping and drainage facilities to keep the work area sufficiently dry
 - 14. Obtaining all required permits, licenses, and approvals from appropriate municipal and utility authorities, prior to commencement of the work of this Section, and paying costs incurred therefrom
- D. Provision of facilities, labor, materials, tools, equipment, appliances, and related work necessary to provide and maintain erosion control during construction operations. All erosion control measures shall be installed prior to earthwork operations and shall be maintained according to plans and other sections of the specifications.
 - 1. Refer to Section 312500 – EROSION AND SEDIMENTATION CONTROLS

- E. Contractor shall be responsible for notifying all affected utility companies before starting work. Comply with the requirements of the State of Maine "Dig Safe" Utilities Underground Plant Damage Prevention System.

1.02 RELATED SECTIONS

- A. Carefully examine the Contract Documents for requirements which affect the work in this Section. Other Specification Sections which directly relate to the work of this Section include, but are not limited to, the following:
 - 1. Section 311000 – SITE CLEARING
 - 2. Section 312500 – EROSION AND SEDIMENTATION CONTROLS
 - 3. Section 321215 – ASPHALT PAVING
 - 4. Section 329000 – PLANTING
 - 5. Section 334000 – STORM DRAINAGE UTILITIES

1.03 REFERENCE STANDARDS

- A. References herein are made in accordance with the listed specific standards of the following organizations and work under this Section shall conform to the latest edition, unless modified by these Specifications.
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. T11 – Standard Method of Test for Materials Finer Than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
 - 2. ASTM International (ASTM):
 - a. D422 (2007) Standard Test Method for Particle-Size Analysis of Soils
 - b. D1557-12 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
 - c. D5268-10 Standard Specification for Topsoil Used for Landscaping Purposes
 - 3. American Concrete Institute (ACI):
 - a. 229R-13 Report on Controlled Low-Strength Materials

1.04 LAWS AND REGULATIONS

- A. Work shall be accomplished in accordance with regulations of local, county, state and federal agencies or utility company standards as they apply.

1.05 QUALITY ASSURANCE

- A. The Owner may retain and pay for the services of an independent testing and inspection firm and/or a Geotechnical Consultant to perform on-site observation and testing during the various phases of the construction operations. The scope of services will be determined by the Owner and the independent testing and inspection firm and/or the Geotechnical Consultant, and results will be provided to the Contractor. The Owner reserves the right to modify or waive the services of the independent testing and inspection firm and/or the Geotechnical Consultant. The services of an independent testing firm and/or Geotechnical Consultant may include, but not necessarily be limited to, the following:

1. Observation during excavation and dewatering of building areas and controlled fill areas.
 2. Laboratory testing and analysis of fill materials as specified herein and proposed by the Contractor for incorporation into the Work.
 3. Observation of construction and performance of water content, gradation and compaction tests at a frequency and locations that the independent testing and inspection firm and/or the Geotechnical Consultant may require. The results of these tests will be submitted to the Owner, Engineer, and Contractor on a timely basis so that action can be taken to remedy indicated deficiencies. During the course of construction, the independent testing and inspection firm and/or the Geotechnical Consultant will advise the Owner in writing, if at any time in their opinion, the Work hereunder is of unacceptable quality. Failure of independent testing and inspection firm and/or the Geotechnical Consultant to give notice, shall not excuse the Contractor from latent defects discovered in their work.
- B. The Contractor shall make provisions for allowing observations and testing of Contractor's work by the independent testing and inspection firm and/or the Geotechnical Consultant.
1. The presence of the independent testing and inspection firm and/or the Geotechnical Consultant does not include supervision or direction of the actual work of the Contractor, and their employees or agents. Neither the presence of the independent testing and inspection firm and/or the Geotechnical Consultant, nor any observations and testing performed by them, nor failure to give notice of defects shall excuse the Contractor from defects discovered in their work.
- C. Costs related to retesting due to unacceptable qualities of work and failures discovered by testing shall be paid for by the Contractor at no additional expense to Owner, and the costs thereof will be deducted by the Owner from the Contract Sum.
- D. Whenever floodplain or wetland compensation areas are designated on the plans, grading elevations are to be considered critical to the volumetric calculations and shall be constructed by the Contractor in strict conformance with the indicated grades.

1.06 SUBMITTALS

- A. Submit, in an airtight container for the testing laboratory, a 50-pound sample of each type of off-site fill material that is to be used at the site. Submit samples a minimum of one week prior to use of proposed material at the site. Submit samples to the testing laboratory and/or the Geotechnical Consultant (copy of these transmittal forms shall be simultaneously sent to Engineer) or if no testing laboratory and/or Geotechnical Consultant is identified, then the Engineer shall be the recipient of the samples. Use of these proposed materials by the Contractor prior to testing and approval shall be at the Contractor's risk.
- B. The Engineer will be responsible for the approval or rejection of the suitability of all materials.
- C. Submit the name of each material supplier and specific type and source of each material. Any change in source throughout the project will require approval of the Owner or Engineer.
- D. For use of geotextile fabrics or geogrids, submit manufacturer's product data including material properties for approval by the Engineer.

1.07 COORDINATION

- A. Prior to start of earthwork the Contractor shall arrange an on-site meeting with the Engineer, the Owner's Representative, the independent testing firm, and/or the Geotechnical Consultant for the purpose of establishing the Contractor's schedule of operations and scheduling observation and testing procedures and requirements.
- B. As construction proceeds, the Contractor shall be responsible for notifying the Owner and Engineer prior to the start of earthwork operations requiring observation and/or testing.

1.08 SUBSURFACE SOIL DATA

- A. A geotechnical engineering report has been prepared by S. W. Cole Engineering, Inc. This report is specifically not part of the Contract Documents but is available to bidders for informational purposes.
- B. Review available logs of borings, test pit logs, jar soil samples, records of explorations and other pertinent data for the site. After obtaining Owner's permission, take whatever additional subsurface explorations deemed necessary at no expense to the Owner.
- C. Boring logs are available by request.
- D. Subsurface soil data is provided for general information and is accurate only at the particular locations and times the subsurface explorations were made. It is the Contractor's responsibility to make interpretations and to draw conclusions based on the character of materials to be encountered and the impact on their work based on their expert knowledge of the area and of earthwork techniques.
- E. The Drawings in the geotechnical report showing existing ground elevations are only for whatever use the Contractor may make of them with no responsibility on the part of the engineers, surveyors, the Owner, the Engineer, and/or their representatives for the accuracy and/or the reliability of the information given.
- F. If a potential conflict exists between the Geotechnical Report and these technical Specifications, the Contractor shall, immediately upon its discovery, request clarification from the Owner's Representative or the Engineer.

PART 2 – PRODUCTS

2.01 SUBGRADE

- A. Subgrade is the material in excavation (cuts) and fills located below subbase, base course layer for slabs, sidewalks, pavement, and other improvements.

2.02 COMMON BORROW

- A. Fill to raise grades in paved and landscape areas should be non-organic compactable earth meeting the requirements of 2020 MaineDOT Standard Specification 703.18 Common Borrow. On-site soils are unsuitable for reuse beneath paved and hardscape areas but may

be suitable for reuses as Common Borrow in landscape area, provided they are at a compactable moisture content at the time of reuse.

2.03 GRANULAR BORROW

- A. Fill to raise grades in building and paved areas, as well as to repair soft areas, should be sand silty sand meeting the requirements of 2020 Maine Department of Transportation (MaineDOT) Standard Specification 703.19 Granular Borrow.

2.04 SAND

- A. Sand shall consist of clean, inert, hard, durable grains of quartz or other hard, durable rock, free from loam or clay, surface coatings and deleterious materials.
1. The allowable amount of material passing a No. 200 sieve as determined by AASHTO-T11 or ASTM D422 shall not exceed 10 percent by weight. The maximum particle size shall be 1/4-inch (i.e., 100 percent passing the No. 4 sieve).
 2. In addition to the above criteria when sand is used for bedding concrete pavers and for utility bedding it shall conform to the following gradation:

Sieve (ASTM D422)	Percent Passing by Weight
No. 4	100
No. 8	80 – 95
No. 16	55 – 85
No. 50	0 – 35
No. 200	0 – 5

2.05 CRUSHED STONE

- A. Crushed Stone used for underdrain aggregate, should be washed ¾-inch crushed stone meeting the requirements of 2020 MaineDOT Standard Specification 703.13 Crushed Stone ¾-inch.

2.06 GRAVEL BASE AND SUBBASE MATERIALS BELOW PAVEMENT OR AS NOTED:

- A. Base: MaineDOT 703.06 Aggregate Base Type A
B. Subbase: MaineDOT 703.06 Aggregate Subbase Type D

2.07 STRUCTURAL FILL

- A. Backfill for foundations, material below exterior entrance slabs, and backfill to repair soft areas, should be clean, non-frost susceptible sand and gravel meeting the following gradation:

Sieve Size	Percent Passing by Weight
4 inch	100
3 inch	90-100
¼ inch	25 to 90
No. 40	0 – 30
No. 200	0 to 6

2.08 CHOKE STONE

- B. Choke Stone shall be hard, durable, clean, rock with a maximum rock diameter of nine inches (9") and shall conform to the following gradation:

Sieve Size	Percent Passing by Weight
9 inches	100
6 inches	75 - 100
2 inches	70 - 85
¾ inches	45 - 60
No. 4	15 - 30
No. 40	5 - 15
No. 200	0 - 10

2.09 STONE FILL

- A. Stone Fill shall be hard, durable, clean, washed rock with a minimum diameter of 1-1/2 inches and a maximum diameter of 3 inches with void ratio of 30 to 40 percent.

2.10 RIPRAP

- A. Revetment shall consist of slope protection of the required type at the location shown on the plans, and in conference with the lines and grades shown on the plans.
- B. Riprap shall consist of a protective covering of angular shaped stones laid on slopes in front of structures, wingwalls, piers, and elsewhere as required, to insure protection of structures and embankments.
- C. Riprap shall be sound, durable rock, which is angular in shape. Rounded stones, boulders, sandstone, or similar soft stone or relatively thin slabs will not be acceptable. Each stone shall weigh not less than 50 pounds and at least 75% of the volume shall consist of stones weighing not less than 500 pounds each. The remainder of the stones shall be so graded that when placed with the larger stones the entire mass will be compact.

2.11 STONE FOR PIPE ENDS

- A. Stone for pipe ends and energy dissipaters shall be sound, durable rock, angular in shape. Rounded stones, boulders, sandstone, or similar stone or relatively thin slabs will not be acceptable. The majority of the larger stones shall weigh not less than 50 pounds nor be less than 1.4 ft. long, 0.5 ft. wide, and 0.5 ft. in height. Each larger stone shall weigh not more than 125 pounds nor be more than 2.0 ft. long, 0.8 ft. wide, and 0.8 ft. in height and at least 50 percent of the larger stone volume shall consist of stones weighing not less than 75 pounds nor be less than 1.6 ft. long, 0.6 ft. wide, and 0.6 ft. height. The remainder of the stones shall be so graded that when placed with the larger stones the entire mass will be compact.

2.12 FILTER FABRIC AND GEOTEXTILES

- A. Filter Fabric used with riprap, stone for pipe ends, slope paving, or channel paving (grouted or ungrouted) shall be as Mirafi 140N or approved equivalent.
- B. Filter Fabric used for prevention of soil intrusion into drains or to assist in stabilizing soil subgrades shall be Mirafi 140N or approved equivalent.
- C. Filter fabric in drainage recharge systems, underdrain systems between crushed stone and granular soils, leaching areas, or where indicated on the plans shall be Mirafi 140N or approved equivalent.

2.13 CONTROLLED DENSITY FILL

- A. Controlled low strength material or controlled density fill shall be a cement concrete backfill material that flows like a liquid, supports like a solid when cured, and levels without tamping or vibrating to reach 100 percent compaction. The material shall be used primarily as a backfill in lieu of compacted fill. The material shall be proportioned to yield a 28-day minimum compressive strength of 200 pounds per square inch. The material shall be produced and installed in accordance with ACI 229R-13, with a mix formulation to be approved by the Engineer or Geotechnical Consultant prior to placement of the material in the project.

PART 3 - EXECUTION

3.01 USE OF MATERIALS

- A. Use of materials shall be as described below and as shown on the plans. Combinations or layering of materials may be necessary in certain instances such as for detention embankments, subsurface disposal areas, and riprap walls as examples.
 - 1. Common/Ordinary Fill: Use common/ordinary fill for general grading as backfill, and as embankment fill in areas outside the building and pavement limits. Stones larger than twelve inches (12") shall be removed prior to compaction.
 - 2. Gravel: Use for pipe bedding backfill and backfill below pavement and slab as base course layer. Use for material placed "in the wet". Use for backfill behind retaining walls and retaining structures. Use for pipe and utility bedding.

3. Sand: Use for conduit bedding and initial backfill, and gas line bedding and backfill. Use for bedding and backfill of direct burial cables and/or flexible piping. Use for bedding and filling joints for concrete unit pavers.
4. Crushed Stone: Use crushed stone as a filter material around perforated pipe and as bedding for piping under wet subgrade conditions.
5. Dense-Graded Crushed Stone: Use dense-graded crushed stone for subbase and base material.
6. Structural Fill: Use structural fill below subgrade elevation in building areas such as beneath floor slabs, foundations, and in other soil bearing situations. Structural fill shall also be used for backfill against building foundations and frost walls. Use structural fills below pavement gravel base course.
7. Blast Rock Fill and Choke Stone: Blast rock fill may be placed to within forty-two (42") of finish grade in pavement and building floor slab areas, and to within eighteen inches (18") of utility line inverts and bottom of foundations. The first lift over the top of rock fill shall be a choke stone layer eighteen inches (18") thick. Compaction shall be by minimum of four (4) passes of a self-propelled vibratory drum roller in each direction (i.e., north-south and east-west). The minimum weight of the drum shall be ten thousand pounds (10,000 lbs.). Blast Rock shall not be placed within a five foot (5') horizontal distance on either side of proposed utility lines. The intent is to leave a zone of Structural Fill that can later be excavated for installation of utilities. Also, large rock fragments shall be kept away from utility pipes.
8. Stone Fill: Use stone fill as additional storage medium for underground stormwater exfiltration trenches or pits.
9. Filter Fabric: Filter Fabric is to be used as a filter barrier between drainage recharge systems, underdrain systems, wastewater absorption systems, and between natural earth material and backfill or other materials to assist in stabilizing soil subgrades.
10. Riprap: Use riprap for slope stabilization and for erosion control in channel bottoms, overflow areas, level spreaders, and where otherwise indicated.
11. Stone for Pipe Ends: Use stone for erosion prevention at pipe ends of drainage pipes, energy dissipaters, stilling basins and at inlets to drainage structures.
12. Controlled Low Strength Material or Controlled Density Fill: Shall be used for trench backfill, anti-flotation bases, and/or lightweight backfill.

3.02 DEWATERING

- A. Provide, operate, and maintain site and subsurface drainage and dewatering in an acceptable manner as required to complete the work throughout the course of the project.
- B. Remove, by pumping or other means, water accumulated in excavations and within two (2) feet below subgrade until earthwork, utilities, concrete, and other work operations are complete. Dewatering shall be considered incidental to the work items and no separate payment shall be made to the Contractor for dewatering operations.
- C. Provide, maintain, and operate wells, pumps, and related equipment including stand-by equipment of sufficient capacity to maintain excavations and trenches free of water 24 hours per day to enable all work to be conducted in-the-dry and to protect bearing surfaces from disturbance.

- D. Water from excavations shall be disposed of in such manner as will not cause injury to public health, public and private property, existing work, work to be completed or in progress, roads, walks, and streets, or cause any interference with use of same by public. Concrete or fill shall not be placed in excavations containing free water.
- E. Construction may require excavation below water level in soil. The Contractor shall complete this work in-the-dry to maintain the undisturbed condition of the bearing soil.
- F. If the dewatering methods have not been adequate and the bearing soils are disturbed, remove disturbed soil and replace with compacted Structural Fill or lean concrete at no additional cost to the Owner.
- G. Sumps shall be surrounded by suitable filter media to minimize the fines removed during pumping.
- H. Pumped groundwater and surface water runoff shall be initially pumped to a settling basin to remove suspended solids prior to discharge. The Contractor shall furnish all treatment systems that are necessary for pretreatment of groundwater prior to discharge in accordance with all applicable permits and regulations. All permits shall be obtained by the Contractor.

3.03 EXCAVATION - GENERAL

A. General Definitions

- 1. **Unclassified Materials**
Unclassified excavation includes the satisfactory removal and disposal of all materials (except contaminated materials defined below) encountered regardless of the nature of the materials and shall be understood to include, but not be limited to, blast rock, bedrock, earth, hardpan, fill, foundations, pavements, curbs, piping, railroad track and ties, cobblestones, footings, bricks, concrete, abandoned drainage and utility structures, and debris. Drilling, blasting, excavation, and disposal of rock shall be considered unclassified excavation and shall be included as a part of the Contract Price, with no separate payment items for its excavation and handling.
- 2. **Contaminated Materials** – Refer to the Soil Management Plan prepared by VHB within the appendix of the Project specifications for additional information.
 - a. The Contractor shall be familiar with the Maine State Department of Environmental Protection (DEP) when conducting earthwork operations.
 - b. In general, a hazardous waste (contaminated with oil or hazardous materials) is a waste or combination of wastes which, because of its quantity, concentration, physical, chemical or infectious characteristics, may cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible or incapacitating reversible illness or pose a substantial present or potential hazard to human health, safety, or welfare, or to the environment when improperly stored, treated, transported, or disposed of, or otherwise managed.
 - c. The Contractor shall immediately halt soil movement activities and notify the Owner if visual, olfactory, or other evidence suggests that soils may be contaminated with oil or hazardous materials. Contractor shall provide reasonable assistance to Owner and to Owner's Representative for access to potential contamination areas for proper assessment of hazardous conditions.

- d. The Owner will contact an environmental professional (such as a Licensed Site Professional) to test any earth materials suspected of containing hazardous waste. The results shall be evaluated by the environmental professional and compared with reporting thresholds found in the Maine DEP standards. The Owner will inform the Contractor of the laboratory test results as soon as possible and discuss the possible soil management, disposal, and recycling options available. Contaminated soils shall be managed and handled in compliance with the referenced state & federal regulations, guidelines, and policies. Time and expenses associated with contaminated soils shall be negotiated between the Contractor and the Owner prior to the start of the soil management, soil disposal, and recycling work. Owner reserves the right to negotiate and contract with other entities for remedial work and, in that event, this Contractor shall make reasonable accommodations for other entities to perform this work.
- e. Although there is no evidence of oil or hazardous material, there is a possibility of the presence of such wastes on this site. Appropriate testing, as recommended by an environmental professional shall be accomplished to assess the potential presence of oil or hazardous material. Earth material shall not be removed from the site unless on-site reuse is not possible.
- f. Proper documentation of legal disposal of hazardous materials handled by this Contractor shall be provided by the Contractor to the Owner, Engineer, and review authorities. Additional guidance for possible disposal activities can be found in the Department of Environmental Protection Policy.
- g. Unless specifically identified as contaminated material under referenced statutes and as defined above, as judged by the Engineer, excavated materials shall be considered unclassified as defined in Item 1., above.

B. Site General Requirements

- 1. Control the grading so that ground is pitched to prevent water from running to excavated areas, damaging other structures, or adjacent properties.
- 2. Where soil has been softened or eroded by flooding, equipment, traffic, or placement during unfavorable weather, or other conditions, it shall be removed and replaced by the Contractor with suitable material, and at no cost to the Owner.
- 3. Exercise care to preserve the material below and beyond the lines of excavation. Where excavation is carried out below indicated grade or beyond the lines of excavation, Contractor shall backfill and compact the over excavation with structural fill to the indicated grade, at no additional cost to the Owner and at the direction of the Engineer.
- 4. Provide sheeting, shoring and bracing to complete and protect all excavated areas, as required for safety and compliance with OSHA. Costs for sheeting, shoring, and bracing shall be included as a part of the Contract Price for completing the work and Owner will make no separate payment for this work.
- 5. Excavated materials unsuitable for reuse, surplus excavated rock, and surplus excavated soil not used to fulfill requirements of the Contract, shall become the property of the Contractor and shall be removed from the site in accordance with the regulations and requirements of all municipalities or agencies having jurisdiction over the disposal sites and the route between the project and the disposal sites.

6. Limits of excavation shall be such that all unsuitable material shall be removed to firm natural ground in the manner specified below:
 - a. In building areas, unsuitable materials shall be removed to a distance of five feet (5') beyond the building lines or within the area defined by a one horizontal to one vertical (1h:1v) line sloping down from outside bottom edge of exterior footings to firm natural ground, whichever is greater.
 - b. Limits of unsuitable material excavation also apply to areas below exterior column footings.
 - c. All abandoned pipes within building areas shall be removed and the excavations shall be properly backfilled.
 7. Unsuitable materials which are classified as organics such as peat, trash, fill, stumps, debris, material determined to be hazardous, and topsoil and subsoil when determined by Engineer to be unacceptable for incorporation into the work.
 8. Under pavement areas, existing fill shall be densified in place and shall not be excavated. Abandoned pipes, that are buried more than four feet from finish grade to the top of pipe and that do not interfere with utilities to remain or to be installed, shall be pumped full of flowable fill or grout, and capped and/or grouted at both ends and left in place. Abandoned pipes less than four feet from finish grade shall be removed and the trench shall be appropriately backfilled with structural fill.
 9. The existing base materials and native soils are unsuitable for reuse as fill in the boardwalk footprint but may be suitable for reuse in landscape areas, provided they are used as the lower lifts of fill and they are compactable moisture content at the time of reuse.
 10. Suitable material, as determined by the Engineer, may be reused on the site provided it meets the gradation requirements for the given materials as specified under 2.0 MATERIALS.
 11. The Contractor shall not over-excavate below proposed design grades for the purpose of obtaining borrow for use off-site.
- C. Proof Rolling
1. Prior to placing compacted fills, the Contractor shall proof roll the natural grades to remain. Where materials of low density are indicated by rutting or weaving under the compactor, the Contractor may be required to make up to three (3) additional complete passes of the area with the compactor as determined by the Engineer. The cost of all proof rolling shall be included in the Contract Price. If materials of low density are encountered that cannot be compacted to the extent necessary to support the proposed embankment fills as determined by the Engineer, the Contractor shall remove those materials and replace them with compacted fill.
 2. Alternately, an initial layer of fill may be allowed to form a working platform. The need, manner of construction, and thickness of such a layer shall be subject to approval of the Engineer and the layer will be permitted only where the lack of support is, as determined by the Engineer, not due to deficient ditching, grading or drainage practices, or where the embankment could be constructed in the approved manner by the use of different equipment or procedures. Thickness of up to eighteen inches (18") may be permitted for such a layer.

3.04 SHEETING SHORING AND BRACING

A. General

1. Whenever sheeting, shoring, and bracing will be required, it shall be furnished and installed by the Contractor in accordance with State and Federal guidelines, regulations and the recommendations of the structural engineer and/or geotechnical engineer engaged by the Contractor.
2. When required, the Contractor shall engage licensed professional structural engineer and/or geotechnical engineer to design sheeting, shoring, and bracing. These engineers shall be licensed in the state where the work is occurring and they shall prepare designs for the sheeting and bracing.
3. Submit the sheeting and bracing designs to the Owner and the Engineer for the project record. The sheeting and bracing plans and calculations shall bear the professional seals and signatures of the Contractor's engineers. These plans and calculations shall be submitted prior to the start of work.
4. The Contractor shall furnish and install the required sheeting, shoring and bracing in accord with the submitted designs. The Contractor shall include the costs for this work in their bid price for the project. No additional or separate compensation will be allowed.

3.05 TRENCH EXCAVATION

- A. Excavate as necessary for all drainage pipes, utilities, and related structures and appurtenances, and for any other trenching necessary to complete the work.

B. Definitions:

1. Trench shall be defined as an excavation of any length where the width is less than twice the depth and where the shortest distance between payment lines does not exceed ten feet (10'). All other excavations shall be defined as open excavations.
2. The words "invert" or "invert elevation" as used herein shall be defined as the elevation at the inside bottom surface of the pipe or channel.
3. The words "bottom of the pipe" as used herein shall be defined as the base of the pipe at its outer surface.

- C. In general, machine excavation of trenches will be permitted with the exception of preparation of pipe beds which will be hand work. Excavate by hand or machine methods to at least six inches (6") below the bottom of pipe or as shown on the Drawings. Excavation to final grade shall be made in such a manner as to maintain the undisturbed bearing character of the soils exposed at the excavation level.
- D. Utilities or piping shall not be laid directly on boulders, cobbles, or other hard material. This material shall be removed to a minimum of six inches (6") below the bottom of pipe at all points and backfilled or compacted as specified.
- E. Remove unsuitable material encountered at subgrade elevations, backfill with material specified herein and as otherwise indicated on the Drawings, specified, or directed. Compact as specified with approved compactors.

- F. In general, the width of trenches shall be kept to a minimum and in the case of piping shall not exceed the sum of the pipe's outside diameter plus 2'-0" to at least twelve inches (12") above the pipe.

3.06 ROCK EXCAVATION

A. Definitions

1. Rock is defined for payment purposes as stone or hard shale in original ledge, boulders over two cubic yards (2 yd³) in volume in open areas, and one cubic yard (1 yd³) in volume in trenches, and masonry or concrete that cannot be broken or removed by normal job equipment (power shovels or track mounted excavator without the use of explosives or drills).
2. The definition does not include materials that can be removed by means other than drilling and blasting or drilling and wedging.

B. General

1. When rock is encountered, such material shall be removed to the clearance limits set forth in these Specifications.
2. Payment for rock excavation shall be made in accordance with Item 3.03A.1.
3. Rock excavation shall be performed to eliminate water pockets in the excavated rock subgrade. Contractor shall provide dewatering as required to keep the excavated rock subgrade dry until earthwork operations are complete.

C. Blasting

1. Prior to commencement of blasting operations, the Contractor shall perform a Pre-Blast Survey of adjacent properties. The Contractor shall submit the intended Pre-Blast Survey limits and methods to the Owner for approval prior to performing the survey.
2. Before doing any blasting work the Contractor shall present to the Owner's Representative written certificate of insurance showing evidence that their insurance includes coverage for blasting operations.
3. No blasting shall be done without giving 24-hour prior notice to the Engineer. Written permission and approval of methods must be obtained from appropriate governing authorities.
4. The driller and geotechnical engineer shall log the bottom elevation of all drill holes made for blasting within the building area.
5. Experienced powdermen or persons who are licensed or otherwise authorized to use explosives shall conduct the blasting. Accurate records shall be maintained, noting location of each blast, time of detonation, total explosive weight in each blast, maximum explosive weight per delay in each blast hole, and designation of delay cap used in each hole.
6. Explosives shall be stored, handled, and employed in accordance with federal, state and local regulations, or, in the absence of such, in accordance with the provisions of AGC Manual of Accident Prevention in Construction of The Associated General Contractors of America, Inc. and in accordance with applicable OSHA regulations.
7. The amount of vibration and air blast overpressure generated by blasting shall not exceed regulatory statutes or directives established by state, local or other governing authorities. In no case shall the maximum Peak Particle Velocity (PPV) exceed the limits

indicated on Figure B-1, Appendix B, of the United State Bureau of Mines Report of Investigations, RI8507, 1980. These limits shall apply at all existing and under construction structures and utilities, as well as at property and construction limits.

8. Contractor shall take great care to prevent damage to existing buildings, foundations, glass and glazing, and trees to remain. Damage caused by Contractor's blasting operations shall be repaired by Contractor at no additional cost to the Owner.

D. Cross-Sectioning and Measurement

1. When rock is encountered, the rock shall be uncovered and exposed, and the Engineer shall be notified in writing by the Contractor before blasting work proceeds. Quantities shall be based on measurements of rock in their original position and to the limits of clearly defined vertical and horizontal construction lines required for the defined construction.
2. The rock shall then be measured, quantities established, and payment amounts determined.
3. Excavation of material in question before agreement by the Engineer as to the character of the material, or failure to notify the Engineer, or failure to take measurements will forfeit the Contractor's right to payment for rock excavation.
4. The quantity of rock to be removed shall be based on the limits established under the Clearance Limits specified below.
5. Measurements shall be made by a registered surveyor, paid for by the Contractor and approved by the Engineer.
6. Cross-sectioning and measuring shall not be required when the payment for rock excavation is included as a part of the lump sum Contract Price.

E. Clearance Limits

1. Foundations and Slabs: Within the limits of the concrete lines as defined by the working plans or as otherwise approved by the Engineer, plus twelve inches (12") outside the vertical concrete lines and twelve inches (12") below base.
2. Utility Trenches: All parts of pipe, valves, and fittings to a depth of six inches (6") below the bottom of the bell and for a width equal to the outside diameter of the pipe, plus fifteen inches (15") beyond the outside diameter on each side, provided that overlapping computed volumes of any ledge or boulder excavation shall be paid for only once.
3. Paved Areas: To the underside of the subbase.
4. Site Structures: Twelve inches (12") outside of structure all around.
5. Lawn areas and shrub planting areas: To a depth of eighteen inches (18") below finished grade.
6. Planting areas for trees over two inches (2") in caliber size: To depth of thirty-six inches (36") below finished grade and for a radius of 3 feet (3') around each tree, except volumes in radius areas shall not overlap.
7. Any foreseen rock or boulder encountered, as defined above, which must be removed for construction of the work defined on the plans or in modification thereto, shall be measured in its original position to the limits of clearly defined vertical construction lines and to the depth required for the defined construction.

F. Reuse of Excavated Rock

1. Riprap
 - a. Excavated rock may be used as riprap, for construction of stone masonry walls, and for sloped riprap for retaining walls, provided that the rock is judged to be adequate quality by the Owner's Representative and the rock is sufficiently broken to meet gradation requirements established for the intended use.
 2. Fills
 - a. Reuse of excavated rock for fill materials shall require prior approval of the Owner's Representative and shall require compliance with gradation requirements for the specific type of fill for which it is being used.
- G. Rock Subgrades under Building Footings and Paved Areas
1. Excavation of rock under footings and paved areas shall include the removal of all loose material to the top of sound bedrock that is acceptable to the Owner's Representative. Sound bedrock is defined as hard, intact rock that cannot be excavated with a track mounted excavator.
 2. Rock surface for footings shall have a maximum slope of four (4) horizontal to one (1) vertical.
 3. Rock excavations for footings carried below design grades shall be backfilled by placement of concrete with same strength as footing at the Contractor's cost. At the discretion of the Structural Engineer of Record (SER), footings could be dropped below design elevation onto competent rock.

3.07 PREPARATION OF EXCAVATION BOTTOMS

- A. General Rock Subgrade Areas
1. Rock surfaces to receive backfill shall have a maximum slope of four (4) horizontal to one (1) vertical.
- B. Building and Pavement Areas
1. Loose rock is covered with 6 inches (6") of crushed stone or choke stone; and
 2. Prior to placing crushed or choked stone, the area is rolled with a heavy vibratory roller Or fully loaded ten wheel dump truck.
 3. Proof-roll subgrade with a vibratory roller or a fully loaded ten-wheeled dump truck. Soft or hard areas and other objectionable material (stumps, wood, organics) shall be excavated and backfilled with compacted structural fill.
 4. Prior to the placement of blast rock fill over a bedrock subgrade, voids in the rock surface shall be choked off with appropriately graded choke stone or crushed stone to prevent migration of fines into fractures, and as approved by the Owner's Representative.
- C. Subgrades under Proposed Landscape Areas
1. Depth to rock under planting areas shall be a minimum of 48 inches (48") below subgrade elevations. Backfill up to subgrade shall be done with topsoil/loam materials.
 2. In lawn areas, scarify subsoil a minimum depth of six inches (6"). Subsoil shall also be cleared of debris and stones larger than four inches (4") prior to topsoil spreading.
 3. In planting areas, scarify subsoil a minimum depth of six inches (6") below the required root ball excavation prior to placement of plant backfill mixture.

D. Trenches

1. Compaction equipment used in open areas where space permits shall consist of vibratory rollers, fully loaded ten-wheel dump trucks, pneumatic compactors, or other similar equipment.
2. Compaction equipment for fill against foundation walls and in other confined areas shall be accomplished by means of drum-type, power-driven, hand-guided vibratory compactors operating at 2,000 cycles per minute, or by hand-guided vibratory plate tampers.

3.08 BACKFILLING AND PLACEMENT OF FILL MATERIALS

A. Site

1. Dewater subgrade areas prior to filling.
2. Compaction by puddling or jetting is prohibited.
3. Control groundwater and surface runoff to minimize disturbance of exposed natural ground surface, previously placed and compacted fill and material being placed.
4. Soil fill moisture shall be maintained at an acceptable working range to allow for proper compaction.
5. Do not place fill on frozen ground.
6. Do not place frozen fill.
7. Place fill in uniform horizontal layers and compact immediately after placement. Where the horizontal layer meets a rising slope, the layer shall be keyed into the slope by cutting a bench during spreading of preceding lift.
8. To the extent that is practical, each layer of fill shall be compacted to the specific density the same day it is placed.
9. Slope fill surfaces at the end of each day to provide for free surface drainage.
10. Protect structures and pipes from damage during backfilling operations. Repair damage at no cost to Owner.
11. Placement of fill shall not begin prior to observation and approval of subgrade conditions by Engineer.
12. Protect foundations, footings, and waterproofing during backfilling. Repair damage at no cost to Owner.
13. Prior to backfilling between foundation wall and sheeting, remove unsuitable material, including rubbish, organic materials, or other debris. Do not commence filling operations until conditions have been observed by Engineer.
14. Backfill shall not be placed against walls until they are braced or have cured sufficiently to develop strength necessary to withstand, without damage, pressure from backfilling and compacting operations.
15. Provide shoring, sheeting, and bracing of excavations as required to assure complete safety against collapse of the earth at the site of excavations. Alternatively, lay back excavations to suitable slope.
16. Upon completion of the work, the final ground surface shall be left in a firm, unyielding, true, uniform condition free from ruts. Repair disturbed areas caused equipment traffic at no cost to Owner.

B. Equipment

1. Compaction equipment used in open areas where space permits shall consist of vibratory rollers, fully loaded ten-wheel dump trucks, pneumatic compactors, or other similar equipment.
 2. Compaction equipment for fill against foundation walls and in other confined areas shall be accomplished by means of drum-type, power-driven, hand-guided vibratory compactors operating at 2,000 cycles per minute, or by hand-guided vibratory plate tampers.
- C. Blast Rock Backfill – Structure and Foundation Backfilling and Compacting
1. Prior to the placement of blast rock fill over a bedrock subgrade, voids in the bedrock surface shall be choked off with appropriately graded crushed stone or choke stone to prevent migration of fines into fractures as approved by the Owner's Representative.
 2. Blast rock fill and crushed stone shall be placed and compacted as indicated below:
 - a. Maximum lift thickness prior to compaction shall be 24 inches (24").
 - b. Material shall be dumped 25 feet behind the fill face and pushed forward to allow mixing and removal of oversized rock and backfilling voids.
 - c. Should the maximum size of blast rock exceed 18 inches (18"), then use a rock rake with teeth spaced at 18 inches (18"), or other means to separate and remove oversized rock.
 - d. Provide a minimum of 18-inch-thick transition zone of choke stone between blast rock fill and granular fill materials. All blast rock fill shall be choked with a transition zone of choke stone, where structural fill is to be placed above or adjacent to it.
 - e. Compact each lift of blast rock fill with a vibratory drum roller or fully loaded ten-wheel dump truck.
 - f. Crushed stone and choke stone placement shall not exceed a maximum lift thickness of 12 inches (12") prior to compaction.
- D. Placing Fill
1. Fill sections and embankments shall be constructed of earth, rock, or a mixture of earth and rock deposited in successive lifts. Except as hereinafter permitted, the loose thickness of each lift shall not be more than twelve inches (12") before compaction.
 2. Rock fill may be used in deep fill areas, placed to the levels and under the conditions described in Section 2.01K.
 3. No rock in excess of six inches (6") in its largest dimension shall be incorporated in the top two foot (2') layer of embankment immediately below the subgrade.
 4. During fill and embankment construction operations, earth moving equipment shall be routed as evenly as possible over the entire width of the work.
 5. At the close of each day's work the working surface shall be crowned, shaped, and rolled with smooth steel or pneumatic tired rollers to ensure proper drainage.
 6. Prior to placing compacted structural fill below the slab, the surface of natural ground, shall be proof-rolled with a heavy vibratory drum roller or a fully loaded ten-wheel dump truck. Hard and soft spots shall be excavated and replaced with structural fill or other material acceptable to the Owner's Representative.
 7. Where excavations for slab-on-grade extend to weathered fractured or blasted bedrock, the Owner's Representative shall assess the rock surface for the presence of

voids and may require placement of a 2 inch to 18-inch layer of choke stone or crushed stone prior to placement of structural fill.

E. Fills under Parking Areas

1. Paved area subgrades shall be excavated to a minimum of 12 inches (12") beneath required subgrade elevation or existing grade, whichever is lower.
2. Proof-roll subgrade with a vibratory roller or a fully loaded ten-wheeled dump truck. Soft or hard areas and other objectionable material (stumps, wood, organics) shall be excavated and backfilled with compacted common fill.
3. Where excavations for pavements extend to weathered, fractured, or blasted bedrock, prepare surface as indicated in Section 3.07B. for building and pavement areas.
4. A minimum of 12 inches (12") of gravel base course shall be provided between subgrade and the bottom of the bituminous surface.

F. Subgrades under Proposed Landscape Areas

1. Fills under tree and shrub planting areas shall be backfilled with topsoil/loam materials.

G. Buildings

1. Prior to the placement of blast rock fill over a bedrock subgrade, voids in the rock surface shall be choked off with appropriately graded choke stone or crushed stone to prevent migration of fines into fractures, as approved by the Owner's Representative.
 - a. Blast rock fill and crushed stone shall be placed and compacted as indicated below.
2. Blast Rock Fill Placement and Compaction:
 - a. Maximum lift thickness prior to compaction shall be 24 inches (24").
 - b. Material shall be dumped 25 feet behind the fill face and pushed forward to allow mixing and removal of oversized rock and backfilling voids.
 - c. Should the maximum size of blast rock exceed 18 in., (18") then use a rock rake with teeth spaced at 18 in. (18") or other means to separate and remove oversized rock.
 - d. Provide a minimum of one-foot thick transition zone of crushed stone between blast rock fill and granular fill. All blast rock fill shall be choked with a transition zone of crushed stone, where granular fill is to be placed above it.
 - e. Compact each lift of blast rock fill with a vibratory drum roller or a fully loaded ten-wheel dump truck.
3. Crushed Stone Placement and Compaction:
 - a. Maximum lift thickness prior to compaction shall be 12 in. (12").
4. Structural Fill: A minimum of 24 inches (24") of compacted structural fill shall be placed in maximum 12-inch (12") lifts immediately below the slabs.

H. Revetments

1. General
 - a. Areas to be protected by revetment shall be free of brush, trees, stumps, and other organic material and be dressed to a smooth surface. All soft or spongy material shall be removed to the depth shown on the plans or as directed by the Engineer and replaced with approved materials.
 - b. A toe trench shall be dug and maintained until the revetment is placed.

- c. Protection for structure foundations shall be provided as early as the foundation construction permits.
 - d. The area to be protected shall be cleaned of waste materials and the surface to be protected shall be prepared as shown on the plans.
 - e. Where shown on the plans, a foundation filter bed shall be placed on the area before the stone is placed. The foundation filter bed will be six inches (6") of dense graded crushed stone and six inches (6") of one-half inch crushed stone and at least 12 inches (12") in total thickness.
- 2. Riprap
 - a. The stones shall be placed upon an approved filter bed to the lines and grades shown on the plans and as directed.
 - b. Each stone shall be carefully placed, by hand or machine as required, on a prepared bed, normal to the slope and firmly bedded thereon.
 - c. The larger stone shall be placed closely together and the intervening spaces filled with smaller stones in such a manner that the entire surface will form a compact mass.
- 3. Stone for Pipe Ends
 - a. Stone for pipe ends shall consist of a protective covering of angular shaped stones laid on slopes in front of and around drainage line ends or structures to insure protection of the pipe ends and the embankment and shall conform to the requirements for "Stone for Pipe Ends."
 - b. The stone shall be placed to line and grade as shown on the plans or as directed on a prepared bed of embankment material or existing materials. Each stone shall be carefully placed by hand, normal to the slope and firmly bedded thereon. The larger stones shall be placed directly at the drainage end to prevent erosion and displacement. Each stone shall weigh not less than the minimum specified nor more than the maximum specified and at least 75 percent of the volume shall consist of stones weighing not less than the d_{50} Median. The remainder of the stones shall be so graded that when placed with the larger stones, the entire mass will be compact with a minimum number of voids and a minimum thickness of 9 inches (9").

3.09 TRENCH BACKFILL

A. General

- 1. Trenches shall be backfilled as soon as practicable with suitable approved materials. All trench backfilling shall be done with special care, in the following manner and as the Engineer may direct from time to time.
- 2. Backfill material for pipe bedding shall be deposited in the trench, uniformly on both sides of the pipe, for the entire width of the trench to the spring-line of the pipe. The backfill material shall be placed by hand shovels in layers not more than 6 inches (6") thick in loose depth and each layer shall be thoroughly and evenly compacted by tamping on each side of the pipe to provide uniform support around the pipe.
- 3. Trench backfilling shall be placed so as not to disturb the previously installed pipes, utilities, concrete, and other work within and near the trench. The moisture content of the backfill material shall be such that proper compaction will be obtained. Backfill of

trenches within areas of pavement construction shall be made in controlled compacted lifts extending to grades required to establish the proper pavement base courses.

4. In backfilling trenches, each layer of backfill material shall be adequately compacted in such a manner as to provide the required bearing value, so that paving can proceed immediately after backfilling is completed.
5. Any trenches or excavations improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and compacted with the surface restored to the required grade and condition, at no additional cost to the Owner.
6. During filling and backfilling operations, pipelines will be checked to determine whether any displacement of the pipe has occurred. If the inspection of the pipelines shows poor alignment, displacement of pipe, or any other defects, the condition shall be remedied by removal, realignment, and backfill of the pipe, in a manner satisfactory to the Engineer at no additional cost to the Owner.

B. Embedment

1. The type of materials to be used in bedding and backfilling shall conform to the details shown on the Drawings and the following:
 - a. Class I - Angular crushed stone or rock, dense or open graded with little or no fines (3/4-inch stone size) (to be used in wet conditions or where shown on the Drawings).
 - b. Class II - Clean, coarse grained gravel, with a maximum stone size of 1-1/2 inches.
 - c. Embedment materials shall be free from lumps of frozen soil or ice when placed.Embedment materials shall be placed and compacted at optimum moisture content.
2. Foundation: A stable utility foundation of Class I or II material must be provided to insure proper line and grade is maintained. Unsuitable foundations such as organics, soft clay, and other soft materials must be removed and the material stabilized. Unsuitable or unstable foundation materials shall be undercut and replaced with a suitable bedding material of Class I or Class II (see 3.09B.1.), placed in 6-inch (6") lifts. The Engineer may approve other methods of stabilization, such as the use of geotextiles.
3. Bedding: Provide a stable and uniform bedding for the pipe and any protruding features of its joints and/or fittings. The bedding for the middle 1/3 of the pipe outside diameter should be loosely placed so that the pipe conforms to the trench. The remainder of the bedding at the base of the trench shall be compacted to a minimum of 95 percent modified proctor density as determined by ASTM D1557. Class I or Class II materials are suitable for use as bedding.
4. Haunching: Proper haunching provides a major portion of the pipe's strength and stability. Care must be exercised to insure placement and compaction of the embedment material in the haunches. For larger diameter pipes (greater than 30" in diameter), embedment materials should be worked under the haunches by hand. Haunching materials may be Class I or Class II materials and shall be placed and compacted in 6-inch (6") maximum lifts, compacted to 95 percent modified proctor density.
5. Initial Backfill: Initial backfill materials are required for a minimum of 3/4 of the pipe diameter. The initial backfill shall be from the pipe's springline to 12 inches above the

pipe to provide protection for the pipe from construction operations during placement of the final backfill and protect the pipe from stones or cobbles in the final backfill.

- a. Class I materials must be used in wet trenches and Class I bedding and haunching materials shall be used.
 - b. Class II materials shall be used unless noted otherwise or wet conditions are encountered. The material shall be compacted in 6 inch (6") lifts to 95 percent modified proctor density (ASTM D1557).
 - c. Flooding or jetting as a procedure for compaction are not allowed.
6. Controlled Low Strength Materials (CLSM) or Controlled Density Fill (flowable fills) are acceptable backfill materials. Several considerations should be accounted for when using CLSM/CDF backfill. Provisions to prevent flotation of the pipe during placement of the CLSM/CDF must be used. This can include anchoring the pipe by placing flowable fill at the each joint and allowing the fill to partially cure prior to placing the flowable fill along the entire length of the pipe. Also, mechanical anchors such as bent rebar driven into competent soil or precast weights may be used at each joint to prevent flotation. When using CLSM/CDF, the fill should always be placed to completely encase the pipe.
 7. Backfill. Backfill from one foot (two feet for HDPE pipe) above the top of the pipe to subgrade elevations shall be structural fill material. Generally, the excavated trench material may be used as this backfill. This backfill shall be placed in 12-inch (12") maximum lifts and compacted to a minimum of 92 percent modified proctor density to prevent excessive settlement at the surface.
 8. Vehicular and Construction Loads: Pipe installation shall be suitable to carry H-25 live loads (40,000 lbs. axle - legal load) with 24 inches (24") of cover.

3.10 BACKFILL AGAINST STRUCTURES

- A. Backfilling against masonry or concrete shall only be done when approved. The Contractor shall not place backfill against or on structures until they have attained sufficient strength to support the loads (including construction loads) to which they will be subjected, without distortion, cracking or other damage. As soon as practicable after the structures are structurally adequate and other necessary work has been satisfactorily completed, any leakage tests or other testing of the structures shall be made by the Contractor, as required by the Engineer, at the Contractor's expense.
 1. After the satisfactory completion of leakage tests and the satisfactory completion of any other required work in connection with the structures, the backfilling around the structures shall proceed using suitable and approved excavation material. The best of the backfill material shall be used for backfilling within 2 feet (2') of the structure. Just prior to placing backfill, the areas shall be cleaned of all excess construction material and debris and the bottom of excavations shall be in a thoroughly compacted condition.
- B. Symmetrical backfill loading shall be maintained. Special care shall be taken to prevent any wedging action or eccentric loading upon or against the structures.
 1. During backfilling operations, care shall be exercised that the equipment used will not overload the structures in passing over and compacting these fills. Except as otherwise specified or directed, backfill shall be placed in layers not more than 12 inches (12") in

loose depth and each layer of backfill shall be compacted thoroughly and evenly using approved types of mechanical equipment. Each pass of the equipment shall cover the entire area of each layer of backfill.

- C. In compacting and other operations, the Contractor shall conduct their operations in a manner to prevent damage to structures due to passage of heavy equipment over and adjacent to structures. Repair damage made by the Contractor, at no additional cost to the Owner.
- D. After backfilling the Contractor shall maintain the surfaces of backfill areas in good condition so as to present a smooth surface at all times level with adjacent surfaces. The Contractor shall repair any subsequent settling over backfilled areas immediately, in a manner satisfactory to the Engineer, and such maintenance shall be provided by the Contractor for the life of this Contract, at no additional cost to the Owner.
- E. The finished subgrade of the filled excavations upon which pavements are to be constructed shall not be disturbed by traffic of other operations and shall be maintained in a satisfactory condition until the finished courses are placed. The storage or stockpiling of materials on finished subgrade will not be permitted.
- F. Uniformly smooth grade all areas to be graded, as indicated including excavated sections and all areas disturbed as a result of the Contractor's operations. The finished surfaces shall be reasonably smooth, compacted and free from surface irregularities.

3.11 COMPACTION

A. Compaction Requirements

1. The degree of compaction is expressed as a percentage of the maximum dry density at optimum moisture content as determined by ASTM D1557, Method C. The compaction requirements are as follows:

Area of Compaction	Minimum Degree
Below footings	95%
Below slabs	95%
Detention basin berms	95%
Pavement base course	95%
Pavement subbase	95%
General fill below pavement subbase	90%
Trench backfill	92%
Lawn areas	90%

2. Compaction percentages are based on the laboratory derived Maximum Density Values.

B. Moisture Control

1. Fill that is too wet for proper compaction shall be harrowed or otherwise dried to a proper moisture content to allow compaction to the required density. If fill cannot be dried within 24 hours of placement, it shall be removed and replaced with drier fill.

2. Fill that is too dry for proper compaction shall receive water uniformly applied over the surface of the loose layer. Sufficient water shall be added to allow compaction to the required density.
 3. In no case shall fill be placed over material that is frozen. No fill material shall be placed, spread, or rolled during unfavorable weather conditions. When work is interrupted by heavy rains, fill operations shall not be resumed until the moisture content and the density of the previously placed fill are as specified.
- C. Lift Thickness of Material
1. Structural Fill and Sand Borrow. Place in layers not to exceed 12 inches (12") in thickness when utilizing heavy compaction equipment, and 6 inches (6") when utilizing light hand-operated compaction equipment.
 2. Common Fill. Place in layers not to exceed 12 inches (12") in thickness when utilizing heavy compaction equipment, and 8 inches (8") when utilizing light hand-operated compaction equipment.
 3. Crushed Stone, Gravel, Dense, Graded Crushed Stone for Subbase. Place in layers not to exceed 9 inches (9") in thickness when utilizing heavy compaction equipment, and 6 inches (6") when utilizing light hand-operated compacted equipment. Compact with a minimum of four (4) coverages of acceptable compaction equipment.

3.12 PROTECTION OF FILL

- A. Protection of compacted fill shall be the responsibility of the Contractor. Newly graded areas shall be protected from the actions of the elements and traffic. Any settlement or washing that occurs prior to acceptance of the work shall be repaired and grades shall be established to the required elevations and slopes. Damage to any compacted lift (including those lifts previously tested and approved by the Engineer) occurring at any time during the course of construction, which is caused by equipment, moisture entering the embankment, or from any other cause, shall be fully repaired by the Contractor prior to placement of overlying materials, at no additional cost to Owner and to the complete satisfaction of the Engineer.
- B. In the event of and prior to the commencement of heavy rains, the Contractor shall suspend fill operations immediately and shall take all necessary steps to keep the site as well drained as possible. Fill operations shall not be resumed until the moisture content of the fill is such as to permit compliance with the Specifications.
- C. All corrective work or operations necessary to maintain proper moisture control of the fill material shall be at the expense of the Contractor.

3.13 GRADING TOLERANCES

- A. Grading shall be completed to meet or exceed the following tolerances of uniformity*:

Location	Tolerance
Top of Subgrade Beneath Structures	1/2 inch
Top of Subgrade Beneath Paving	1/2 inch
Top of Subgrade Beneath Landscape Areas	1 inches
Top of Gravel and Gravel Bases	1/4 inch

- * Uniformity is defined as no variations in the surface materials at the grades and slopes indicated on the Drawings that exceed the listed tolerance over a length of ten feet (10') horizontally in any direction.

END OF SECTION 310000

SECTION 311000
SITE CLEARING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. This Section specifies requirements for site clearing including demolition of site structures.
- B. The work includes:
 - 1. Protection of existing vegetation to remain
 - 2. Clearing and grubbing
 - 3. Selective clearing and thinning
 - 4. Site demolition of structures, retaining walls, signage, light standards, foundations and appurtenances
 - 5. Removal and abandonment of utilities
 - 6. Filling or removal of underground tanks and piping
 - 7. Disposal of material from clearing, grubbing, thinning and demolition in approved off-site disposal areas
 - 8. Filling of voids and excavations resulting from the work

1.02 RELATED SECTIONS

- A. Other Specification Sections which directly relate to the work of this Section include but are not limited to:
 - 1. Section 312500 – EROSION AND SEDIMENTATION CONTROLS
 - 2. Section 310000 – EARTHWORK
 - 3. Section 323113 – CHAIN LINK FENCES AND GATES

1.03 SITE CONDITIONS

- A. Site conditions existing during the bidding period will be maintained by the Owner insofar as practical.
- B. Actual site condition variations that differ from those of the bidding period and which affect site clearing operations shall be brought to the attention of the Owner prior to the commencement of any site work.

1.04 SUBMITTALS

- A. The Contractor shall submit the following information to the Engineer for review before commencing work:
 - 1. All permits and notices authorizing site clearing and demolition
 - 2. Certificates of utility service severances
 - 3. Permits for transport and disposal of debris
 - 4. Demolition procedures and operational sequence
 - 5. Calculations

PART 2 – PRODUCTS

2.01 TREE PROTECTION FENCING

- A. Tree protection fencing shall be an orange plastic web fence, 4 feet high minimum. Wood stakes shall be six (6) foot long by 1 inch by 1 inch square driven a minimum of two (2) feet into the ground. Posts shall be spaced eight (8) feet on center, maximum.

PART 3 – EXECUTION

3.01 PROTECTION

- A. The Contractor shall flag the limits of clearing shown on the drawings by accurate field survey with marked stakes or other means acceptable to the Engineer. Trees to remain and trees to be saved and transplanted shall be clearly identified during this staking process. The Engineer shall be notified a minimum of five (5) working days prior to scheduled commencement of clearing operations to review the flagged limits. Adjust the clearing limits as directed by the Engineer.
- B. Before clearing begins, protect designated trees to remain with tree protection fencing to the approximate diameter of foliage (dripline of the tree) to prevent damage to the trunk, foliage and root system by construction equipment and procedures.
- C. Place tree protection fencing as required to protect other plants, adjacent property areas to remain uncleared, monuments, and existing improvements from damage.
- D. The Contractor shall repair or replace immediately any damage to existing trees or root systems that are to remain and to trees that are to be transplanted. The Contractor shall employ an arborist licensed in the jurisdiction of the Project (State of Maine) to determine the repair and replacement needs and methods for approval by the Engineer.
- E. Replace damaged shrubs and other vegetation designated to remain with the same size and species.
- F. The tree protection fencing shall be maintained for the duration of construction operations. The work shall include immediate replacement of any damaged fence. Fencing shall be removed from the site at the completion of construction operations. The fencing disposal shall be in accordance with local, state, and federal laws and regulations for the disposal of the material.

3.02 UTILITIES

- A. Notify all corporations, companies, individuals, or local authorities owning or having jurisdiction over utilities running to, through, or across areas to be affected by site clearing operations.
- B. Locate and identify existing utilities that are to remain and protect them from damage.

- C. For utilities to be disconnected, have utility services disconnected in accordance with the requirements of the utility owner.

3.03 CLEARING AND GRUBBING

- A. Clearing shall include cutting, removal, and off-site disposal of trees, bushes, shrubs, stumps, fallen timber, brush, refuse, trash, fencing and other incidental materials not required for reuse on the site.
- B. The Contractor shall grub the area within the clearing limits to completely remove stumps and root systems, except for those to remain **[or those to be transplanted]**.
- C. Depressions, excavations and voids resulting from the removal of stumps or roots shall be filled with suitable material and compacted as specified under Section 310000 – EARTHWORK.

3.04 SELECTIVE CLEARING AND THINNING

- A. Selective clearing and thinning shall be completed as directed by the Landscape Architect. Approximate limits of selective clearing and thinning are shown on the Drawings.
- B. The work shall include the removal of dead and diseased tree limbs and plants, and pruning and removal of live vegetation that interferes with the growth of other trees and plants. Areas of dense growth shall be thinned to provide room for healthy growth.

3.05 DEMOLITION REQUIREMENTS

- A. Conduct demolition operations in a manner that will prevent damage to adjacent structures, utilities, pavements, and other facilities to remain.
- B. Cease operations immediately if any damage, settlement or other adverse effect on adjacent structures occurs. However, if an obvious unsafe condition is created that would potentially cause injury to persons or undue harm to properties, the Contractor shall take whatever measures are warranted to prevent such injury or harm. Immediately notify the Engineer and regulatory authorities. Do not resume operations until conditions are corrected, damage repaired and approval has been received from the appropriate authorities and the Owner's Representative.
- C. Obtain written permission from adjacent property owners when demolition equipment will traverse, infringe upon, or affect access to their property. Copies of the permission documents shall be submitted to the Engineer.
- D. Provide hoses and water connections. Spray water on demolition debris to minimize dust.
- E. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition which existed prior to start of work.
- F. All hazardous waste removal shall be performed by a hazardous waste contractor qualified and duly licensed in the jurisdiction of the Project [State of Maine] to remove, transport, and dispose of each type of hazardous substance.

- G. Comply with federal, state, and local regulations pertaining to the crushing, processing, and reuse of Asphalt Pavement, Brick and Concrete Rubble.

3.08 REMOVAL AND ABANDONMENT OF UTILITIES

- A. All existing structures, utilities, and appurtenances of any kind shall be completely removed within the limits of excavation for the new structure.
- B. Outside the limits of excavation for the new structure, all abandoned utilities and utility structures greater than 8 inches in diameter located at least 4 feet below bottom of finished grade shall be sealed with concrete or brick masonry at the limit of excavation. All utilities shall be entirely removed within 4 feet of finished grade.
- C. Manholes and catch basins designated to be abandoned shall have all lines plugged with brick and mortar prior to filling with sand or gravel. The top 4 feet of these structures shall be removed and the bottom slab broken up to permit drainage prior to filling.
- D. The Contractor shall remove frames, covers, and grates from manholes, catch basins and gate valves and satisfactorily store and protect them until they are required for reuse in the work. Existing frames, covers, and grates determined by the Engineer to be unsuitable for reuse shall be removed from the site.

3.09 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove from site all materials resulting from site clearing and demolition operations.
- B. No burning of any material will be allowed.

END OF SECTION 311000

SECTION 312500
EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This work consists of furnishing, constructing, and maintaining permanent and temporary erosion and sediment control measures.

1.02 RELATED SECTIONS

- B. A. Sections which directly relate to the work of this Section include but are not limited to:
1. Section 311000 – SITE CLEARING
 2. Section 310000 – EARTHWORK
 3. Section 329000 – PLANTING

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Erosion control bales, wattles, logs, and rolls

1. Straw bales. Furnish bales tied with either commercial quality baling wire or string. Conform to the following:

a) Straw	Subsection 2.1 E
b) Approximate length	3.5 feet
c) Shape	rectangular
d) Approximate mass	70 pounds

2. Wood excelsior bales. Furnish bales of curled wood excelsior. Tie the bales with either a commercial baling wire, plastic, or string. Conform to the following:

a) Approximate dimensions	16 by 18 by 36 inches
b) Approximate mass	70 pounds

3. Excelsior fiber wattles, logs or rolls. Furnish wattles, logs, or rolls of curled excelsior fiber rolled into a cylindrical shape and encased in a seamless photodegradable tubular netting. Conform to the following:

a) Diameter	12 inches min.
b) Mass	3 pounds per foot min.

4. Straw wattles, logs or rolls. Furnish straw wattles that are manufactured from weed free straw and wrapped in a biodegradable netting. Conform to the following:

a) Diameter	9 inches min.
b) Netting strand thickness	0.030 inches
c) Netting knot thickness	0.055 inches
d) Mass of netting	0.315 to 0.385 ounces per foot

- B. Mulch.

1. Straw. Furnish certified weed free straw from oats, wheat, rye, or other grain crops that is free from mold or other objectionable material. Furnish straw in an air-dry condition suitable for placing with mulch blower equipment.
2. Wood fiber. Furnish processed wood fiber from wood chips conforming to the following:
 - a) Colored with a green dye non injurious to plant growth;
 - b) Readily dispersible in water;
 - c) Nontoxic to seed or other plant material;
 - d) Free of growth or germination inhibiting substances;
 - e) Free of weed seed;
 - f) Air dried to an equilibrium moisture content of 12 ± 3 percent;
 - g) Packaged in new labeled containers; and
 - h) Packaged in a condition appropriate for mixing in a homogeneous slurry suitable for application with power spray equipment
3. Grass straw cellulose fiber. Furnish processed grass straw fiber conforming to the following:
 - a) Colored with a green dye noninjurious to plant growth;
 - b) Readily dispersible in water;
 - c) Nontoxic to seed or other plant material;
 - d) Free of growth or germination inhibiting substances;
 - e) Free of weed seed;
 - f) Air dried to a moisture content of 10 ± 0.2 percent;
 - g) Air dried to a uniform mass of ± 5 percent;
 - h) Packaged in new containers labeled with the manufacturer's name and air-dry mass; and
 - i) Packaged in a condition appropriate for mixing in a homogeneous slurry suitable for application with power spray equipment.
4. Peat moss. Furnish a granulated sphagnum peat moss conforming to the following:

a) Sticks, stones, and mineral matter	0%
b) Partially decomposed stems and leaves of sphagnum	75% min.
c) Color	brown
d) Textured from porous fibrous to spongy fibrous	
e) pH	3.5 to 7.5
f) Air-dried	
5. Mature compost. Furnish partially decomposed organic material, such as leaves, grass, shrubs, and yard trimmings, cured for 4 to 8 weeks. Maturity is indicated by temperature stability and soil-like odor. Furnish friable, dark brown, weed-free, and pathogen-free mature compost conforming to the following:

a) Carbon/nitrogen ratio	25/1 to 35/1
b) Carbon/phosphorus ratio	120/1 to 240/1
c) pH	6.0 to 7.8
d) Water content	40% max.
e) Particle size	
Seeding and sodding	1/2 inch max.
Erosion control	1 inch max.
f) Organic material	50% min.
g) Man-made inserts (plastic, glass, metal)	2% max.

6. Straw for hydroseeding. Furnish clean agricultural straw milled to 1 inch or less in length. Dry the fibers to 10 percent moisture for compaction. Bale in heat-sealed plastic bags.
 7. Bonded fiber matrix hydromulch. Furnish a mixture of long-wood fibers and bonding agent which, when hydraulically applied and dried, produce a matrix conforming to the following:
 - a) Does not dissolve or disperse when wetted;
 - b) Holds at least 10 ounces of water per ounce of dry matrix;
 - c) Has no germination or growth inhibiting factors;
 - d) Forms no water insensitive crust;
 - e) Contains material that is 100 percent biodegradable; and
 - f) Is colored with a green dye non injurious to plant growth.
 8. Recycled pulp fiber. Furnish cellulose fiber mulch products manufactured from natural material diverted from the waste-stream of manufacturing processes or produced from recycled material. These include newsprint, chipboard, corrugated cardboard, wood chips, and similar material. Process the material to eliminate substances that inhibit seed germination and plant growth. Add a colored dye that is non-injurious to plant growth and fades rapidly with exposure to light. The fiber shall readily blend with water, grass seed, fertilizer, and other additives to for a slurry suitable for application with power spray equipment. Furnish a homogeneous mixture conforming to the following:
 - a) Synthetic, plastic, metal, or glass material 0%
 - b) Weed Seed 0%
 - c) Moisture content 15% max.
 - d) Ash content 7% max.
 - e) Organic matter 90% min.
 - f) Boron 250 ppm max.
 - g) Water-holding capacity 800 to 1200% by mass
 - h) pH 4.0 to 8.5
- C. Silt fence – Conform to AASHTO M 288.
- D. Water – Conform to the following:
1. Water for mixing or curing cement concrete, mortar, or grout. Conform to AASHTO M 157. Potable water of known quality may be used without testing according to AASHTO T 26. Potable water is safe for human consumption as defined by the public health authority having jurisdiction.
 2. Water for planting or care of vegetation. Furnish water that is free of substances injurious to plant life such as oils, acids, alkalies, or salts.
 3. Water for earthwork, pavement courses, dust control, and incidental construction. Furnish water free of substances detrimental to the work.
- E. Geotextile – Refer to specification Section 334000

- F. Riprap rock – Refer to specification Section 310000.

PART 3 – EXECUTION

3.01 CONSTRUCTION REQUIREMENTS

A. General

1. Provide permanent and temporary erosion control measures to minimize erosion and sedimentation during and after construction according to the state and local standards and this Section. Contract permits amend the requirements of this Section.
2. When erosion control measures are not functioning as intended, immediately take corrective action.

B. Controls and Limitations on Work

1. Before clearing and/or grubbing construct erosion controls for the project
2. Construct erosion control and sediment control measures as follows:
 - a. Construct temporary erosion controls in incremental stages as construction proceeds.
 - b. Construct temporary slope drains, diversion channels, and earth berms to protect disturbed areas and slopes.
 - c. Apply permanent turf establishment to the finished slopes and ditches within 14 days.
 - d. Construct outlet protection as soon as culverts or other structures are complete.
 - e. Construct permanent erosion controls including slope treatments as soon as practical or upon completion of the roadbed.
 - f. Construct and maintain erosion controls on and around soil stockpiles to prevent soil loss.
 - g. Following each day's grading operations, shape earthwork to minimize and control erosion from storm runoff.

C. Filter Barriers

1. Construct silt fence, bales, wattles, logs, rolls, and brush barriers for filtering sediment from runoff and reducing the velocity of sheet flow.

D. Outlet Protection

1. Construct riprap aprons or basins to reduce water velocity and prevent scour at the outlet of permanent and temporary erosion control measures. Construct riprap according to Subsection 2.1 B.

E. Slope Protection and Stabilization

1. Use plastic lining, riprap, check dams, erosion control blankets and mats, and temporary slope drains as follows:
 - a. Plastic lining. Use plastic lining to protect underlying soil from erosion. Place the plastic lining loosely on a smooth soil surface free of projections or depressions that may cause the liner to puncture or tear. Lap transverse joints a minimum of 36 inches in the direction of flow. Do not use longitudinal joints. Anchor the lining in place using riprap.
 - b. Riprap. Construct riprap for channel lining according to Subsection 2.1 A.
 - c. Check dams. Construct riprap, sandbags, or earth berms for temporary dams to reduce the velocity of runoff in ditches and swales.
 - d. Rolled erosion control products. Use rolled erosion control products to stabilize waterways and slopes before or after temporary or permanent seeding.
 - e. Temporary slope drains. Use drainpipe, riprap, or plastic lined waterway for temporary slope drains to channel runoff down slopes. Channel water into the slope drain with an earth berm constructed at the top of a cut or fill. Anchor slope drains to the slope. Provide outlet protection.

F. Inspection and Reporting

1. Inspect all erosion control facilities at least every 7 days, within 24 hours after more than 3/8 inch of rain in a 24-hour period, and as required by the contract permits.
2. Within 24 hours, furnish inspection reports to the Contracting Officer (CO) which include all of the following:
 - a. Summary of the inspection;
 - b. Names of personnel making the inspection;
 - c. Date and time of inspection;
 - d. Observations made; and
 - e. Corrective action necessary, action taken, and date and time of action.

G. Maintenance and Cleanup

1. Maintain temporary erosion control measures in working condition until the project is complete or the measures are no longer needed. Clean erosion control measures when half full of sediment. Use the sediment in the work, if acceptable, or dispose of it legally off the project.
2. Replace erosion control measures that cannot be maintained and those that are damaged by construction operations.
3. Remove and dispose of temporary erosion control measures when the vegetation is satisfactorily established, and drainage ditches and channels are lined and stabilized. Dispose of debris and unsuitable and excess material as follows:
 - a. Remove from project. Recycle or dispose of material legally off the project. Furnish a statement documenting the nature and quantity of material processed or sold for recycling. Otherwise, furnish a signed copy of the disposal agreement before disposal begins.
 - b. Hazardous material. Furnish a copy of all disposal permits. Dispose of material according to Federal, State, and local regulations.

4. Restore the ground to its natural or intended condition and provide permanent erosion control measures.

END OF SECTION 31 25 00

SECTION 321215
ASPHALT PAVING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. General: Work under this Section consists of providing asphalt paving complete, as indicated on the Drawings and as specified herein including:
 - 1. Furnishing hot mix asphalt (HMA) pavement (note - on the Drawings, this is also referred to as 'bituminous concrete pavement') composed of mineral aggregate, reclaimed asphalt pavement (RAP), asphalt binder material and an anti-strip additive (if required), that are mixed in a central mixing plant and then placing the mix on a prepared course in accordance with these specifications and conformance to the lines, grades, thicknesses and typical cross sections as shown on the Drawings or as directed by the Owner.
- B. The work includes:
 - 1. Preparation for HMA paving and furnishing and installing HMA.
 - 2. HMA overlays over existing pavement, including surface preparation, and leveling courses, tack coating and all other associated operations required.
 - 3. Sawcutting existing pavements.
- C. Quality Control and Acceptance:
 - 1. The Contractor is responsible for controlling the quality of materials and workmanship during production and placement.

1.02 RELATED SECTIONS

- A. Sections which directly relate to the Work of this Section include:
 - 1. Section 310000 – EARTHWORK
 - 2. Section 321610 – CURBING
 - 3. Section 321723 – PAVEMENT MARKINGS

1.03 REFERENCE STANDARDS

- A. References herein are made in accordance with the listed specific standards of the following organizations and work under this Section shall conform to the latest edition, unless modified by these Specifications.
 - 1. American Association of State Highway and Transportation Officials (AASHTO)
 - 2. ASTM International (ASTM)
 - 3. Asphalt Institute (AI)
 - 4. U.S. Department of Transportation Federal Highway Administration (FHWA)
 - 5. MaineDOT Standard Specifications
 - 6. NorthEast Transportation Training and Certification Program (NETTCP)

1.04 SUBMITTALS

- A. Job Mix Formula (JMF): No HMA shall be produced until a JMF has been submitted by the Contractor and reviewed by the Owner's representative. The HMA shall be designed in accordance with the volumetric mixture design specifications contained in AASHTO M 323 and procedures contained in AASHTO R 35, as modified herein, and shall meet the requirements of Table 3 and Table 4.
- B. JMF Submittal: The job mix formula shall be submitted in writing by the Contractor at least 30 days prior to the start of paving operations and shall include as a minimum:
1. Percent passing each sieve size.
 2. Gradation and percent of each individual aggregate or mineral filler, including source, location, and bulk specific gravity.
 3. Percent of asphalt binder.
 4. Performance graded asphalt binder certified test results and Material Certificate certifying the PG grade, including source and location.
 5. Number of gyrations for the estimated design ESAL loading.
 6. Mixing temperature.
 7. Compaction temperature.
 8. Temperature of mix when discharged from the mixer.
 9. Plot of the combined gradation on the Federal Highway Administration (FHWA) 0.45 power gradation curve.
 10. Percent natural sand.
 11. Percent fractured faces.
 12. Percent flat or elongated particles.
 13. Tensile Strength Ratio (TSR)
 14. Anti-strip agent (anti-stripping additive) – type, quantity, supplier and location.
 15. Sand equivalent value.
 16. Sulfate soundness loss.
 17. Individual and combined aggregate specific gravity.
 18. Dust to effective asphalt ratio.
 19. Graphical plot of air voids, voids in mineral aggregate (VMA), and voids filled with asphalt (VFA) versus asphalt content. The Superpave mixes shall also show density at $N_{initial}$, density at N_{design} , and density at $N_{maximum}$ versus asphalt content.
- C. Performance Graded Asphalt Binder Material: The certification(s) shall show the appropriate AASHTO and/or ASTM test(s) for each material, the test results, and a statement that the material meets the specification requirement.

Reference AASHTO MP-1 and AASHTO PP6.

1. Flash point.
2. Rotational viscosity at 135°C. and 165°C.
3. Specific gravity at 25°C.
4. Original $G^*/\sin\delta$ and phase angle at test temperature.
5. RTFO percent mass loss (rolling thin film oven).
6. RTFO - $G^*/\sin\delta$ and phase angle at test temperature.
7. PAV Residue - $G^*(\sin\delta)$ and phase angle at test temperature.

8. Creep stiffness and m-value at test temperature.
 9. Direct tension results (when equipment available).
 10. Strain sweep in accordance with AASHTO T315 (optional).
 11. Physical hardening after 24 hours in accordance with AASHTO T313 (optional).
 12. Mixing and Compaction viscosity-temperature chart.
- D. Asphalt Anti-Stripping Additive: This specification provides for an additive to asphalt to assist in the coating of wet aggregate and to increase the resistance of the asphalt binder coating to stripping in the presence of water. The additive shall be chemically inert to asphalt (heat stable) and when blended with asphalt shall withstand storage at a temperature of 400°F. for extended periods without loss of effectiveness.

Composition: Anti stripping compound shall be an organic chemical compound, free from inorganic mineral salts or inorganic mineral soaps. It shall contain no ingredient harmful to the binder material or to the operator, and shall not appreciably alter the specified characteristics of the binder material.

Anti stripping additive shall be incorporated and thoroughly dispersed in the asphalt binder material in an amount equal to the percent by weight established by the job mix formula. This percent is based on the efficiency of the additive as determined by laboratory tests. The treated composite mixture shall have a minimum tensile strength ratio (TSR) of not less than 80, when tested in accordance with AASHTO T283 with the freeze/thaw cycle. The specimens for the AASHTO procedure shall be 4" (100mm) in diameter, compacted the Superpave gyratory compactor to the desired air void level of 7.0 + 1.0%. If the TSR ratio is less than 80, the aggregates shall be treated with an approved antistrip in sufficient quantity to produce acceptable results. The hot mix asphalt materials and asphalt binder material that require antistrip additives (either liquid or mineral) shall continue to meet all requirements specified herein for binder and HMA. The anti-strip agent shall be included in the bid price.

- E. Testing Laboratory: The laboratory used to develop the JMF shall meet the requirements of ASTM D3666. A certification signed by the manager of the laboratory stating that it meets these requirements shall be submitted with the JMF.
- F. Certified Test Reports: Submit certified test report(s) signed by the material producer and Contractor certifying that materials comply with, or exceed, the requirements herein. Owner reserves the right to employ an independent testing laboratory for testing materials included in the JMF, and Contractor shall, upon request of Owner, supply suitable quantities of these materials for such testing.

1.05 WEATHER LIMITATIONS

- A. The HMA shall not be placed when weather conditions of fog or rain prevail or when the pavement surface or base shows signs of free moisture (film of water) or when surface temperature is less than 40°F measured in the shade. When the surface temperature of the underlying course is less than 50°F, the estimated time available for compaction shall be provided by the Contractor to the Engineer. The Engineer and the Contractor shall

determine if there is an adequate amount of time available to compact the mixture. The Contractor assumes responsibility for constructing the pavement to meet compaction and specification requirements. The estimated time available for compaction can be calculated with computer programs, e.g., Pave Cool Tool.

This program is available at the following web location:

<http://www.dot.state.mn.us/app/pavecool/>

The Engineer will not permit work to continue when overtaken by sudden storms until the pavement surface shows no signs of free moisture. The material in transit at the time of shutdown will not be placed until the pavement surface shows no signs of free moisture, provided the mixture is within temperature limits as specified.

- B. When air temperature falls below 50°F, extra precautions shall be taken in drying the aggregates, controlling the temperature of the materials, and in placing and compacting the mixtures. Refer to section 3.03(B) of this specification.

1.06 COORDINATION

- A. The Contractor shall coordinate paving with all other work, especially underground utility construction, to prevent covering up unfinished or uninspected work and loss of time or labor by improper scheduling. Any repaving required shall be done at no cost to Owner.

1.07 PAVEMENT WITHIN PUBLIC RIGHT-OF-WAY

- A. The construction of all pavements within public rights-of-way shall be in accordance with the rules, regulations and requirements of the public agency having control and ownership of such rights-of-way.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Aggregate: Aggregate shall consist of crushed stone, with or without sand or other inert finely divided mineral aggregate. The portion of the materials retained on the #4 sieve (4.75 mm) shall be known as coarse aggregate, the portion passing the #4 sieve (4.75 mm) and being retained by the #200 sieve (0.075 μ m) as fine aggregate, and the portion passing the #200 sieve (0.075 μ m) as mineral filler.
1. Coarse Aggregate
 - a. Coarse aggregate shall consist of sound, tough, durable particles, free from adherent coatings of clay, organic matter, and other deleterious substances. It shall show no more wear than thirty (30) percent loss when tested in accordance with AASHTO - T96, nor shall the sodium sulfate or magnesium sulfate soundness loss exceed ten (10) percent, after five cycles, when tested in accordance with AASHTO T104.
 - b. The coarse aggregate shall not contain more than ten (10) percent, by weight, of flat or elongated pieces, when tested in accordance with ASTM D4791 at a ratio stated within the standard specifications, or in lieu of, 3:1. A flat particle is one having a ratio of width to thickness greater than the stated ratio; an elongated particle one having a ratio of length to width greater than the stated ratio. An aggregate particle whose maximum length is the stated ratio times its maximum thickness is considered flat and elongated.
 - c. For design ESALs less than 3 million, the coarse aggregate shall contain a minimum of 75% by weight having at least one or more fractured faces, when tested in accordance with ASTM D5821. For design ESALs greater than or equal to 3 million, the coarse aggregate shall contain a minimum of 90% by weight having at least two or more fractured faces and 95% by weight having at least one fractured face, when tested in accordance with ASTM D5821. When two fractured faces are continuous, the angle between the planes of fracture shall be at least 30 degrees to count as two fractured faces
 2. Fine Aggregate
 - a. Fine aggregate shall consist of clean, sound, durable, angular particles produced by crushing natural stone, or gravel that meets the requirements for wear and soundness specified for the coarse aggregate. The aggregate particles shall be free from coatings of clay, silt, or other objectionable matter and shall contain no clay balls. The combined materials that passed the No. 100 mesh sieve shall not have sufficient plasticity to permit the performing of the plastic limit test using AASHTO T90.
 - b. Fine aggregates shall have sand equivalent values of 45 or greater when tested in accordance with AASHTO T 176. The sand equivalent value shall be determined for the combined mix aggregates, including coarse and fine aggregates and mineral filler portions.
 - c. In the fine aggregate sieve analysis passing #4 (4.75mm), the amount between two successive sieves #16, #30, #50, and #100 shall not exceed 33% of the fine aggregate total.

- d. The aggregate shall have a fine aggregate angularity value of 40% or greater when tested in accordance with AASHTO T304, Method A. The uncompacted void content shall be evaluated for the combined mix aggregates including both coarse and fine aggregate portions.
- e. The fine aggregate, as delivered to the mixer, shall meet the following gradation requirement:

TABLE 2

Sieve	Percent Passing	
	Minimum	Maximum
3/8 inch	95	100
No. 8	70	95
No. 50	20	40
No. 200	2	16

- 3. Mineral Filler: If filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of AASHTO M 17.
- B. Recycled Asphalt Pavement (RAP): The use of a maximum of 15% recycled asphalt pavement (RAP) will be allowed in the HMA surface courses. All other HMA mixtures may contain a maximum of 40% RAP by mass of the entire mixture.
- 1. The RAP, incorporated into the HMA mixtures, shall be maintained as a separate captive stockpile and shall not be added to without prior approval. RAP shall consist of asphalt pavement recovered by cold milling or other removal techniques. The RAP shall be crushed so that 100 percent passes the 3/4 inch sieve, or a smaller size depending on the mixture being produced. The Contractor shall assure that the RAP is free from contaminating substances such as joint seal compound.
 - 2. The coarse aggregate in the RAP shall be crushed stone and the top-size shall not exceed the maximum aggregate size established by the JMF. The final HMA mixture containing RAP shall conform to all the specification requirements contained herein.
 - 3. For mixtures containing 25% or less RAP, the asphalt binder shall be a PG 64-28. For mixtures containing greater than 25% and up to 40% RAP, the asphalt binder grade shall be a determined per AASHTO M323. The Contractor shall not use any RAP stockpile that has not been tested in this manner. All proposed RAP stockpile changes shall be submitted to the Engineer in writing and shall be retested for gradation and binder aging. The mixture shall then have the binder grade determined again per AASHTO M323.
 - 4. For design purposes, the specific gravity of the combined aggregate blend with RAP used in a HMA mixture shall be determined in accordance with the attached test method for BULK SPECIFIC GRAVITY OF AGGREGATE BLENDS WITH RAP.

- C. Asphalt Binder Material: The types, grades, controlling specifications, and maximum mixing temperatures for the asphalt binder materials shall conform to the following:
1. The PGAB Grade selected for this Contract is PG 64-28. If traffic speed and/or level warrant, the PGAB may be adjusted by the Owner for the Design Traffic conditions in accordance with Table below:

SUPERPAVE PGAB Adjustment for Design Traffic Conditions

Traffic Loading	Adjustment to PGAB Grade
Standing (<20 km/h)	Increase high temperature grade by 2 grades (12° C.). Use low temperature grade as determined by LTTP BIND software.
Slow Transient (20 to 70 km/h)	Increase high temperature grade by 1 grade (6° C.). Use low temperature grade as determined by LTTP BIND software.
Traffic Level (ESALs)	Adjustment to PGAB Grade
1×10^7 to 3×10^7	Consideration should be given to increasing high temperature grade by 1 grade (6° C.). Use low temperature grade as determined by LTTP BIND software
$>3 \times 10^7$	Switch binder grade to 64E-28 per AASHTO M332.

2. The blending at the HMA plants of PG binder from different suppliers is strictly prohibited. Contractors may switch to another approved source of PG binder, upon written notification to the Owner, and by certifying that the tank to be utilized has been drained to an un-pumpable condition. The tank shall not retain more than 0.5% in volume capacity of previous residue source. Contractors who blend PG binders will be reclassified as a supplier and required to certify the binder in accordance with AASHTO MP1 and AASHTO PP-26. Also if any modifications, blending, or addition of additives occurs, the Contractor shall re-certify the material in accordance with AASHTO MP1 and AASHTO PP-26.
- D. Tack Coat: Emulsified asphalt; AASHTO M 140/ASTM D997 or AASHTO M 208/ASTM D2397, RS-1h or CRS-1.
- E. Mineral Filler: Rock or slag dust, Portland cement, or other inert material complying with AASHTO M 17/ASTM D242.

HMA mixtures that pass beneath the Primary Control Sieve (PCS) control point established by AASHTO M323 may contain a dust to effective asphalt ratio by mass between 0.8 and 1.6. All other mixtures must contain at dust to effective asphalt ratio by mass of between 0.6 to 1.2.

- F. Anti-stripping Additive: Shall be incorporated and thoroughly dispersed in the asphalt binder material in an amount equal to the percent by weight established by the job mix formula. This percent is based on the efficiency of the additive as determined by laboratory tests. The treated composite mixture shall have a minimum tensile strength ratio (TSR) of not less than 75, when tested in accordance with AASHTO T 283 with the freeze/thaw cycle. The specimens for the AASHTO procedure shall be 4 inch (100mm) in diameter, compacted with the Superpave gyratory compactor to the desired air void level of 7.0 + 1.0%. If the TSR ratio is less than 75, the aggregates shall be treated with an approved anti-stripping additive in sufficient quantity to produce acceptable results. The hot mix asphalt materials and asphalt binder material that require anti-stripping additives (either liquid or mineral) shall continue to meet all requirements specified herein for binder and HMA. The anti-stripping additive shall be included in the bid price.
- G. Hot Mix Asphalt: Plant mix may be composed of a homogeneous mixture of aggregate, filler if required, asphalt binder, and/or additives, combined to meet the composition limits by weight and other characteristics as specified. The several aggregate fractions shall be sized, uniformly graded and combined in such proportions that the resulting mixture meets the grading requirements of the following specifications:

TABLE 3 – SUPERPAVE AGGREGATE GRADATION CONTROL POINTS
NOMINAL MAXIMUM AGGREGATE SIZE
(% PASSING BY WEIGHT)

Sieve	3/8" (9.5 mm)	1/2" (12.5 mm)	3/4" (19.0 mm)
2 inch			
1 inch			100
3/4 inch		100	90 – 100
5/8 inch			
1/2 inch	100	90 – 100	≤90
3/8 inch	90 – 100	≤90	
No. 4	≤90		
No. 8	32 – 67	28 – 58	23 – 49
No. 16			
No. 30			
No. 50			
No. 100			
No. 200	2 – 10	2 – 10	2 – 8
Temp. Mix (°F.)	265 - 325	265 — 325	265 — 325

- The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation or gradations specified in Table 3 when tested in accordance with AASHTO T 27 and T 11.
- The gradations in Table 3 represent the limits, which shall determine the suitability of aggregate for use from the sources of supply. The aggregate, as selected (and used in the JMF) and blended, shall have a gradation within the limits designated in Table 3

and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be well graded from coarse to fine.

3. Deviations from the final approved mix design for gradation of aggregates shall be within the tolerances for individual measurements as specified in these requirements. The job mix formula tolerances will apply if they fall outside the grading band in Table 3. All mixture furnished for the work shall conform to the job mix formula within the tolerance ranges as specified.
4. The maximum size aggregate used shall not be more than one-half of the thickness of the compacted course being constructed on a prepared surface or that which can be placed to achieve specification requirements. The maximum size is defined as one sieve size larger than the nominal maximum size. The nominal maximum size is defined as one sieve size larger than the first sieve to cumulatively retain more than 10 percent.

H. Additional Criteria

1. In addition to the above requirements, the mixtures shall also conform to the following:

TABLE 4 – MINIMUM PERCENT VOIDS IN MINERAL AGGREGATE

U.S.A. Standard Sieve Designation (inches)	Nominal Maximum Particle Size		Minimum Voids in Mineral Aggregate (Percent)
	(inches)	(mm.)	
3/8	0.375	9.5	15
1/2	0.500	12.5	14
3/4	0.750	19.0	13
1	1.000	25.0	12

2. Voids in mineral aggregate (VMA), for each plant sample, shall be computed in accordance with AASHTO T 312.
3. Each mixture shall be evaluated for stripping by performing indirect tensile tests on compacted mixtures. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by AASHTO T 283 with freeze/thaw cycle, is less than 75, the aggregates shall be rejected or the asphalt treated with an approved anti-stripping agent. The amount of anti-stripping agent added to the asphalt shall be sufficient to produce a TSR of not less than 75. If an anti-stripping agent is required, it will be provided by the Contractor at no additional cost.

PART 3 - EXECUTION

3.01 GENERAL

- A. The Contractor shall install all pavements in the location and to the grades shown on the Drawings, or approved by the Owner. The type and thickness of pavement courses shall be as shown on the Drawings.

- B. Equipment: Maintain equipment in satisfactory operating condition and correct breakdowns in a manner that will not delay or be detrimental to progress of paving operations.

3.02 PREPARATION

- A. Proof roll prepared base material surface to identify areas requiring removal and re-compaction, and to provide a uniform degree of compaction over the entire pavement area.
- B. Do not begin paving work until deficient base material areas have been corrected and are ready to receive paving. Paving shall not be applied until the Owner inspects and approves the finished base.
- C. Check all frames, covers, grates, water valve boxes and other miscellaneous castings that are located in the proposed pavement areas to ensure that all have been correctly positioned and set to the proper slope and elevation. All covers and grates shall be set flush with the required finished surface. No depressions or mounds will be permitted in the pavement to accommodate inaccuracies in the setting of castings.
- D. All vertical surfaces of structures and existing concrete surfaces in contact with new hot mix asphalt pavement shall be painted with a uniform coating of an approved tack coat material. Extreme care shall be exercised in the application of this material to prevent splattering or staining of surfaces that will be exposed after the paving is completed. Surfaces that are stained as a result of the Contractor's operation shall be repaired or replaced at no additional cost to the Owner.
- E. All existing paved and milled surfaces to be overlaid shall be thoroughly cleaned by a self-propelled sweeper. Areas inaccessible by power sweeper shall be broom swept until the pavement surface is clean.

3.03 APPLICATION

- A. Tack Coat
 - 1. Apply to contact surfaces of all cement concrete and other surfaces abutting or projecting into pavement. Intermediate (binder) course pavement that was placed less than 24 hours prior to surface course placement and has not been exposed to traffic or otherwise contaminated may be directly paved with no tack application at the discretion of the Engineer.
 - 2. Apply tack coat to existing pavement surfaces to receive HMA overlay at a rate of 0.06 to 0.08 gallons per square yard of residual asphalt on the surface. For typical RS-1h and CRS-1 asphalt emulsions, this equates to an emulsion application rate of between 0.06 and 0.08 gallons per square yard. For milled surfaces, application rate of typical emulsions shall be not less than 0.07 gallons per square yard.
 - 3. Tack coat shall be applied evenly by spray. Hand sprinkling shall not be used.
 - 4. Allow to dry until at proper condition to receive paving.

- B. Weather Limitations: The hot mix asphalt shall not be placed when weather conditions of fog or rain prevail or when the pavement surface or base shows signs of free moisture (film of water). When the surface temperature of the underlying course is less than 50°F. (10°C.) the Contractor shall determine the time available for compaction. The time available for compaction shall be calculated based on the time, date, air temperature, average wind speed, sky conditions, latitude, mix type, PG grade, lift thickness, mix delivery temperature, existing surface type, existing moisture content of surface, existing state of moisture in surface, and surface temperature.
1. The estimated time available for compaction can be calculated with the computer program called Pave Cool Tool. This program is available at the following web location: <http://www.dot.state.mn.us/app/pavecool/>
 2. The information regarding the air temperature, average wind speed, sky conditions, mix delivery temperature, and existing moisture conditions shall be evaluated by the Owner and a Contractor's representative located at the paving operation. The estimated time available for compaction shall be provided by the Contractor to the Owner. The Owner and the Contractor shall determine if there is an adequate amount of time available to compact the mixture. Options can be explored to extend the time available for compaction. If there is an adequate amount of time available to compact the mixture, the temperature requirements may be waived by the Owner; however all other requirements including compaction shall be met. The Contractor assumes responsibility for constructing the pavement to meet compaction and specification requirements.
 3. The Owner will not permit work to continue when overtaken by sudden storms until the pavement surface shows no signs of free moisture. The material in transit at the time of shutdown will not be placed until the pavement surface shows no signs of free moisture, provided the mixture is within temperature limits as specified

3.04 HOT MIX ASPHALT PAVEMENT PRODUCTION AND PLACEMENT

- A. Asphalt Binder Material: The Contractor shall set aside one (1) 1-qt samples of the asphalt binder material obtained from each truckload, shipment, or equivalent of asphalt binder material shipped to the production facility. Each sample shall be labeled with the PG grade, source and batch number, quantity, project name, plant, date, and the sampling inspector. The Contractor shall maintain documentation in the form of a Materials Certificate of each shipment, with a copy attached to each quart sample.
1. After receiving the quart samples, obtained by the Contractor, the Owner may test the samples for verification of the performance grade. Material shall conform to the specification requirements for the applicable performance grade as specified herein. Material not conforming to specification requirements shall be subject to corrective action, production suspension, rejection, removal, or reduced payment as determined by the Owner.

- B. Job Mix Formula (JMF): No HMA shall be produced until a JMF has been submitted by the Contractor and approved by the Owner. The HMA shall meet the requirements of Table 3 and Table 4 in this specification.
1. All tests for initial aggregate submittals necessary to determine compliance with requirements specified herein shall be made by the Contractor.
 2. A separate job mix formula shall be submitted for each mixture and each approved RAP stockpile (the stockpile shall be of a uniform quality throughout).
- C. Sampling: The Contractor shall submit representative samples from actual sources of supply for all aggregates to be used for the production of HMA. ASTM D75 shall be used in sampling coarse aggregate and fine aggregate, and ASTM C183 shall be used in sampling mineral filler. Sampling may be observed and supervised by the Owner or their representative. No aggregate shall be used in the production mixtures without prior approval.
1. The approved JMF for each mixture shall be in effect until modified in writing by the Contractor. Should a change in sources of materials be made, a new JMF must be developed and approved before the new material is used. All mixture furnished for the work shall conform to the job mix formula within the tolerance ranges as specified.
- D. JMF Tolerances: The job mix formula with the allowable tolerances shall govern the production limits for the aggregate gradation, binder content, and air voids for each mixture.

TABLE 5 - JOB MIX FORMULA TOLERANCES (BASED ON A SINGLE TEST)

Material	Tolerance Plus or Minus
Aggregate passing No. 4 sieve or larger	6 percent
Aggregate passing No. 8 sieve	5 percent
Aggregate passing No. 16 – No. 50 sieves	3 percent
Aggregate passing No. 100 sieve	2 percent
Aggregate passing No. 200 sieve	1 percent
Asphalt Binder	0.3 percent
Design Air Voids (4.0%)	1 percent
Temperature of Mix	20 degrees F. (-7 C.)

- E. Hot Mix Asphalt Mixing Plants, Haul Vehicles, Pavers and Compactors: Shall conform to MaineDOT Standard Specifications, unless modified herein.
- F. Sampling Platform: A safe and adequate platform or catwalk with stairway and railing shall be provided to accommodate the inspector while checking temperatures and obtaining samples of the mixture from haul vehicles. The height of the platforms and raised platforms shall be adequate to accommodate safe acquisition of mix samples from the type of hauling unit(s) being utilized on the project.

- G. Testing Laboratory: The Contractor or producer shall provide a fully equipped asphalt testing laboratory for control and acceptance testing functions during periods of mix production, sampling, and testing, and whenever materials subject to the provisions of these specifications are being supplied or tested. The laboratory shall provide adequate equipment, space, and utilities as required for the performance of the specified tests. The laboratory and all testing equipment shall be located at the production facility. The Owner shall have priority in the use of the equipment necessary for acceptance testing. The equipment shall conform to the applicable ASTM and AASHTO Specification requirements for the specific testing being performed.
1. Laboratory shall be in compliance with ASTM D3666 latest edition.
 2. The laboratory shall contain all of the equipment necessary to perform testing in accordance with ASTM and AASHTO Standards referenced herein and with MaineDOT Standard Specifications, latest edition, in addition to, those requirements listed below:
 - a. Electronic Balance: 20,000 gm capacity minimum, sensitivity 0.1 gm.
 - b. Bulk Specific Gravity determination equipment (AASHTO T-166). In addition, all ancillary and miscellaneous equipment needed to perform the testing in accordance with these specifications shall be provided.
- H. Temporary Storage of Hot Mix Asphalt: Use of surge bins or storage bins for temporary storage of hot mix asphalt mixtures will be permitted:
1. For hot mix asphalt containing more than 10% RAP, the storage period shall be established from the Rolling Thin Film Oven (RTFO) residue at 140°F. (60°C.), tested in accordance with AASHTO T 240. Prior to production the Contractor shall recover, by AASHTO T 170, a sufficient quantity of the RAP binder. The RAP binder shall be blended with the virgin binder at the JMF percentages. The laboratory RAP-virgin binder blend shall be subjected to the RTFO at 140°F. (60°C.) and the viscosity of the residue shall establish the maximum viscosity allowed for the binder after silo storage. The viscosity of the residue shall be determined in accordance with AASHTO T 202 or AASHTO TP48.
 2. If the Owner determines that there is an excessive amount of heat loss, segregation and/or oxidation of the mixture due to temporary storage, use of surge bins or storage bins will be discontinued.
- I. Hand Work: Whenever possible, all pavement shall be spread by a self-propelled finishing machine. At inaccessible or irregular areas, pavement may be placed by hand methods. If hand methods are used, the hot mixture shall be spread uniformly to the required depth with hot shovels and lutes. After spreading, the hot mixture shall be carefully smoothed to remove all segregated coarse aggregate and lute marks. Lutes used for hand spreading shall be of the type designed for this use. Material loads shall not be dumped faster than they can be properly spread. Workers shall not stand on the loose mixture while spreading.
- J. Paving Machine Placement: Upon arrival, the mixture shall be placed to the full width by a hot mix asphalt paver. The mixture shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling or tearing of the hot mix asphalt mat. Unless otherwise permitted, placement of the mixture shall begin along the centerline of a crowned section or on the low side of areas with a

one-way slope. The top course in larger parking fields shall be placed in the direction of surface-water flow. The mixture shall be placed in consecutive adjacent strips having a minimum width of 10 feet except where edge lanes require less width to complete the area.

1. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 1 foot. Transverse joints in one course shall be offset by at least 10 feet from transverse joints in the previous course.
 2. The placement of the material along the longitudinal joint may be performed by setting the screed to overlay the first mat. The elevation of the screed above the surface of the first mat should be equal to the amount of roll-down expected during compaction of the new mat. The overlapped material shall be bumped by the lutes, if necessary, to optimize the density along the longitudinal joint. Under no circumstances should the overlapped material be broadcast across the mat. Excess material should be removed by hand and returned to the screed.
 3. Trafficking over freshly placed surface course material shall not be permitted until the material has been compacted, and allowed to cool to a temperature of 140 degrees F. minimum.
- K. Joints: Make joints between old and new pavements, and between successive days' work, to ensure continuous bond between adjoining work. Construction joints shall have the same texture, density, and smoothness as other sections of paving. Clean contact surfaces and apply tack coat.

3.05 ROLLING AND COMPACTION

- A. The mixture, after being spread, shall be thoroughly compacted by rollers having a minimum weight of 240 pounds per inch of drum width as soon as it will bear the weight of the rollers without undue displacement. The number, weight, and types of rollers and sequences of rolling operations shall be such that the required compaction and surface texture are consistently attained while the mixture is in a workable condition. Rolling shall continue until the surface is of uniform texture, true to grade and cross section, and the required field compaction is obtained. The number of rollers and passes required shall be governed by the compaction results; however, at least two rollers shall be provided for each paver employed on the paving operation. Each roller shall be operated by a competent, experienced roller operator and shall be kept in as nearly continuous operation as practicable while work is underway. A plate shall be attached to each roller showing the ballasted and unballasted weight per length-width of tread. The contractor is encouraged to deploy pneumatic and or oscillating steel drum rollers when possible.
- B. Compact mixture with hot hand tampers, hand rollers, or vibratory plate compactors in areas inaccessible by self-propelled rollers.
- C. Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling, if required, with hot material.

- D. Follow breakdown rolling as soon as possible, while mixture is hot. Continue rolling until mixture has been thoroughly compacted.
- E. Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained specified density.
- F. Remove and replace paving areas mixed with foreign materials and defective areas and fill with fresh, hot top or intermediate course material. Compact by rolling to specified surface density and smoothness. This work shall be done at Contractor's expense.
- G. After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic.

3.06 HMA SIDEWALKS

- A. Forms: Where walls, curbing or other suitable permanent supports are not present, satisfactory forms shall be installed to assist in securing alignment and adequate compaction of the courses. All forms shall be removed after paving has been completed and the area backfilled and compacted.
- B. Placing HMA: The HMA walkway surface shall be laid in two courses to a depth after compaction of [2-1/2] inches. The bottom course shall be [1-1/2] inch in thickness after compaction, and its surface after rolling shall be parallel to the proposed grade of the finished surface. The top course shall be 1-1/2 inch in thickness after compaction.
- C. Unless otherwise directed, the walkway shall have a 1.50% slope to provide for proper drainage and shall conform to handicap accessibility requirements.
 - 1. Spreading Mixture: The mixture shall be dumped, as needed, into a self-propelled sidewalk paver, or into wheel barrows or an approved steel dump sheets outside the areas on which it is to be placed. It shall then be immediately distributed into place by means of shovels and lutes into a uniformly loose layer to the full width required and of such depth that, when the work is completed, it shall conform to the grade and surface contour required.
 - 2. Rolling: The surface shall be rolled with a self-propelled tandem roller weighing not less than 1-1/2 tons and not more than 5 tons. In places not accessible to a power roller, compaction shall be obtained by means of mechanical rammers or by hand tampers weighing not less than 50 pounds and having a tamping face not exceeding 100 square inches.
 - 3. Testing Surface: When tested with a 10-foot straightedge placed parallel to the centerline of the courses, there shall be no deviation from a true surface in excess of 1/4 of an inch.

3.07 FIELD QUALITY ASSURANCE

- A. Independent Testing Laboratory, selected and paid for by the Owner, may be retained to perform construction testing of in-place HMA courses for compliance with requirements for

density, thickness and surface smoothness. Top and base courses will be randomly cored by the testing laboratory technicians at a minimum rate of three cores for every course and construction phase or 40,000 square feet of paving, however, no less than three cores in light duty areas and three cores in heavy duty areas will be obtained.

1. Samples of all material including compacted specimens and certified copies of all reports and print-outs shall be made available to the Owner or their representative as often as requested including:
 - a. Performance Graded Binders.
 - b. Recycling agents.
 - c. Virgin aggregates.
 - d. Reclaimed pavement materials.
 - e. Loose and compacted mixture specimens.
 - f. Combined aggregate samples.
- B. Grade Control: Establish and maintain required lines and elevations.
- C. Thickness: In-place compacted thickness shall not be less than the thickness indicated on the Drawings. Areas of deficient paving thickness shall receive a tack coat and a minimum 1-inch compacted thickness overlay; or shall be removed and replaced to the proper thickness, at the discretion of the Owner, until specified thickness of the course is met or exceeded, at no additional cost to the Owner.
- D. Surface Smoothness: Testing shall be performed on the finished surface of each course for smoothness, using a 10-foot straightedge applied parallel with, and at right angles to centerline of paved area. The results of these tests shall be made available to the Owner upon request. Surfaces will not be acceptable if they exceed the following tolerances for smoothness:
 1. Intermediate (binder) course: 3/8 inch.
 2. Top course: 1/4 inch.
- E. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable paving as directed by Owner.
- F. Compaction: The in-place compaction of each course shall be compacted to a density of at least ninety-two (92.0) percent (ninety (90.0) percent at longitudinal joint locations) and no more than ninety-seven (97.0) percent of the theoretical density. Density shall be calculated in accordance with one of the following standards:
 1. Bulk Specific Gravity and Density of Compacted Bituminous Mixture Using Paraffin-Coated Specimens: ASTM D1188.
 2. Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface Dry Specimens: ASTM D2726.
 3. The theoretical maximum specific gravity for the mixture shall be measured for each sample in accordance with AASHTO T 209, Type C, D, or E container.
 4. Areas of insufficient compaction shall be delineated, removed, and replaced in compliance with the specifications at no additional cost to the Owner.

- G. Control Strip: If it is determined, during the performance of the contract, that the material does not conform to the material acceptance requirements, the Owner may order the Contractor to cease all operations and construct a CONTROL STRIP consisting of a sufficient quantity of HMA according to the JMF. The Contractor shall construct a test section 300 feet (90 m) long by, 20 to 30 feet (6 to 9 m) wide placed in two lanes, with a longitudinal cold joint, and shall be of the same depth specified for the construction of the course which it represents. The underlying grade or pavement structure upon which the control strip is to be constructed shall be the same as the remainder of the course represented by the control strip. The equipment used in construction of the control strip shall be the same type and weight to be used on the remainder of the course represented by the control strip. A control strip may be required if a change is made in the JMF, sources of supply, or paving and rolling equipment.
1. The mixture shall be prepared, placed, and compacted in accordance with this specification. When the control strip pavement has cooled sufficiently, a total of six, Six-inch (6 inch) diameter core samples of the finished pavement including three (3) core samples that span the longitudinal joint shall be taken and tested for conformance to compaction requirements. The material will also be evaluated for conformance to the requirements of plant produced material.
 2. If the tests by the Owner indicate that pavement does not conform to specification requirements, necessary adjustment to JMF, plant operation, placing procedures, and/or rolling procedures shall be made. A second control strip shall then be placed. If the second control strip also does not meet specification requirements, both sections shall be removed at the Contractor's expense. Additional control strips, as required shall be constructed and evaluated for conformance to the specifications. Any additional sections that are not acceptable shall be removed at the Contractor's expense. No payment will be made for material and labor employed, either in placement or removal of the non-conforming strip.
 3. In no case shall the test result of any one mat core density fall below 90% of theoretical and 88% of theoretical for joint compaction.

3.08 MATERIAL ACCEPTANCE

- A. Acceptance Sampling and Testing: All acceptance sampling and testing necessary to determine conformance with the requirements specified in this section may be performed by the Owner or their representative.
1. Plant Produced Material: Plant produced material may be tested for gradation, asphalt content, and air voids on a random basis, in accordance with ASTM D3665. Sampling shall be from material deposited into trucks at the plant or from trucks at the job site. Where more than one plant is simultaneously producing material for the job, the random sample will be obtained from one facility and considered representative of the day's production.
 - a. Sampling: Each sample, obtained by the Owner or their representative and selected on a random basis, will consist of sufficient material for preparation of test specimens. One set of laboratory compacted specimens will be prepared for each sample in accordance with AASHTO T 245, at the number of blows required

- by Table 3. Each set of laboratory compacted specimens will consist of two test portions prepared from the same field sample.
- b. The sample of HMA may be reheated in a covered metal tin and placed in an oven to obtain the compaction temperature. The compaction temperature of the specimens will be as specified in the job mix formula.
 - c. Testing: Sample specimens shall be tested for bulk specific gravity in accordance with AASHTO T 166 or AASHTO T 275; whichever is applicable, for use in computing air voids.
 - d. The theoretical maximum specific gravity for the mixture shall be measured for each sample in accordance with AASHTO T 209, Type C, D, or E container. Samples shall be taken on a random basis, in accordance with ASTM D3665. The value used in the field placed void computations shall be the average of all maximum specific gravity measurements for each course and construction phase
 - e. Asphalt Binder Content: Extraction tests may be performed once per sample in accordance with AASHTO T 164 or AASHTO T 308 for determination of asphalt content. The weight of ash portion of the extraction test, as described in AASHTO T 164, shall be determined as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. The last weight of ash value obtained shall be used in the calculation of the asphalt content for the mixture. If utilizing AASHTO T 308 for asphalt content determination, the calibration process and calibration factor, as described in AASHTO T 308, shall be determined as stated, prior to acceptance testing. A verification shall be performed as part of every twentieth test performed thereafter or when changes in the mix are apparent.
 - 1). The use of the nuclear method for determining asphalt content in accordance with AASHTO T 287 is permitted, provided that it is calibrated for the specific mix being used.
 - f. Gradation: Aggregate gradations shall be determined once for each sample from mechanical analysis of extracted aggregate in accordance with AASHTO T 30 and AASHTO T 27 (Dry Sieve). When asphalt content is determined by the nuclear method, aggregate gradation shall be determined from hot bin samples on batch plants, or from the cold feed on drum mix or continuous mix plants, and tested in accordance with AASHTO T 27 (dry sieve) using actual batch weights to determine the combined aggregate gradation of the mixture.
2. Field Placed Material: Material placed in the field may be tested for mat and joint density, and compacted thickness on a random basis, in accordance with ASTM D3665. No surface course material shall be placed until an evaluation of the intermediate course for specification conformance is completed. The Owner, prior to placement of the surface course, may determine the quality and acceptance for the intermediate course.
- a. Mat Compaction: The lot size shall be the total quantity of each course placed per construction phase or per 200,000 square feet maximum of construction. Three, 6 inch diameter cores of finished, compacted material shall be taken by the Owner or the Owner's representative from each course and each lot, or partial lot. Core locations will be determined by the Owner on a random basis. Cores shall not be

- taken closer than 1 foot (0.3 meters) from a longitudinal joint and 10 feet (3.0 meters) from a transverse joint.
- b. Joint Compaction: The lot size shall be the total length of longitudinal joints constructed by a material course placed per lot of construction. Three (3) cores of finished, compacted materials shall be taken by the Owner or the Owner's Representative from each course and each lot, or partial lot. Core locations will be determined by the Owner on a random basis and be located directly over the joint, not adjacent to the joint.
 - c. Sampling: Samples shall be neatly cut with a core drill. The cutting edge of the core drill bit shall be of hardened steel or other suitable material with diamond chips embedded in the metal cutting edge. The minimum diameter of the sample shall be 6 inches (152.4 mm). Samples that are clearly defective, as a result of sampling, shall be discarded and another sample taken. The Owner or the Owner's Representative shall furnish all tools, labor, and materials for cutting samples and filling the cored pavement. Cored holes shall be filled in a manner acceptable to the Owner and within one day after sampling.
 - d. Testing: The bulk specific gravity of each cored sample will be measured by the laboratory technician in accordance with AASHTO T 166 or AASHTO T 275, whichever is applicable. The theoretical maximum specific gravity shall be measured once for each plant sample in accordance with the plant-produced material section. The theoretical value used for the percent density of the core samples shall be the average of the maximum specific gravity measurements for the material course and construction lot. The percent density of each sample will be determined in accordance with AASHTO T 269, using the bulk specific gravity of each sample and the average theoretical maximum specific gravity for the material course and construction lot.

3.09 ACCEPTANCE CRITERIA

- A. General: Acceptance will be based on the following characteristics of the hot mix asphalt and completed pavement on a material course and construction phase basis:
 - 1. Hot Mix Asphalt Production
 - Plant air voids
 - Gradation
 - Asphalt binder content
 - Mixture temperature
 - 2. Hot Mix Asphalt Placement
 - Mat density
 - Joint density
 - Thickness
 - Inferior material
 - Smoothness
 - Grade
 - 3. Hot Mix Asphalt Production

- a. Plant Air Voids - The average plant bulk specific gravity shall be determined per set of laboratory compacted specimens. The theoretical maximum specific gravity, for the sample, shall then be used to determine the air voids in accordance with AASTHO T 269. Material shall conform to the specification requirements for air voids listed in Table 3. Material not conforming to specification requirements shall be subject to corrective action, production suspension, rejection, removal, or reduced payment.
 - 1). Corrective action shall be taken by the Contractor when the calculated plant produced air voids per set of laboratory compacted specimens, fall outside the specification range by up to and including 1.5%, either on the high side or the low side. The Contractor shall be required to suspend production when the calculated air voids fall outside the specification range by more than 1.5%, either on the high side or the low side. If two consecutive calculations fall outside the specification range by up to 1.5%, either on the high side or the low side, the Contractor shall be required to suspend production. If production is suspended, the Contractor shall be required to produce material on a trial basis for testing purposes without shipment to the project. The Owner or their representative shall pay for acceptance sampling and testing for the first set of trials, necessary to determine conformance with the specification requirements. If the first set of trials does not conform to specification requirements, the Contractor shall pay for any additional trial sampling and testing for acceptance. When trials have been approved, the plant will return to its normal operation.
- b. Gradation and Asphalt Binder Content: The Contractor shall take corrective action and/or suspension of production when the individual results for asphalt content and/or gradation fall outside the following control limits:

TABLE 6 - CONTROL LIMITS FOR INDIVIDUAL MEASUREMENTS

Sieve Size	Limits	
	Action	Suspension
25.4 mm	0%	0%
19.0 mm	±6%	±9%
12.5 mm	±6%	±9%
9.5 mm	±6%	±9%
4.75 mm	±6%	±9%
2.36 mm	±5%	±7.5%
1.18 mm	±5%	±7.5%
0.600 mm	±4%	±5.5
0.300 mm	±3%	±4.5
0.150 mm	±3%	±4.5
0.075 mm	±2%	±3%
Asphalt Binder Content	±0.4%	±0.70%

- 1). These limits shall be applied to the target values established in the JMF. Corrective action shall be taken by the Contractor when the calculated individual result for gradation or asphalt content falls outside the target JMF value beyond the action limit listed in Table 6. The Contractor shall take the appropriate action when results indicate the material is out of tolerance. The Contractor shall be required to suspend production when the calculated individual result for gradation falls outside the target JMF value beyond the suspension limit listed in Table 6, or when the asphalt binder content is below the minimum values stated in Table 3. The Contractor shall be required to suspend production if two points in a row fall outside the Action Limits for individual measurements. If production is suspended, the Contractor shall be required to produce material on a trial basis for testing purposes without shipment to the project. The Owner or their representative shall pay for acceptance sampling and testing for the first set of trials, necessary to determine conformance with the specification requirements. If the first set of trials does not conform to specification requirements, the Contractor shall pay for any additional trial sampling and testing for acceptance. When trials have been approved, the plant will return to its normal operation.
- c. Mixture Temperature: The temperature of the mixture shall be in accordance with the Performance Graded Asphalt Binder (PGAB) allowable mixing and compaction temperature range.
- d. Failure to stop production and make adjustments when required due to an individual test not meeting the specified requirements shall subject all mix from the stop point to the point when the next individual test is back on or within the action limits, or to the point when production is actually stopped, whichever occurs first, to be considered unacceptable. This material shall be removed and replaced with materials that comply with the specifications at the Contractor's expense.
4. Hot Mix Asphalt Placement
 - a. Mat Density and Joint Density: Mat and Joint Density will be evaluated based on the test results obtained by the Owner. Sampling and testing shall be performed in accordance with 'Field Quality Assurance'.

The bulk specific gravity shall be determined for each compacted core specimen. The theoretical maximum specific gravity shall then be used to determine the density of the compacted specimen in accordance with AASHTO T269, using the bulk specific gravity of each sample and the average theoretical maximum specific gravity for the material course and construction lot.

$$\text{Density} = (G_{mb}/G_{mm}) \times 100$$

Where G_{mb} = bulk specific gravity of compacted specimen
 G_{mm} = theoretical maximum specific gravity

HMA material shall conform to the specification requirements for density listed below. Material not conforming to specification requirements shall be subject to corrective action, production suspension, rejection, removal, or reduced payment as determined by the Owner.

 - 1). Mat Density. The in-place density of each course shall be compacted to a density of at least ninety-two (92.0) percent and no more than ninety-seven

- (97.0) percent of the theoretical density as determined from field or plant samples.
- 2). Joint Density. The in-place density of each course shall be compacted to a density of at least ninety (90.0) percent and no more than ninety-seven (97.0) percent of the theoretical density as determined from field or plant samples.
 - 3). Acceptance of field placed material for mat density and joint density will be based on the test results obtained by the Owner.
- b. Thickness Determinations: The compacted thickness shall be evaluated based on the test results obtained by the Owner. Sampling and testing shall be performed in accordance with Section 3.07 Field Quality Assurance. The thickness requirements shall apply only when each pavement layer is specified to be a uniform compacted thickness of 1 inch (25mm) or greater. The compacted thickness of each layer of the hot mix asphalt or mixes will be measured to determine compliance with the acceptance tolerances in Table 7. Thickness shall be evaluated for compliance by the Owner to the requirements shown on the plans. The thickness shall be determined for each compacted core specimen in accordance with ASTM D3549.

TABLE 7 - THICKNESS ACCEPTANCE TOLERANCES

<u>Specified Thickness</u>	<u>Allowable Tolerances (T)</u>
1 inch to 2 inches	±1/4 inch
Over 2 inches to 5 inches	±3/8 inch
Over 5 inches	±1/2 inch

- 1). Material shall conform to the specification requirements for thickness listed above. Material not conforming to specification requirements shall be subject to corrective action, production suspension, rejection, removal, or reduced payment as determined by the Owner.
- c. Inferior Material: The Owner may at any time, notwithstanding previous acceptance, notify the Contractor of inferior material and recommend the rejection of any batch of HMA which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or improper mix temperature. Such recommendation may be based on only visual inspection or temperature measurements. In the event of such notification, the Contractor should evaluate and dispose of any inferior material. If inferior material is not rejected by the Contractor, the Owner will take a representative sample of the rejected material in the presence of the Contractor, and if it can be demonstrated in the laboratory, that such material was erroneously incorporated into the work, payment will not be made for that material and the Contractor will remove and replace the defective material identified by the Owner.
- d. Smoothness: The finished surfaces of the pavement shall be uniform in appearance, free from irregularities in contour and texture and shall present a smooth-riding surface. Smoothness evaluation applies to all hot mix asphalt

concrete roadways receiving 1.5 inch (38 mm) or more in plan (compacted) thickness

- 1.) The finished surface of the pavement shall not vary more than 1/4 inch (6.2 mm) for the surface course and 3/8 inch (9.5 mm) for the intermediate course. Each area shall be evaluated with a 10-foot (3.0 m) straightedge.
- 2.) Measurements will be made perpendicular and parallel to the paver passes at distances not to exceed 50 feet (15.2m).
- 3.) When profile corrections are required, the Contractor shall use one or more of the following corrective methods:
 - (a.) Removing and replacing the entire pavement thickness;
 - (b.) Diamond grinding or micro milling;
 - (c.) Overlaying (not patching) with the specified surface course;
 - (d.) Removing the surface by milling and applying a lift(s) of the specified course(s);
 - (e.) Use of other methods that will provide the desired results;
- e. Grade: The finished surface of the pavement shall not vary from the gradeline elevations and cross sections shown on the plans by more than 1/2 inch (12.70 mm). The Contractor shall remove deficient areas and replace with new material. Sufficient material shall be removed to allow at least 1.5 inches (37.5 mm) of hot mix asphalt to be placed. Skin patching for correcting low areas shall not be permitted. High points may be ground off. The Contractor shall make tests for conformity with the specified crown and grade immediately after initial compaction. Any variation shall be corrected by the removal or addition of materials and by continuous rolling.
- f. Shaping Edges: While the surface is being compacted and finished, the Contractor shall carefully trim the unsupported outside edges of the pavement not receiving curbing. Edges so formed shall be beveled while still hot with the back of a lute or smoothing iron and thoroughly compacted by tampers or by other satisfactory methods.
- g. The corrective method(s) chosen by the Contractor shall be performed at the Contractor's expense, including all necessary equipment and traffic control.
 - 1.) Areas of removal and replacement shall be removed the full width of the paver pass. The removal areas shall be reconstructed with a transverse butt joint, using a transverse saw cut perpendicular to the paver pass.
 - 2.) Replacement materials shall be placed in sufficient quantity so the finished surface will conform to grade and smoothness requirements. The corrective area shall conform to all material and compaction specification requirements.
 - 3.) When the corrective work consists of an overlay, the overlay shall cover those paver passes sufficient to correct the defects. The area overlaid shall be placed with a transverse butt joint using a transverse saw cut and asphalt removal.
 - 4.) All materials shall meet contract requirements. The overlay shall be placed so the finished surface will conform to grade and smoothness requirements. The overlay area shall be compacted to the specified density.

- 5.) The Owner shall retest any sections where corrections were made to verify that the corrections produced a surface that conforms to the grade and smoothness requirements.

3.10 MEETING EXISTING PAVEMENTS

- A. Where new pavements will abut existing pavements, the Contractor shall sawcut the existing pavements to produce a uniform, smooth joint surface. Sawcutting of existing pavements shall be neat, straight and even lines, and done in a manner that prevents damage to the pavement to remain.
- B. Full-Depth Pavement: Sawcut by approved method to the full depth of the pavement prior to placement of any new pavement. The sawcut surface shall be a neat true line with straight vertical edges free from irregularities. The sawcut surface shall be tack coated immediately prior to the installation of the new abutting HMA material to provide a bond between the old and new pavement. The new compacted pavement surface shall be finished flush with the abutting pavement.
- C. HMA Overlays: The existing hot mix asphalt pavement shall be sawcut to a neat true line with straight vertical edges free of irregularities for a minimum depth of one and one half inches (1-1/2 in.). Prior to completing overlays, existing pavements shall be tapered by grinding. The taper, along the entire length of the joint, shall be one and one-half inches (1-1/2 in.) deep at the sawcut face and shall taper to zero inches (0 in.) deep toward the overlay at a distance of two feet (2 ft.) from the sawcut face in driveways and at a distance of six feet (6 ft.) in roadways and parking areas. The taper shall be cleaned and shall receive an asphalt emulsion tack coat immediately prior to placement of the overlay. The new compacted surface at the joint shall be flush with the abutting existing pavement.
- D. Immediately prior to the placement of the HMA overlay, the sawcut edges of the existing pavement shall be tack coated to bond the new pavement to the old pavement. The new pavement surface shall be finished flush with the abutting pavement. The surface seam of the pavement joint shall be sealed with tack coat and back sanded.

END OF SECTION 321215

APPENDIX A TO SECTION 321215

METHOD OF TEST FOR BULK SPECIFIC GRAVITY OF AGGREGATE BLENDS WITH RAP

1.0 SCOPE

- 1.1 This test method covers the procedure to determine the bulk specific gravity (Gsb) of a combined aggregate blend with RAP used in a HMA mixture.
- 1.2 This test method may involve hazardous materials, operations, and equipment. This test method does not purport to address all of the safety problems associated with the test method's use. The test method user's responsibility is to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2.0 REFERENCED DOCUMENTS

2.1 AASHTO Standards

- T 2 Sampling Aggregates
- T 84 Specific Gravity and Absorption of Fine Aggregates
- T 85 Specific Gravity and Absorption of Coarse Aggregate
- T 100 Specific Gravity of Soils
- T 164 Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
- T 170 Recovery of Asphalt From Solution by Abson Method
- T 209 Maximum Specific Gravity of Bituminous Paving Mixtures
- T 228 Specific Gravity of Semi-Solid Bituminous Materials (Pycnometer Method)

2.2 Asphalt Institute

- MS-2 Mix Design Methods for Asphalt Concrete by the Asphalt Institute

3.0 TERMINOLOGY

- 3.1 Terms and Abbreviations. Definitions for terms and abbreviations shall be in accordance with the Standard Specifications.

4.0 SIGNIFICANCE AND USE

- 4.1 This test method is used to determine the bulk specific gravity of a combined aggregate blend with RAP used in HMA mixture.
- 4.2 The bulk specific gravity (Gsb) of a combined aggregate blend is calculated using an estimate of the bulk specific gravity of the aggregate in the RAP and the actual bulk specific gravity of the other aggregates.
- 4.3 The bulk specific gravity of an aggregate blend is used to perform a volumetric analysis on compacted HMA in accordance with the Mix Design Methods for Asphalt Concrete by the Asphalt Institute.

5.0 APPARATUS

- 5.1 Apparatus shall be as stated in the referenced test methods.

6.0 SAMPLING

- 6.1 Sampling shall be as stated in the referenced test methods.

7.0 PROCEDURE

- 7.1 Identify the coarse aggregate(s), fine aggregate(s), and RAP selected for use in the mix designs.

- 7.2 Identify and record the actual percentages for each of the aggregate components used in the combined aggregate blend of the mix design.
- 7.3 Obtain a representative sample of the coarse aggregate, fine aggregate, mineral filler, and RAP in accordance with the AASHTO procedures.
- 7.4 Determine and record the bulk specific gravity of each of the coarse aggregate(s) in accordance with AASHTO T 85.
- 7.5 Determine and record the bulk specific gravity of each of the fine aggregate(s) in accordance with AASHTO T 84.
- 7.6 Determine and record the maximum specific gravity of the RAP in accordance with AASHTO T 209, Type C, D, or E container.
- 7.7 Determine and record the asphalt content of the RAP using AASHTO T 164.
- 7.8 Calculate and record the effective specific gravity of the RAP aggregate in accordance with the following:

$$Gse = \frac{100 - P_{brap}}{(100/G_{mrap}) - (P_{brap}/G_{brap})}$$

Where:

Gse = Effective specific gravity of the RAP aggregate

Pbrap = Percent binder of the RAP

Gmrap = Maximum specific gravity of the RAP

Gbrap = Specific gravity of asphalt in the RAP (AASHTO T228)

- 7.9 Calculate and record the effective specific gravity of the combined aggregate blend as follows.

$$GsbBlend = \frac{\%CA1 + \%CA2 + \%FA1 + \%FA2 + \%BHF + \%RAP}{\frac{CA1}{Gsb} + \frac{\%CA2}{Gsb} + \frac{\%FA1}{Gsb} + \frac{\%FA2}{Gsb} + \frac{\%BHF}{Gsb} + \frac{\%RAP}{Gse}}$$

Where:

GsbBlend = Bulk specific gravity of the combined aggregate blend.

Gsb = Bulk specific gravity of each respective aggregate.

Gse = Effective specific gravity of the RAP.

%CA1 = Percent of aggregate blend that is coarse aggregate #1.

%CA2 = Percent of aggregate blend that is coarse aggregate #2.

%FA1 = Percent of aggregate blend that is fine aggregate #1.

%FA2 = Percent of aggregate blend that is fine aggregate #2.

%BHF = Percent of aggregate blend that is bag house fines.

%RAP = Percent of aggregate blend that is RAP.

8.0 REPORT

- 8.1 Report the Gsb of the combined aggregate blend to the nearest 0.001.

END OF APPENDIX A TO SECTION 321215

SECTION 321610
CURBING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. This Section specifies requirements for furnishing and installing all types of curbing including the following: granite curb and granite edging.
- B. The work includes:
 - 1. Furnishing and installing granite curb, granite edging, curb inlets, and curb corners, precast concrete curb, cast-in-place concrete curb, and bituminous concrete curb and berms.
 - 2. All associated items and operations required to complete the installations, including surface preparation, concrete support, jointing, and finishing.

1.02 RELATED SECTIONS

- A. Sections which directly relate to the work of this Section include:
 - 1. Section 033055 – CAST-IN-PLACE CONCRETE (SITE)
 - 2. Section 311000 – SITE CLEARING
 - 3. Section 310000 – EARTHWORK
 - 4. Section 321215 – ASPHALT PAVING

1.03 REFERENCE STANDARDS

- A. References herein are made in accordance with the following abbreviations and all work under this Section shall conform to the latest editions as applicable.
- B. ACI 304 – Guide for Measuring, Mixing, Transporting and Placing Concrete
- C. ANSI/ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- D. ANSI/ASTM D1752 – Standard Specification for Preformed Sponge Rubber, Cork, and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
- E. ASTM C33 – Standard Specification for Concrete Aggregates
- F. ASTM C94 – Specification for Ready-Mixed Concrete
- G. ASTM C150 – Standard Specification for Portland Cement

- H. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete
- I. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- J. ASTM C494 – Standard Specification for Chemical Admixtures for Concrete

1.04 SUBMITTALS

- A. Submit shop drawings and manufacturer's literature for granite and precast curb, edging, corners and inlets indicating size, shape and dimensions, finish, and setting method for Engineer's approval.
- B. Submit copies of tests on representative samples of the concrete used in the manufacture of precast units showing a compressive strength of 5,000 psi to the Engineer prior to shipping any units.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Granite and precast curb units shall be adequately protected from damage during transit to the site.
- B. Curbing shall be protected against staining, chipping, and other damage. Cracked, badly chipped, or stained units will be rejected and shall not be employed in the work.

1.06 SAMPLES

- A. The Contractor shall supply to the site three (3) samples of all curb types for approval prior to ordering materials. Approved sample material may be used in the work upon approval by the Engineer.

PART 2 – PRODUCTS

2.01 GRANITE CURB

- A. Granite curb shall be light gray in color, free from seams and other structural imperfections or flaws which would impair its structural integrity, and of a smooth splitting appearance. Natural color variation characteristic of the deposit from which the curb is obtained will be permitted.
- B. Whenever curbing is sawed, all surfaces that are to be exposed shall be thoroughly cleaned and any iron rust or iron particles removed by sandblasting or other methods approved by the Engineer and any saw mark in excess of 1/8 inch shall be removed.

C. Dimensions

1. The stones for the several types of granite curb shall be cut to the dimensions and curvature hereinafter needed:

Type	Minimum Length	Width at Top	Depth	Minimum Width at Bottom
VA-4	6 feet	6 inches	17 to 19 inches	4 inches (for 2/3 length)

2. Stones to be set on a radius of 100 feet or less shall be cut to the required curvature, unless otherwise approved and, except for making closures, shall be of the following minimum lengths:

Radius	Minimum Length
50 feet to 100 feet	6 feet
25 feet to less than 50 feet	4 feet-6 inches
10 feet to less than 25 feet	3 feet

D. Finish

1. Granite curb shall have a top surface free from wind, and shall be peen hammered or sawed to an approximately true plane, and shall have no projections or depressions greater than 1/8 inch. The front and back arris lines shall be pitched straight and true and there shall be no projection on the back surface for 3 inches down from the top which would exceed a batter of 4 inches to 1 foot.
 - a. The front face shall be at right angles to the planes of the top and ends of the curb unit and shall be smooth quarry split, free from drill holes and with no projection of more than 1 inch and no depression of more than 1/2 inch measured from the vertical plane of the face through the arris or pitch line for a distance down from the top of 8 inches. For the remaining distance, there shall be no projection or depression greater than 1 inch measured in the same manner.
 - b. The ends of all stones shall be square with the planes of the top and face of the curb so that when the stones are placed end to end as closely as possible, no space shall show in the joint at the top and face of more than 1/2 inch for the full width of the top and for 8 inches down on the face; after which the end may break back not over 8 inches from the plane of the joint. The arris formed by the intersection of the plane of the joint with the planes of the top and exposed faces shall have no variation from the plane of the top and exposed faces greater than 1/8 inch.

2.02 GRANITE EDGING

- A. Granite shall conform to ASTM C615. Stone shall be hard and durable granite of a uniformly light grayish white color free from seams that would impair the structural integrity.

- B. The stones for the granite edging shall be cut to the following dimensions:

Top Width	Nominal Depth	Minimum Length
4 inches	12 inches	3 feet

- C. The exposed face shall be smooth quarry split to an approximate true plane and still have no projections of more than 1-1/2 inches and no depression greater than 1 inch. The top shall be sawed and shall have no projection or depression greater than 1/4 inch. Any projection not meeting the above shall be dressed off.
- D. The top and bottom lines of the face shall be pitched off to a straight line and shall not show over 1 inch between stone and straight edge when a straightedge is placed along the top and bottom lines.
- E. The ends shall be square to the plane of the face so when placed end to end no space more than 1-1/2 inches shall show except on a radius of 10 feet or less where the finish joint shall be no more than 3/4 inch.
- F. Drill holes not more than 3-1/2 inches or 1/2 inch in depth shall be permitted.
- G. The sides shall not be under the square more than 4 inches or over the square at the back more than 1 inch.
- H. The arris formed by the intersection of the plane of the face with the plane of the end joint shall not vary from the plane of the face more than 1/4 inch.

2.03 CEMENT MORTAR

- A. Cement mortar shall be composed of one part Portland cement and two parts of sand by volume with sufficient water to form a workable mix. Cement shall be Portland cement ASTM C150, Type II.

2.04 TRANSITION SECTIONS

- A. Horizontal transition sections shall be provided at all locations where curb sections change (i.e., vertical to sloped). Vertical transition sections shall also be provided for precast curb sections at wheelchair ramps. Vertical transition sections for granite curb shall be made as shown on the Drawings.

PART 3 – EXECUTION

3.01 GENERAL

- A. Trenching, excavation, backfilling, and compaction shall be completed in accordance with Section 310000 – EARTHWORK, except as modified within this Section.
- B. Cement mortar bedding, if required, shall be placed as shown on the Drawings and in accordance with Section 033055 – CAST-IN-PLACE CONCRETE (SITE).

3.02 GRANITE CURB AND EDGING INSTALLATION

- A. Excavation shall extend six (6) inches below and behind curb, as shown on the Drawings.
 - 1. The gravel base shall be placed in the excavated area, graded and compacted to above the proposed curb subgrade.
- B. Curbing and curb corners shall be set on additional gravel spread upon the foundation. All spaces under the curb and curb corners shall be filled with gravel thoroughly compacted so that the curb and curb corners will be completely supported throughout their length. The curb shall be set at the line and grade required as shown on the plans unless otherwise directed.
- C. Edging shall be set on a thoroughly compacted base so that the edging will be completely supported throughout their length. Concrete shall be placed to support the edging base as shown on the plans.
- D. Curb, curb corners or edging shall be fitted together as closely as possible.
- E. Immediately after the curb, curb corners, curb inlets, and edging is set, the space between it and the wall of the trench shall be filled with gravel thoroughly tamped to a depth of 6 inches, care being taken not to affect the line or grade of the curb, curb corners, curb inlets and edging. The trench shall continue to be filled with gravel and compacted in 6-inch lifts until grade is achieved. If the curb materials and trench are part of reconstruction work and existing bituminous concrete surface is to remain, then the use of concrete backfill is acceptable, to an elevation suitable to support the pavement patch or section.
- F. The joints between curbstones (both front and back) or edging shall be carefully filled with cement mortar and neatly pointed on the top and front exposed portions. After pointing, the curbstones or edging shall be satisfactorily cleaned of all excess mortar that may have been forced out of the joints.
- G. Transitions from normal curb settings to wheelchair ramps shall be accomplished with transition curb as shown on the drawings. Transitions shall be of the same type curb and similar to that abutting the transition piece and, if on a curve, of the same radius.
- H. The ends of the stone curb at driveways and intersections shall be cut at a bevel or rounded, as shown on the Drawings.
- I. If curb, curb corners, curb inlets, or edging of different quarries is used on the same project, curbing of each particular quarry shall be segregated and set to give uniform appearance.

- J. Procedures for removal and resetting of existing granite curb, and new granite curb, in existing pavements shall include the following:
1. Prior to excavation for existing granite curb removal, the pavement surface shall be saw cut a minimum of one foot from the face of curb.
 2. Existing curb shall be carefully excavated, and removed in a manner that protects the curb and existing pavement to remain from damage.
 3. Existing granite curb shall be cleaned by sandblasting as required to remove bituminous material, paint and concrete from exposed surfaces prior to resetting in the proposed work.
 4. New granite curb shall be set to match the top of existing granite curb remaining in place at abutting sections and, if required, transitioned to the typical section shown on Drawings within the first section of curb. Cement concrete shall be placed along the front face of the curb as shown on the Drawings.

END OF SECTION 321610

SECTION 321723
PAVEMENT MARKINGS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. This Section specifies requirements for removal of existing pavement markings and construction of new pavement markings.
- B. The work includes:
 - 1. Removal of existing markings by approved methods.
 - 2. Pavement surface preparation.
 - 3. Furnishing and installing new pavement markings.

1.02 RELATED SECTIONS

- A. Sections which directly relate to the work of this Section include:
 - 1. Section 310000 – EARTHWORK
 - 2. Section 321610 – CURBING
 - 3. Section 321216 – ASPHALT PAVING

1.03 REFERENCE

- A. Reference Standards:
 - 1. MaineDOT Standards and Specifications
 - 2. American Association of State Highway and Transportation Officials
 - 3. Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways

1.04 SITE CONDITIONS

- A. The Contractor shall cordon off areas where markings are being applied, but maintain access for vehicular and pedestrian traffic as required for other construction activities. Flagmen, barricades, drums, warning signs, warning lights, and similar devices shall be used as required.

1.05 SUBMITTALS

- A. Submit material certificate to the Engineer, signed by the material producer and Contractor, certifying that materials comply with these specifications and have been approved for use by the Maine Department of Transportation (MaineDOT).

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Provide in accordance with MaineDOT Section 627.
- B. General: Alkyd-resin type, ready mixed complying with AASHTO M 248, Type I
- C. Color: White for shoulder striping, parking striping, stop bars, directional arrows; blue for ADA accessible space parking symbols; yellow for lane demarcation.

PART 3 – EXECUTION

3.01 PREPARATION

- A. The Contractor shall clean the pavement of dust, dirt, old pavement markings, concrete curing compounds, and other foreign material which may be detrimental to the adhesion of the pavement marking materials.

3.02 REMOVAL OF EXISTING PAVEMENT MARKINGS

- A. Existing pavement markings that conflict with the proposed markings and those shown on the Drawings shall be removed.
 - 1. Pavement markings shall be removed before any change is made in the traffic pattern.
 - 2. Any excessive damage to the pavement caused by pavement marking removal shall be repaired by the Contractor by methods acceptable to the Engineer at no additional cost to the Owner.
- B. Approved methods of pavement markings removal include:
 - 1. Sandblasting using air or water
 - 2. High pressure water
 - 3. Steam or superheated water
 - 4. Mechanical devices such as grinders, sanders, scrapers, scarifiers and wire brushes
- C. Painting over a pavement marking line with asphaltic liquids or paints will not be allowed unless approved by the Engineer.
- D. Material deposited on the pavement from removal operations shall be removed as the work progresses. Accumulations of sand or other material which might interfere with drainage or could constitute a hazard to traffic will not be permitted.
- E. Where sandblasting is used for the removal of pavement markings and the removal operation is being performed within 10 feet of a lane occupied by traffic, the residue, including dust, shall be removed immediately as the marking removal progresses by a vacuum attachment operating concurrently with the blast cleaning operation, or by other methods approved by the Engineer.

3.03 PAVEMENT MARKING APPLICATION

- A. Apply and install pavement markings in accordance with MUTCD and MaineDOT Standard Specifications Section 627.

END OF SECTION 321723

SECTION 323000
SITE FURNISHINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Granite Cap Flank Walls.
2. Landscape Boulders.
3. Bollards.
4. Steel Edging.
5. Table Tennis Table.
6. Foosball Table.

B. Related Requirements:

1. Section 033000 - Cast-in-Place Concrete for installing anchor bolts cast in concrete footings.
2. Section 312000 - Earth Moving for excavation for installing concrete footings.
3. Section 017419 - Construction and Demolition Waste Management and Disposal.
4. Section 018113 - Sustainable Design Requirements.

1.3 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

1.4 ACTION SUBMITTALS

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

B. LEED Submittals:

1. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.

- C. Samples: For each exposed product and for each color and texture specified.

- D. Samples for Initial Selection: For units with factory-applied finishes.

- E. Samples for Verification: For each type of exposed finish, not less than 6-inch- (152-mm-) long linear components and 4-inch- (102-mm-) square sheet components.

1. Include Samples of bollard finish and steel edging finishes.

- F. Product Schedule: For site furnishings. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Boulders:

1. Contractor shall submit representative images of proposed boulders for review and approval by the landscape architect. The landscape architect reserves the right to reject a boulder in the field if it differs substantially from the size, material, finish, or general quality and appearance approved boulder images.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For site furnishings to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Bench Replacement Slats: No fewer than 20 full-size units for each size indicated.
 2. Trash Receptacle Inner Containers: Five full-size units for each size indicated.

PART 2 - PRODUCTS

2.1 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2-PRODUCTS of Section 018113 – Sustainable Design Requirements.

2.2 GRANITE CAP FLANK WALLS

A. General

1. Provide granite wall cap assemblies installed over cast-in-place concrete flank walls as indicated on the Contract Documents and approved Shop Drawings.
2. Concrete wall, reinforcement, and formwork are specified in Section 03 30 00 – Cast-in-Place Concrete.
3. Coordinate cap installation with completion and curing of concrete wall and with adjacent finishes.

B. Submittals

1. Shop Drawings:
 - a. Indicate dimensions, joint layout, dowel anchorage, drip edges, mortar bed thickness, and sealant joint configuration.
 - b. Include interface details with concrete wall, granite boulders, and adjacent finishes.
2. Mock-Up:
 - a. Construct a representative section of wall (minimum 4 ft long) including board-form liner concrete, granite cap, and joint sealant for approval of appearance, workmanship, and color.
3. Product Data: Submit manufacturer data for form liner, granite, epoxy anchoring adhesive, mortar, and sealant.

C. Materials

1. Granite Cap
 - a. Granite Type: Chelmsford Gray Granite, meeting ASTM C615 – Standard Specification for Granite Dimension Stone.
 - b. Compressive Strength: Minimum 19,000 psi per ASTM C615.
 - c. Color Range: Natural range of Chelmsford Gray with moderate variation acceptable; final selection by Landscape Architect.
 - d. Dimensions:
 - 1) Thickness: 4 inches
 - 2) Width: 24 inches
 - 3) Maximum length: 4 feet
 - 4) Overhang: 1-½ inches each side of wall face
 - e. Edge Treatments:

- 1) Top surface: Thermal finish
 - 2) Exposed side edges: Split-face finish
 - 3) Underside: Continuous drip edges, ½ inch from outer face.
 - f. Ends: Where cap abuts granite boulders, set in mortar.
2. Form Liner
 - a. Provide Sika horizontal board-style form liner (or approved equal) to achieve the board-form texture indicated.
 - b. Color and pattern to be reviewed and approved during mock-up.
 - c. Concrete color and texture to match approved sample panel.
 - d. Clean and treat liners per manufacturer recommendations; apply uniform form release agent compatible with liner material.
 - e. Vibrate concrete carefully to ensure full consolidation against liner surfaces.
 - f. Do not over-vibrate or cause segregation.
 - g. Remove liners only after concrete has achieved sufficient strength to avoid surface tearing or delamination.
3. Concrete Finish Standard:
 - a.
 - a. Concrete surface finish shall conform to ACI 301 – Specifications for Structural Concrete, *Class F-4, Rubbed Finish*, except as modified herein.
 - b. Use of form liners shall produce a uniform horizontal board pattern consistent with approved mock-up, with crisp definition and minimal surface voids.
 - c. Limit surface voids (“bug holes”) greater than ⅛ inch (3 mm) in diameter to not more than five (5) per square foot.
 - d. No single void shall exceed ¼ inch (6 mm) in diameter or ⅛ inch (3 mm) in depth.
 - e. Areas with excessive voids, honeycombing, or form joint misalignment shall be rejected and replaced or repaired per ACI 301 and ACI 117 tolerances.
4. Mortar
 - a. Type: ASTM C270, Type N mortar for granite setting.
 - b. Bed thickness: ½ inch nominal.
 - c. Mortar color to match concrete.
5. Dowel Anchors
 - a. Material: Type 316 stainless steel rods, minimum ½ inch diameter.
 - b. Embedment: Minimum 4 inches into concrete, 3 inches into granite, or as shown on Shop Drawings.
 - c. Adhesive: Two-component epoxy anchoring adhesive conforming to ASTM C881, Type IV, Grade 3, e.g., Hilti HIT-RE 500 V3 or approved equal.
6. Joint Backer and Sealant
 - a. Backer Rod: Closed-cell polyethylene foam, non-gassing, compatible with sealant.
 - b. Sealant: One-part, neutral-cure silicone sealant conforming to ASTM C920, Type S, Grade NS, Class 25, Use NT, G, M, A, e.g., Dow 795 or approved equal.
 - c. Color: Match granite.
- D. Fabrication and Tolerances
 1. Fabricate granite true to line and plane with smooth, consistent finishes.
 2. Dimensional Tolerances: ±1/16 inch on thickness; ±1/8 inch on length and width.
 3. Drill anchor holes and drip edges accurately to ensure alignment in field.
 4. Maintain joint width uniform within ±1/8 inch.
- E. Installation
 1. Install granite caps only after concrete walls have fully cured and form liner finish has been approved.
 2. Set caps in full bed of Type N mortar; maintain ½ inch bed thickness.
 3. Align and level to true plane, maintaining 1-½ inch overhang each side.

4. Install stainless steel dowels using epoxy adhesive; ensure full embedment per Shop Drawings.
 5. Tool and clean joints; fill perimeter joints with backer rod and silicone sealant.
 6. Where cap abuts boulders, bed joint in mortar.
 7. Remove excess mortar; clean exposed surfaces with water and mild detergent.
 8. Do not apply sealers or surface treatments unless directed.
- F. Quality Control and Cleaning
1. All work shall conform to approved mock-up for finish, joint alignment, and color uniformity.
 2. Clean granite surfaces with non-acidic cleaners; rinse thoroughly.
 3. Protect finished surfaces from staining and damage during construction.

2.3 LANDSCAPE BOULDERS

- A. Boulders selected for placement shall be existing boulders from on-site sources and/or imported from off-site local stone supplier if necessary.
- B. Boulders selected for "Landscape Boulders" shall be derived from on-site if possible and have minimum width dimensions ranging from 1.5'x1.5'x1.5' to 3'x3'x4' and per the Drawings. Boulders shall be rounded with no sharp edges and reviewed and approved by the landscape architect.



- C. Boulders shall be gray or earth stone color. Place selected boulders at the direction of the Landscape Architect in the field, and generally as shown on the Contract Documents. Placement shall include adjustment of exposed face or orientation.
- D. The Contractor shall work with the Architect until approved orientation is achieved, Excavate to the lines and grades shown on the Contract Documents, and embed approximately 1/3 minimum of boulder below finish grade such that the widest circumference of the boulder is flush with the proposed finish grade of the adjacent material(s).

2.4 BOLLARDS

- A. Contractor shall furnish and install bollards and related appurtenances as specified below and shown in the contract documents.
- B. Bollard shall be 2.9" diameter "Urban" bollard (model#585C) as manufactured by Vestre, Inc. 230 Park Ave, 3rd floor New York, NY 10169; dan@vestre.com. Or approved equal.
- C. Color: Unpainted (Galv. Steel)

- D. Submit product information for all bollard components for review and approval by the landscape architect.
- E. Install bollard and related appurtenances per manufacturer recommendations and as shown in the contract documents.

2.5 STEEL EDGING

- A. Fabrication
 - 1. Fabricate steel edging to sizes, shapes, and dimensions indicated on the Contract Documents and approved Shop Drawings.
 - 2. Fabricate true to line and grade, with consistent radius, smooth curves, and uniform height.
 - 3. Maintain fabrication tolerances of $\pm 1/8$ inch (3 mm) in vertical and horizontal alignment and $\pm 1/16$ inch (1.5 mm) in thickness and edge straightness, unless otherwise indicated.
- B. Submittals
 - 1. Shop Drawings: Submit detailed shop drawings showing materials, dimensions, fabrication details, weld locations, anchorage, and method of installation.
 - a. Indicate joints, connections, and transitions at corners and curves.
 - b. Include provisions for thermal movement, drainage, and interface with adjacent paving or planting areas.
 - 2. Product Data: Submit manufacturer data for steel plate, galvanizing, and fasteners.
 - 3. Welding Certificates: Submit certification of welders in accordance with AWS D1.1.
- C. Materials and Coating
 - 1. Base steel and fasteners shall conform to ASTM A36.
 - 2. Hot-dip galvanizing shall conform to ASTM A123, applied in accordance with the design and preparation requirements of ASTM A385.
 - 3. Repair damaged or uncoated areas in accordance with ASTM A780.
- D. Welding and Finish
 - 1. Welding shall conform to AWS D1.1.
 - 2. Remove all weld spatter and slag.
 - 3. Grind all exposed welds smooth and flush with adjacent surfaces prior to hot-dip galvanizing to ensure a uniform finish and continuous zinc coating.
- E. Installation
 - 1. Furnish and install steel edging where indicated on the Drawings.
 - 2. Set true to line, grade, and alignment, with smooth transitions at joints and corners.
 - 3. Field cutting or adjustment shall not compromise galvanizing; repair any damaged coating in accordance with ASTM A780.

2.6 TABLE TENNIS TABLE

- A. Contractor shall furnish and install outdoor-rated table tennis table.
- B. Basis-of-design product is "Tibhar 7000W Table Tennis" as manufactured by Rene Pierre (18, rue du Consier 71530 CRISSEY – FRANCE). Or approved equal.
- C. Material: Galv and powdercoated steel frame and legs, melamine playing surface
- D. Attachment: Contractor shall secure table tennis table to the decking using tamper-proof, stainless steel fasteners

2.7 FOOSBALL TABLE

- A. Contractor shall furnish and install outdoor-rated 4-player foosball table.

- B. Basis-of-design product is "Tahiti Table Football" as manufactured by Rene Pierre (18, rue du Consier 71530 CRISSEY – FRANCE). Or approved equal.
- C. Material: UV-resistant HDPE cabinet, stainless steel legs and crossbars
- D. Attachment: Contractor shall secure foosball table to the decking using tamper-proof, stainless steel fasteners

2.8 CONCRETE BASE OR FOOTING

- A. Cast-in-place concrete for site furnishings shall conform to the requirements and applicable provisions of Section M4 of the Standard Specification. Minimum 28-day compressive strength shall be 3,000 pounds per square inch, or 4,000 pounds per square inch, as indicated on the Drawings.
- B. Reinforcing Bars shall be new, deformed billet steel bars, conforming to ASTM A615, Grade 60 deformed.
- C. Steel expansion dowels shall be hot-rolled plain steel rounds conforming to the requirements of AASHTO M31, Grade 60 and consisting of a 1/2 inches by 24 inches smooth steel dowel and compatible waxed tube sleeve, 12 inches in length.
- D. Dowels and sleeves shall be as furnished by A.H. Harris & Sons, Inc., by U.S. Steel Corp., by Edgecombe Steel Corp., or approved equal.

2.9 NON-SHRINK GROUT

- A. Grout as required for anchoring shall be a pourable, quick setting, non-metallic and non-shrinking hydraulic cement grout equal to the following:
 - 1. Five Star Grout, U.S. Grout Corporation, 425 Stillson Road, Fairfield, CT 06430, (800) 243-2206.
 - 2. Sika Grout 212, Sika Corporation, Lyndhurst, NJ 07071, (201) 933-8800.
 - 3. Harris Construction Grout, AH Harris & Sons, 10 West Mill St., Medfield, MA 02052, (508) 359-7321.

2.10 SEALANT

- A. Joint sealant and primer shall be polyurethane-based, one component, elastomeric sealants, complying with Fed. Spec. TT-S-00230C, Class A Type 1. Color shall be as selected by the Owner. Sealants shall be self-leveling pour grade type.
 - 1. Vulkem 45, as manufactured by Mameko International, 4475 East 175th Street, Cleveland Ohio 44182, (800) 321-6412.
 - 2. Urexpan NR-210, as manufactured by Pecora Corporation, 165 Wambold Road, Harleysville, PA 10348, (215) 723-6051
 - 3. PSI 951, as manufactured by Polymeric Systems Inc., Phoenixville, PA, (800) 228-5548.
- B. Provide only materials which are known to be fully compatible with the actual installation condition, as shown by the manufacturer's published data or certification. Use manufacturer's recommended joint primer.
- C. Color of joint sealant shall match adjacent pavement.

2.11 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

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

3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
- B. Install site furnishings in accordance with shop drawings and manufacturer's instructions at locations indicated on the drawings.
- C. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
- D. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.
- E. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
- F. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch (19 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.
- G. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.
- H. Joints between metal edge segments shall be of a consistent width, tight to each other and with outer

END OF SECTION 323000

SECTION 323113
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specifies requirements for furnishing and installing chain link fence and gates.
- B. The work includes:
 - 1. Galvanized steel chain link fabric
 - 2. Aluminum-coated, steel chain link fabric
 - 3. Zn-5-Al-MM alloy-coated, steel chain link fabric
 - 4. PVC-coated, steel chain link fabric
 - 5. Aluminum chain link fabric
 - 6. Galvanized steel framework
 - 7. Polymer-coated steel framework
 - 8. Aluminum framework
 - 9. Privacy slats
 - 10. Barbed wire
 - 11. Barbed tape
 - 12. Gate operator
 - 13. Grounding and bonding

1.02. RELATED SECTIONS

- A. Sections which directly relate to the work of this Section include:
 - 1. Section 033055 – CAST-IN-PLACE CONCRETE (SITE)
 - 2. Section 260540 – ELECTRICAL (SITE)
 - 3. Section 310000 – EARTHWORK

1.03 REFERENCE STANDARDS

- A. References herein are made in accordance with the following abbreviations and all work shall conform to the latest editions, as applicable.
- B. ASTM International (ASTM):
 - A53 Standard Specification for Pipe, Steel, Black, and Hot-Dipped Zinc-Coated, Welded and Seamless
 - A116 Standard Specification for Metallic-Coated, Steel Woven Wire Fabric
 - A121 Standard Specification for Metallic-Coated Steel Barbed Wire
 - A123 Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
 - A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

- A392 Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
- A428 Standard Test Method for Weight [Mass] of Coating on Aluminum-Coated Iron or Steel Articles
- A491 Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric
- A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- A817 Standard Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric and Marcellled Tension Wire
- A824 Standard Specification for Metallic-Coated Steel Marcellled Tension Wire for Use With Chain-Link Fence
- A1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
- B211 Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire
- B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
- B429 Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
- C94 Standard Specification for Ready-Mixed Concrete
- C1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
- F567 Standard Practice Installation of Chain-Link Fence
- F626 Standard Specification for Fence Fittings
- F668 Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain Link Fence Fabric
- F900 Standard Specification for Industrial and Commercial Swing Gates
- F934 Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials
- F969 Standard Practice for Construction of Chain-Link Tennis Court Fence
- F1043 Standard Specification for Strength and Protective Coatings on Steel Industrial Chain Link Fence Framework
- F1083 Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
- F1183 Standard Specification for Aluminum Alloy Chain Link Fence Fabric
- F1184 Standard Specification for Industrial and Commercial Horizontal Slide Gates
- F1345 Standard Specification for Zinc-5% Aluminum-Mischmetal Alloy-Coated Steel Chain-Link Fence Fabric

C. Chain Link Fence Manufacturers Institute (CLFMI):

Product Manual Chain Link Fence Manufacturers Institute Product Manual

- D. IEEE (formerly Institute of Electrical and Electronics Engineers, Inc.):
 - 81 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
 - C2 National Electrical Safety Code (NESC)
- E. InterNational Electrical Testing Association (NETA)
- F. National Fire Protection Association (NFPA):
 - 70 National Electrical Code
 - 780 Standard for the Installation of Lighting Protection Systems
- G. Occupational Safety & Health Administration (OSHA)
- H. Underwriters Laboratories Inc. (UL):
 - 325 UL Standard for Safety Door, Drapery, Gate, Louver, Window Operations and Systems
 - 467 UL Standard for Safety Grounding and Bonding Equipment

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's product data including material descriptions, construction details, dimensions of individual components and profiles, and finishes for the following:
 - 1. Fence and gate posts, rails, and fittings
 - 2. Chain-link fabric, reinforcements, and attachments
 - 3. Gates and hardware
 - 4. Privacy slats
 - 5. Barbed wire
 - 6. Barbed tape
 - 7. Gate operators, including operating instructions
 - 8. Motors showing nameplate data, ratings, characteristics, and mounting arrangements
- B. Shop Drawings: Submit shop drawings showing locations of fence, each gate, posts, rails, and tension wires and details of extended posts, extension arms, gate swing, or other operation, hardware, and accessories. Indicate materials, dimensions, sizes, weights, and finishes of components. Include plans, elevations, sections, gate swing and other required installation and operational clearances, and details of post anchorage and attachment and bracing.
- C. Samples for Initial Selection: Submit manufacturer's color charts or 6-inch (150-mm) lengths of actual units showing the full range of colors available for components with factory-applied color finishes.

- D. Samples for Verification: Submit samples for verification for the following products, in sizes indicated, showing the full range of color, texture, and pattern variations expected. Prepare samples from the same material to be used for the Work.
 - 1. PVC-coated steel wire fabric in 6-inch lengths
 - 2. Polymer coating in 6-inch lengths on shapes for posts, rails, gate framing, and wires
- E. Product Certificates: Submit manufacturer's product certificates signed by manufacturers of chain-link fences and gates certifying that products furnished comply with requirements.
- F. Qualification Data: Submit qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of owners, and other information specified.
- G. Field Test Reports: Submit field test reports which indicate and interpret test results for compliance of chain-link fence and gate grounding and bonding with performance requirements.
- H. Maintenance Data: Submit maintenance data for the following to include in maintenance manuals specified in Division 01 – GENERAL REQUIREMENTS:
 - 1. Polymer finishes
 - 2. Gate operator

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed chain-link fence and gate installations similar in material, design, and extent to those indicated for this Project and whose work has resulted in a successful record of in-service performance for these installations.
- B. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association (NETA) and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association (NETA) or the National Institute for Certification in Engineering Technologies (NICET), to supervise on-site testing specified in Part 3.
- C. Source Limitations for Chain-Link Fences and Gates: Obtain each color, grade, finish, type, and variety of component for chain-link fences and gates from one source with resources to provide chain-link fences and gates of consistent quality in appearance and physical properties.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. UL Standard: Provide gate operators that comply with UL 325.

- F. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators serving as a required means of access.

1.06 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others.
- B. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - 1. Merchants Metals, Statesville, North Carolina
 - 2. Master-HALCO, Dallas, Texas
 - 3. Gregory Industries, Canton, Ohio

2.02 CHAIN-LINK FENCE FABRIC

- A. Steel Chain-Link Fence Fabric: Height indicated on Drawings. Provide fabric fabricated in one-piece widths for fencing in height of 12 feet and less. Comply with CLFMI "Product Manual" and with requirements indicated below:
 - 1. Mesh and Wire Size: 2-inch mesh, 0.148-inch diameter (9 gauge)
 - 2. PVC-Coated Fabric: ASTM F668, Class 2b over zinc-coated steel wire with a minimum PVC thickness of .007 inches. Color: as indicated on the plans or, as selected by Owner from manufacturer's full range complying with ASTM F934.
 - 3. Coat selvage ends of fabric that is metallic coated during the weaving process with manufacturer's standard clear protective coating.

2.03 INDUSTRIAL FENCE FRAMING

- A. Round Steel Pipe: Standard weight, Schedule 40, galvanized steel pipe complying with ASTM F1083. Comply with ASTM F1043, Material Design Group IA, external and internal coating Type A, consisting of not less than 1.8 oz./sq. ft. zinc. Exterior of pipe to have ASTM F1043 PVC thermally fused color coating, , minimum thickness 10 mils. Color shall be black or other color as selected by OWNER/ARCHITECT from manufacturer's standard color range.

- B. The frame shall comply with the following strength and stiffness requirements:
 - 1. Line, End, Corner, and Pull Posts and Top Rail: Per CLFMI requirements for Standard Industrial Fence.
- C. Post Brace Rails: Match top rail for coating and strength and stiffness requirements. Provide brace rail with truss rod assembly for each gate, end, and pull post. Provide two brace rails extending in opposing directions, each with truss rod assembly, for each corner post and for pull posts. Provide rail ends and clamps for attaching rails to posts.
- D. Top Rails: Fabricate top rail from lengths 21 feet (6.4 m) or longer, with swaged-end or fabricated for expansion type coupling, forming a continuous rail along top of chain-link fabric.
- E. Intermediate and Bottom Rails: Match top rail for coating and strength and stiffness requirements.
- F. Extended Members: Extend end, corner and pull posts above top of chain-link fabric as required to attach barbed wire assemblies.

2.04 INDUSTRIAL SWING GATES

- A. General: Comply with ASTM F900 for the single and double swing-gate types.
- B. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F1083 and ASTM F1043 for materials and protective coatings.
- C. Frames and Bracing: Fabricate members from round galvanized steel tubing with outside dimension and weight according to ASTM F900 for the appropriate gate fabric height:
- D. Frame Corner Construction: As follows:
 - 1. Welded or assembled with corner fittings and 5/16-inch diameter, adjustable truss rods for panels 5 feet wide or wider.
- E. Gate Posts: Fabricate members from round galvanized steel pipe with outside dimension and minimum weight according to ASTM F900.
- F. Hardware: Latches permitting operation from both sides of gate, hinges, center gate stops, and (for each gate leaf more than 5 feet wide) keepers.

2.05 FITTINGS

- A. General: Provide fittings for a complete fence installation, including special fittings for corners. . All fittings shall be thermally fused color coated having a minimum thickness of 0.006" per ASTM F626. PVC color to match fabric and framework. Moveable parts, nuts and bolts to be field coated with PVC liquid touch up after installation.

- B. Post and Line Caps: Provide weathertight closure cap for each post. Material shall match post material.
 - 1. Provide line post caps with loop to receive top rail
- C. Rail and Brace Ends: Provide rail ends or other means for attaching rails securely to each gate, corner, pull, and end post. Material shall match rails.
- D. Rail Fittings: Provide the following:
 - 1. Rail Sleeves: Not less than 6 inches (153 mm) long. Material shall match rails.
 - 2. Rail Clamps: Provide line and corner boulevard clamps for connecting rails in the fence line to line posts. Materials shall match rails.
- E. Tension Bars: Length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two bars for each corner and pull post. Material shall match fence fabric.
- F. Truss Rod Assemblies: Rod and turnbuckle or other means of adjustment. Material shall match rails.
- G. Barbed Wire Arms: Hot-dip galvanized pressed steel. Provide the Type I, single slanted arm according to ASTM F626, with clips, slots, or other means for attaching strands of barbed wire. Type I, single slanted arm. Use only where specifically indicated on the drawings.
- H. Tie Wires, Clips, and Fasteners: Provide the following types according to ASTM F626:
 - 1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
 - a. Hot-Dip Galvanized Steel: 0.148-inch diameter wire, galvanized coating thickness matching coating thickness of chain-link fence fabric
 - b. Aluminum: ASTM B211; alloy 1350-H19; 0.148-inch diameter, mill-finished wire
 - 2. Power-driven fasteners
 - 3. Round Wire Clips: Hot-dip galvanized steel or aluminum for attaching chain-link fabric to H-beam posts
 - 4. Round Wire Hog Rings: Hot-dip galvanized steel or aluminum for attaching chain-link fabric to horizontal tension wires
- I. Pipe Sleeves: For posts set into concrete, provide preset hot-dip galvanized steel pipe sleeves complying with ASTM A53, not less than 6 inches long with inside dimensions not less than 1/2 inch more than outside dimension of post, and flat steel plate forming bottom closure.

2.06 TENSION WIRE

- A. General: Provide horizontal tension wire at the following locations:
 - 1. Location: Extended along bottom of fence fabric, when bottom rail is not shown on the Drawings.
- B. Metallic-Coated Steel Wire: 0.177-inch diameter, marcelled tension wire complying with ASTM A824 and the following:

1. Coating: ASTM F668, Class 2b over zinc-coated steel wire with a minimum PVC thickness of .007 inches. Color: as indicated on the plans or, as selected by Owner from manufacturer's full range complying with ASTM F934.
- C. Aluminum Wire: 0.192-inch diameter tension wire, mill finished, complying with ASTM B211, alloy 6061-T94 with 50,000-psi minimum tensile strength.

2.07 CAST-IN-PLACE CONCRETE

- A. General: Comply with ACI 301 for cast-in-place concrete and Section 033000, CAST-IN-PLACE CONCRETE or Section 033055, CAST-IN-PLACE CONCRETE (SITE) of these Specifications.

2.08 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107. Provide grout recommended in writing by the manufacturer for exterior applications.
- B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer for exterior applications.

2.09 FENCE GROUNDING

- A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger
 1. Material Above and Below Finished Grade: Copper
 2. Bonding Jumpers: Braided copper tape, 1 inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules
- B. Connectors and Ground Rods: Listed in UL 467
 1. Connectors for Below-Grade Use: Exothermic welded type
 2. Ground Rods: Copper-clad steel. Size: 5/8 inch by 96 inches

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance.

1. Do not begin installation before final grading is completed, unless otherwise permitted by Owner's Representative.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler (irrigation) system, underground structures, benchmarks, property monuments, and other features which may affect the Work.

3.03 INSTALLATION, GENERAL

- A. General: Install chain-link fencing to comply with ASTM F567 and more stringent requirements specified.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed, or compacted soil.
- C. Post Setting: Hand-excavate holes for post foundations in firm, undisturbed or compacted soil. Set posts in concrete footing. Protect portion of posts aboveground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Verify that posts are set plumb, aligned, and are at the correct height and spacing, and hold in position during placement and finishing operations until concrete has sufficiently cured.
 1. Dimensions and Profile: As indicated on Drawings
 2. Exposed Concrete Footings: Extend concrete 1 inches (25 mm) above grade, smooth, and shape to shed water
 3. Concealed Concrete Footings: Stop footings below grade as indicated on Drawings to allow covering with surface material
 4. Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
 5. Posts Set into Concrete in Voids: Form or core drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than outside diameter (OD) of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.

3.04 CHAIN-LINK FENCE INSTALLATION

- A. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more as indicated on Drawings.

- B. Line Posts: Space line posts uniformly at 8 feet o.c.
- C. Post Bracing Assemblies: Install according to ASTM F567, maintaining plumb position and alignment of fencing. Install braces at end and gate posts and at both sides of corner and pull posts. Locate horizontal braces at midheight of fabric on fences with top rail and at two-thirds fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
- D. Tension Wire: Install according to ASTM F567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric.
 - 1. Bottom Tension Wire: Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same gage and type of wire
- E. Top Rail: Install according to ASTM F567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended by fencing manufacturer.
- F. Intermediate Rails: Install in one piece at post-height center span as indicated on Drawings, spanning between posts, using fittings, special offset fittings, and accessories.
- G. Bottom Rails: Install spanning between posts using fittings and accessories.
- H. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 2 inches between finish grade or surface and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- I. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.
- J. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing.
 - 1. Maximum Spacing: Tie fabric to line posts 12 inches o.c. and to braces 24 inches o.c.
- K. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side.

3.05 GATE INSTALLATION

- A. General: Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware

using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.06 GROUNDING AND BONDING

- A. Fence Grounding: Install at maximum intervals of 1,500 feet except as follows:
 - 1. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
 - 2. Gates and Other Fence Openings: Ground fence on each side of opening.
 - a. Bond metal gates to gate posts.
 - b. Bond across openings, with and without gates, except openings indicated as 'intentional fence discontinuities.' Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.
- B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.
- C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2, unless otherwise indicated.
- D. Grounding Method: At each grounding location, drive a ground rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location, including the following:
 - 1. Each Barbed Wire Strand. Make grounding connections to barbed wire with wire-to-wire connectors designed for this purpose.
 - 2. Each Barbed Tape Coil: Make grounding connections to barbed tape with connectors designed for this purpose.
- E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
- F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- G. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

3.7 FIELD QUALITY CONTROL

- A. Ground-Resistance Testing Agency: Engage a qualified independent testing agency to perform field quality control testing.
- B. Ground-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure ground resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by two-point method according to IEEE 81.
- C. Desired Maximum Grounding Resistance Value: 25 ohms.
- D. Excessive Ground Resistance: If resistance to ground exceeds desired value, notify Owner's Representative promptly. Include recommendations to reduce ground resistance and proposal to accomplish recommended work.
- E. Report: Prepare test reports, certified by testing agency, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results.

3.09 ADJUSTING

- A. Gate: Adjust gate to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain gates. Allow one day within Contract amount.
 - 1. Test and adjust hardware, and other operable components. Replace damaged or malfunctioning operable components.
 - 2. Train Owner's personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 - 3. Review data in maintenance manuals.
 - 4. Schedule training with Owner with at least seven (7) days advance notice.

END OF SECTION 323113

SECTION 329113
SOIL PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes soil preparation consisting of providing all landscape soils, imported topsoil, plant backfill mix, coarse sand, compost, and soil amendment products, soils testing, sampling, labor, amending per approved soils reports for existing subsoil, and imported topsoil to meet the specified requirements of subsoil, imported topsoil, and plant backfill mix. Provide amendments, materials, equipment, services transportation, scarification to mitigate compaction, spreading and installation, and amending, and all other items that are required to complete the specified Soil Preparation as shown on the Drawings and as specified herein.
- B. Related work includes the following:
 - 1. Section 329300 - Planting
 - 2. Section 328400 - Irrigation
 - 3. Section 017419 - Construction and Demolition Waste Management and Disposal.
 - 4. Section 018113 - Sustainable Design Requirements.

1.2 DEFINITIONS

- A. Subgrade: Subsoil material(s) and levels resulting from the approved rough grading work.
 - 1. Cultivation of all subgrade areas prior to amending is included in this section.
 - 2. Subgrade soil(s): Subgrade soil shall be existing soil or other materials which are either undisturbed or have been placed resulting from the approved rough grading work on grade and are located in lawn, tree or shrub planting areas.
- B. Existing Topsoil: No existing topsoil is available for use. Imported Topsoil shall be supplied as specified.
- C. Imported Topsoil: This material does not exist on the site and will have to be purchased, supplied, tested, amended by the Contractor (as required in the approved soil testing reports) to meet the requirements of this Section and the quantities required for the work at no additional cost to the Owner.
- D. Amended Plant Backfill Mix for on Lawns on Grade: See Item 2.2 Imported Topsoil: Amended Topsoil for on grade use is made by amending as necessary Imported Topsoil to meet the specified requirements of Plant Backfill Mix for On Grade use for lawns.
- E. Plant Backfill Mix: Refer to Item 2.3 Plant Backfill Mix. Plant Backfill Mix shall be placed around the root ball of a plant in a plant pits or plant beds shown on the Drawings for on grade planting.
 - 1. It shall be comprised of Topsoil that has been amended and mixed with specified components by the Contractor as required by the specifications and the soils test report for the plant species specified.
- F. Landscape Soils: A collective term for all topsoil and subsoil and plant backfill mix(s) in landscaped areas.
- G. References to Landscape Architect shall mean Architect or the Architect's designated representative.

1.3 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for

the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

1.3 SUBMITTALS

A. Overview of Submittals:

1. Refer to Part 1 General, Submittals for each material's specified product data and submitted sample requirement(s).
2. Refer to Part 2 – MATERIALS for each material's requirements and tests and send to the testing laboratory each item to be tested.
3. Refer to Part 3 - EXECUTION for sampling and testing specified therein and send material(s) to the testing lab for each item to be tested.
4. Submittals are not satisfactory until they are approved in writing by the Landscape Architect. Multiple submissions may be required in order to gain written approval. See 1.4 for "Critical Path Processing".
5. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.

B. Submit Test Results and Product Data: Test Results and Product Data shall be submitted including Manufacturer's current product data / specifications, written confirmatory granular analysis, and other written confirmatory analysis requirements to confirm that the submitted material (s) has the same characteristics as the specified material(s). See also Part 2 - Materials of this Specification Section, for the specified materials requirements for the following:

1. Existing Subsoil: Submit Soils Testing Laboratory's tests, analysis and recommended amendments required for agricultural suitability of the existing subsoil.
 - a. The Landscape Architect reserves the right to reject and or adjust these recommended modifications, if it is determined that they will unacceptably affect the cost of the Work and/or not appreciably affect the quality of the work.
 - b. Other amendments as specified and/or if required by Soils Testing Laboratory's report, to make the acceptable subsoil meet the requirements for Topsoil Amended for Lawns and Plant Backfill Mix. Submit samples, product data / Test analysis and recommendations.
2. Imported Topsoil:
 - a. Submit Soil Testing Laboratory's tests, analysis and reports recommending amendments required for:
 - 1). Topsoil for use in Plant Backfill Mix at lawns when on grade and for Plant Backfill Mix.
 - b. Submit other amendments as specified and/or if required by Soils Testing Laboratory's report to make the acceptable topsoil meet the requirements for Topsoil Amended for Lawns on grade and Plant Backfill Mix. Submit samples, product data / Test analysis and recommendations.
3. Submit Test Results and Recommendations for Plant Backfill Mix – the combination of Approved Components and Approved Amending requirements, and which include the following:

- a. Approved Coarse Sand
- b. Approved Compost
- c. Approved Imported Topsoil.
- d. Other Approved Components if required by Soils Testing Laboratory's report to make the acceptable Imported Topsoil meet the requirements for the Plant Backfill Mix: Product data / Test analysis.
- e. Submit Plant Backfill Mix's Approved written Amending Requirements based upon the soils test(s) and review for use at:
 - 1). Plant Backfill Mix shall be amended for the lawn, plant beds and tree pit locations: Test analysis and amendment recommendations shall be as required for the plant backfill mix to support the plants as shown on the Drawings.
 - a). Supplemental Plant Backfill Mix amending may be required by adding Supplemental Fertilizer(s) at each of the 3 use conditions – lawns, plant beds, and tree pits.
 - b). Fertilizer Tablets shall also be used at individual plants per Part 2 requirements.
 - 2). Other amendment's written data as specified and/or if required by Soils Testing Laboratory's report to make the acceptable topsoil complete the requirements for the approved Plant Backfill Mix's Product data / Test analysis and recommendations.
4. Coarse Sand: Submit written granular analysis and other written confirmatory analysis requirements to confirm that the submitted mater(s) has the same characteristics as the specified material(s).
5. Fertilizer(s): Submit Data/Samples as required by the Approved Soils Testing Report and where specified herein.
6. Compost: Submit Compost Testing Laboratory's(s) written approved tests / analysis, and product data, and any recommendations.
7. Organic Components: Submit Analysis / Data if required, by the approved soils testing report such as but not limited to Peat moss and or other organic matter amendment(s),
8. Agricultural Chemical Components(s): Submit Data as required by the approved soils testing report
9. Other written product data Items: Submit, if required, by the approved soils testing report.
- C. Material Samples Submittals: Samples shall be submitted for testing analysis for the following items:
 1. Existing Subsoil: The size of the samples and method of sampling shall be as follows: Samples shall be representative of the material on site. Each Sample shall be a composite sample which shall be taken from a minimum of (6) locations on site for each set of tests.
 - a. (1) composite sample minimum at 2 gal. for each sample taken at each of 6 locations selected by the Landscape Architect and sent to the Soils Testing Laboratory. A composite means several small samples taken within the immediate area of each sample's location. Samples shall be taken from areas of resulting cut and resulting fill.
 - b. Label each sample and make a record of the locations from where each sample was taken. Provide a copy of the location map to the Landscape Architect.

2. Imported Topsoil: The size of the samples and method of sampling shall be as follows: Samples shall be representative of the material on the imported topsoil site. Each composite sample shall be a composite sample taken from a minimum of (5) locations on site for each set of tests.
 - a. (1) composite sample minimum at 2 gal. for each sample taken at locations selected by the Contractor and send to the Soils Testing Laboratory.
 - 1). A 1 gallon sample of the Imported Topsoil shall be submitted to each of the following: the Soils Testing Laboratory, the Contractor's Field Office, and the Landscape Architect and kept for the duration of the project.
3. Coarse Sand: (2) samples minimum at 2 gal. for each sample send to the Soils Testing Laboratory for review and approval.
4. Compost: (2) samples minimum at 2 gal. for each sample and send to the Compost testing and Certification laboratories.
 - a. Note: Refer to Item 2.5 Compost for other items relating to samples and to the laboratories doing the testing for any additional requirements.
 - b. Compost Certification Sample of Compost at 2 gal. for each sample.
 - c. Nutrient Content Sample of Compost at 2 gal. for each sample.
5. Control Mix Batching Submittal for Plant Backfill Mix:
 - a. Once all (3) three Plant Backfill Mix components are approved individually, the Contractor shall submit individual samples of the 3 approved components to the Soils Testing Laboratory for their use.
 - b. All materials and test reports shall be submitted to the Soils Testing Laboratory with copy of each submittal submitted to the Landscape Architect.
 - c. Materials and Test Reports:
 - 1). Approved Imported Topsoil amended for Plant Backfill Mix: (2) samples minimum, 2 gallons each sample. Approved Topsoil shall be analyzed by the Soils Testing Laboratory for amendments required.
 - 2). Approved Coarse Sand: (1) sample minimum – 2 gallons each sample.
 - 3). Approved Compost: (1) sample minimum 2 gallons each sample.
 - 4). Other approved materials and test reports if required by the soils testing recommendations and/or the Soils Testing Laboratory as part of the approved tests.
 - c. Plant Backfill Mix Control Mix Batching and Sampling: All samples shall be submitted to the Soils Testing Laboratory.
 - 1). Once all (3) three Plant Backfill Mix components are approved individually, the Contractor can begin batching the Plant Backfill Control Mix in the proportions set forth in these specifications. The Contractor shall thoroughly mix an initial 4 cubic yard sample (with specified proportions – see Part 2) of the Plant Backfill Mix. Samples shall be provided for soils testing by the Soils Testing Laboratory from this sample to confirm the mix specifications and/or to provide additional amendment requirements. Further batching is to cease until test results have been obtained and recommendations/approval is given to the Contractor by the Landscape Architect.
 - 2). Recommendations for amending and/or correcting the Plant Backfill Mix will be provided to the Contractor by the Soils Testing Laboratory if necessary.

- 3). If adjustment to the batched Plant Backfill Mix is required by the Soils Testing Laboratory, the revised batch shall have samples taken and resubmitted until the batched mix is approved. All subsequent batching is to incorporate the final approved recommendations.
- 4). Control Mix: The resultant approved Plant Backfill Mix shall become the standard for the rest of the Plant Backfill Mix.
 - a). A 1 - gallon sample of the approved "Control Mix" shall be submitted to each of the following: the Soils Testing Laboratory, the Contractor's field office, and the Landscape Architect and kept for the duration of the project to. This control mix will be the standard against which all subsequent soil mixing and testing will be evaluated.
- 5). During Construction "Batch Tests" of the Plant Backfill Mix prior to Installation.
 - a). Batch Tests: For every 500 cubic yards of Plant Backfill Mix prepared, submit one 2 gallon sample of the Mix to the Soils Testing Laboratory for evaluation and review and for subsequent approval by the Landscape Architect prior to the shipment to the site. Each 500 cubic yards batch shall be numbered and dated.
 - b). The Contractor shall schedule this testing in a timely manor in order to permit reasonable time for testing, evaluation, and approvals prior to scheduled installation.
6. Materials Samples taken from the batching and/or installation site for Confirmatory Testing (if required by the Soils Testing Laboratory and/or the Landscape Architect):
 - a. Amended subgrade soil(s): (2) samples minimum at 2 gal. for each sample taken at locations selected by the Landscape Architect, if he requires sampling.
 - b. Amended Plant Backfill Mix for Lawns: (2) samples minimum at 2 gal. each type of soil may be taken at locations selected by the Landscape Architect, if he requires sampling.
 - c. Plant Backfill Mix (for plants): Sample size shall be as required by the Soils Testing Laboratory and sample locations shall be selected by them and/or the Landscape Architect if he requires sampling.
7. Other items requiring samples and/or sampling: If specified and/or required by the Soils Testing Reports, the Landscape Architect.
8. Contractor's Certification of Soils Installation and Amending Compliance: The Contractor shall submit a written certification of his installation of landscape soils and plant backfill mixes for conformance and compliance with the Approved Soils Testing Report(s).
9. Landscape Soils, blends and mixes shall be fully approved prior to any delivery or further delivery to the site.
10. On-site sampling shall be provided by the Contractor as specified. The Soils Testing Laboratory and/or the Landscape Architect may carry out or require additional confirmatory sampling as specified.
11. If any deficiencies in the approved Landscape Soils blends and mixes and materials are found through the testing process, they shall be corrected by the Contractor as directed by the Soils Testing Laboratory and/or the Landscape Architect at no additional cost to the Owner.

1.4 CRITICAL PATH PROCESSING

- A. Critical Path Processing, Soil Testing, and Soils Testing Report Submittals:

1. CRITICAL PATH PROCESSING: The Contractor shall be responsible for recognizing that these critical project materials warrant timely and serious attention, that the testing process to achieve approved materials SHALL BE CONSIDERED A LEAD TIME ITEM, and that under no circumstance shall failure to comply with all specification requirements be an excuse for "staying on project construction schedule of for expedient substitution of unacceptable material (s)".
- B. The Contractor shall submit all representative samples as required in 1.3.
- C. The Contractor shall submit all test results from the Soils Testing Laboratory to the Landscape Architect whom shall review the recommendations and will approve them and/or will make or recommend any additional recommendations, or will reject them, and will send the report to the Contractor. The Contractor shall correct all deficiencies per the soils testing analysis or resubmit new materials meeting the specifications for testing if the material is rejected.
- D. Soils Testing and Testing Reports Submittals:
 1. Subsoil Testing: All testing of Subsoil shall be carried out by the Soils Testing Laboratory which the Contractor shall retain for his use.
 - a. Test Results and recommendations for accepting and/or correcting the subsoil will be provided to the Contractor by the Soils Testing Laboratory. The Contractor will then submit these recommendations to the Landscape Architect for their review and recommendations.
 - b. The Recommendations for accepting and/or correcting amending of subsoil will be provided to the Contractor after review and approval by the Landscape Architect.
 2. Imported Topsoil Testing: All testing of Imported Topsoil shall be carried out by the Soils Testing Laboratory, which the Contractor shall retain for his use.
 - a. Test Results and recommendations for accepting and/or correcting the existing topsoil and the Imported Topsoil will be provided to the Contractor by the Soils Testing Laboratory. The Contractor will then send these recommendations to the Landscape Architect for their review and recommendations.
 - b. The Recommendations for accepting and/or correcting amending of the Imported Topsoil will be provided to the Contractor after review and approval by the Landscape Architect.
 3. Plant Backfill Mix: All testing of the Plant Backfill Mix will be done by the Soils Testing Laboratory.
 - a. Recommendations for amending and/or correcting the Plant Backfill Mix will be provided to the Contractor by the Soils Testing Laboratory. Acceptance for amending and/or correcting the Plant Backfill Mix will be provided to the Contractor after approval by the Landscape Architect.
 4. Coarse Sand: All testing of Coarse Sand will be done by the Soils Testing Laboratory.
 - a. Recommendations for accepting the Coarse Sand will be provided to the Contractor after approval by the Soils Testing Laboratory.
 5. Compost Testing: All testing of the Compost will be done by the Soils Testing Laboratory and the Woods End Research Laboratory as applicable, which the Contractor shall retain for his use. Note: Refer to Part 2 Materials Item 2.5 Compost for which lab does which tests:
 - a. Test Results and recommendations for accepting and/or correcting the Compost will be provided to the Contractor by the Soils Testing Laboratory. The

Contractor will then send these recommendations to the Landscape Architect for their review and recommendations.

- b. Recommendations for accepting the Compost will be provided to the Contractor after approval by the Landscape Architect.
- 6. Failure of any material by testing and/ or amendment procedure to meet specification requirements shall require the Contractor to seek another source for the failed material and the initiation of all testing procedures for the new replacement material shall immediately take place.

1.5 SOILS TESTING LABORATORY AND SOILS TESTING REPORTS

- A. Soils Testing Laboratory: The Contractor shall retain the following Soil Testing Laboratory which is capable of providing all the soil testing regarding subsoil, Imported Topsoil, Coarse Sand, and batched Plant Backfill Mix specified in this Section and as specified below:
 - 1. Soils Testing Laboratory
UMass Soil & Plant Nutrient Testing Lab
203 Paige Laboratory
161 Holdsworth Way
Amherst, MA 01003
413-545-2311
 - a. Soils Testing Laboratory: The Contractor shall provide the Soils Testing Laboratory with a copy of this Soil Preparation Section – 32 91 13 of the Specifications for items related to their testing work.
 - 1). Refer to Part 1 SUBMITTALS for each material's specified product data and submitted sample requirement(s) to be sent to the Soils Testing Laboratory.
 - 2). Refer to Part 2 MATERIALS for each material's specific requirements and any other tests and or requirements.
 - 3). Refer to Part 3 EXECUTION – for sampling and testing specified therein and send material(s) to testing lab for each item to be tested.
 - b. The Soils Testing Laboratory shall carry out all analysis testing of Subsoil, Topsoil(s), and Coarse Sand and shall make or obtain recommendations for chemical and organic amendments for the subsoil and topsoil.
 - 1). These recommendations shall be provided to the Landscape Architect for their Acceptance for the amending and/or correcting the laboratory's analysis and their approval or rejection of the laboratory's recommendations. Note that physical analysis must meet specifications in order to be considered for approval.
 - 2). Failure of Imported Topsoil by testing to meet the specification requirements shall require the Contractor to either seek another source for the failed material and the initiation of all testing procedures for the new replacement material shall immediately take place or amend the physical characteristics if it is an option as determined by the Soils Testing Laboratory and/or the Landscape Architect. Amended soils associated with this process shall be resubmitted for testing and approval. It is recommended that more than one source be submitted (clearly identified) at the same time in order to expedite the approval process.
 - 2. Soil Testing Reports shall contain at a minimum the following tests and the laboratory's recommendations for amending the Imported Topsoil(s).
 - a. Mechanical gradation (sieve analysis) shall be performed and compared to the USDA Soil Classification System and this specification for Imported Topsoil.
 - b. The silt and clay content shall be determined by a Hydrometer Test.

- c. Percentage of organics shall be determined by the Soils Testing Laboratory.
 - d. Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Aluminum, Soluble Salts, and Acidity (pH).
 - e. Soil Analysis Tests shall include recommendations for each of the tested soils for soil amendments to correct soils deficiencies as necessary, to perform for their respective relationship to plant types including lawns.
 - 1). Provide rates of application for all additives per 1000 sq. ft. and or per cubic yard.
 - f. All tests shall be performed in accordance with the current standards of the Association of Official Agricultural Chemists.
 - g. The Contractor shall pay for all sampling and testing.
3. The Landscape Architect reserves the right to reject the recommendations of the Soils Testing Laboratory if it is determined that they will unacceptable effect the cost of the Work and/or not appreciably affect the quality of the Work.

1.6 COMPOST TESTING AND CERTIFICATION LABORATORIES

- A. The Soils Testing Laboratory shall retain the following 2 laboratories for his use which are capable of providing review testing, and recommendations regarding compost testing and certification.
- 1. Woods End Research Laboratory
P.O. Box 297
Mt. Vernon, ME
Tel (207) 293 2457
 - 2. UMass Soil & Plant Nutrient Testing Lab
203 Paige Laboratory
161 Holdsworth Way
Amherst, MA 01003
413-545-2311
- a). Coordination between the two Testing Laboratories: The Soils Testing Laboratory shall provide both laboratories with a copy of this specification section and all coordination and samples necessary between these 2 laboratories to get the required Compost Testing and Compost Certification as specified.
- 3. The Contractor shall pay for all sampling and testing.
 - 4. Compost Testing and Certification shall be as specified herein in Part 2 – COMPOST. The above laboratories are able to do all the analysis, testing, and certification specified in Item 2.5 Compost and herein and according to regulations and the specifications.

1.7 PROJECT/SITE CONDITIONS AND DOCUMENTS

- A. Existing Conditions
- 1. The Contractor shall become familiar with and review the Owner's soil boring data.

1.8 SEQUENCING AND SCHEDULING

- A. The following sequencing is general only and not all specified items are listed.
- B. On Grade installation of Topsoil and Plant Backfill Mix: Install on grade the topsoil and Plant Backfill Mix only after subgrade approval, subgrade compaction mitigation and subgrade cultivation, and any required amending and preparation has been completed.

PART 2 – MATERIALS

2.1 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2–PRODUCTS of Section 018113 – Sustainable Design Requirements.

2.2 EXISTING SUBSOIL

- A. Existing Subsoil shall be tested for Agricultural Suitability by the Soils Testing Laboratory.
 - 1. The Contractor shall take samples of subsoil as specified in Part 1 Submittals – Material Samples for Existing Subsoil.
 - a. The Landscape Architect reserves the right to reject these recommended modifications if it is determined that they will unacceptably effect the cost of the Work and/or not appreciably affect the quality of the work.
- B. The Project Soils Consultant shall review the test results and approve / disapprove the suitability for use on the project.

2.2 TOPSOIL

- A. Imported topsoil shall meet the following requirements:
 - 1. Imported Topsoil's Source shall be from comparable topographic and geological conditions as the existing project. It shall have the gradation and soil chemistry, pH and organic content meeting the specification requirements for the intended use.
 - a. All screening of Imported Topsoil shall be done "off " the project site unless approved in writing by the Contracting Officer.
 - b. No Imported Topsoil shall be purchased or brought on to the site until it has met all specified approvals required.
 - 2. Imported Topsoil that does not initially meet the required specifications may be subsequently amended to be made acceptable, if in the opinion of the Soils Testing Laboratory and/or the Landscape Architect, it can be easily blended with minimal amending and mixing to become consistent and meet the specification requirements and the Soil Testing Laboratory's Recommendations.
- B. Imported Topsoil shall not be stripped, dug, loaded, delivered, screened, spread, or stockpiled or amended or mixed for plant backfill mix(s) while in a frozen or muddy condition.
- C. Amendments: As required by the approved Soils Testing Report to meet the specifications of Item 2.2 Topsoil.
- D. Quantity: Quantity of Existing and Imported Topsoil required, screened, spread, and amended and tested for the work shall be calculated and paid for by the Contractor at no additional cost to the Owner.
- E. Imported Topsoil from off site, as required for the work shall be screened, well drained, arable, and shall be free of subsoil, stones over 1/2 inch diameter, sticks, oils, chemicals, noxious weeds, sod clumps, plaster, concrete, earth clods, sticks, stumps, clay lumps, roots or other objectionable, extraneous matter of debris. It shall also be free of quack – grass rhizomes, Agropyron Repens, and the nut – like tubers of nut grass, Cyperus esculentus, and all other primary noxious weeds.
- F. Imported Topsoil shall conform to and have the following tests and analysis:
 - 1. Mechanical gradation (sieve analysis) shall be performed and compared to the USDA Soil Classification System.

2. The silt and clay content shall be determined by Hydrometer Test.
3. Percent of organics shall be determined by procedures performed by the Soils Testing Laboratory.
4. Soil analysis tests shall show recommendations for soil additives to correct soils deficiencies as necessary, and for additives necessary to accomplish particular lawn and planting objectives noted.
 - a. Provide rates of application for all additives per 1,000 sq. ft. and also per cubic yard.
5. All tests shall be performed in accordance with the current standards of the Association of Official Agricultural Chemists.
6. Chemical Analysis: Chemical analysis shall be done for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Aluminum, Soluble Salts, and acidity (pH).
7. Structure Analysis: Imported Topsoil Grain Size Distribution, pH factor, Organic Content shall conform to the following:
 - a. Grain Size Distribution: Analysis of grain size distribution for material passing the # 10 Sieve for Imported Topsoil shall be done as follows:

U.S. Sieve No.	% Passing Minimum	% Passing Maximum
10	100--	---
18	84	100
35	63	88
60	45	72
140	30	44
270	24	34
0.002mm	2	5

- b. The ratio of the particle size for 80% passing (D 80) to the particle size for 30% passing (D 30) shall be 7 or less. ($D / 80 D / 30 < 7$).
 - c. Maximum size shall be one half - (1/2)-inch largest dimension. The maximum retained of the # 10 sieve shall be 15% by weight of the total sample.
 - d. pH Factor: Imported Topsoil shall not have a pH factor of less than 6.0 or greater than 7.0
 - e. Organic Content: Imported Topsoil shall have an organic content of between 4.0 and 6 percent.
 - f. Gradation Tests: These tests shall be by combined hydrometer and wet sieving in compliance with ASTM D422 after destruction of organic matter by ignition.
 - g. Other Tests and Analysis: As required by the Soil's Testing Laboratory
8. Imported Topsoil's Soil Analysis Tests shall show recommendations for soil additives to correct soils deficiencies as necessary, and for additives necessary

to accomplish particular lawn, and Plant Backfill Mixes for all plants specified herein.

a Provide Rates of Application for all additives per 1,000 square feet and also per cubic yard for the following project materials.

- 1) Plant backfill Mix(s) for Lawns on grade.
- 2) Plant Backfill Mix amended for the types of Plants used in the documents. See the Drawings for the plant list and applicable details.

G. The Soils Testing Laboratory and/or Landscape Architect shall review the test results and approve / disapprove the suitability for use on the project.

2.3 PLANT BACKFILL MIX

A Plant Backfill Mix's Component Parts by Volume: (Note: This is an approximate ratio which may be modified by the Soils Testing Laboratory and/or Landscape Architect at no additional cost to the Owner as necessary to meet the requirements of each of these component items Plant Backfill Mix's components submitted and approved analysis). The mix shall be blended uniformly in the ratio of the components are listed below:

1. 2 – parts Approved Imported Topsoil
2. 1 – part Approved Coarse Sand
3. 1 – part Approved Compost.

B. The Plant Backfill Mix when blended shall meet all specification requirements of imported topsoil except that the Organic Content shall be between 5.5 and 8.0 percent.

C. Plant Backfill Mix Amendments per approved Soils Tests and Supplemental Amending which is required for plants only.

1. Plant Backfill Mix shall be amended for the types of Plants used in the Contract. See the Drawings for the plant list and applicable details and locations on grade.
 - a. Supplemental Amending of Plant Backfill Mix for plants only shall be done by adding Supplemental Fertilizer Tablets: Refer to Section 32 93 90 Planting for Fertilizer Tablets and amending requirements, which shall also be used to amend each individual Plant whether in beds or in lawns.

D. The Landscape Architect shall review the test results and approve / disapprove the suitability for use on the project.

2.4 COARSE SAND

A. Coarse Sand for the following items: Tree Pit Sand Drainage Layer, and Drainage layer under shrub beds, for amending topsoil for on grade for use, and for any other specified uses shall be a uniformly graded Coarse Sand consisting of clean, inert, rounded grains of quartz or other durable rock which is free from topsoil, clay, surface coatings, mica, and any other deleterious materials and shall have the following gradation:

1. Coarse Sand Gradation:

U.S. Sieve No.	% Passing by Weight Minimum	Maximum

10	100	-
18	60	80
35	35	55
60	8	20
140	0	8
270	0	3
0.002mm	0	0.3

- 2 Maximum size shall be one half – ½ inch largest dimension. The maximum retained on the #10 sieve shall be 20% by weight of the total sample.
- 3 The ratio of the particle size for 70% passing (D/70) to the particle size for 20% passing (D/30) shall be 3.0 or less. (D/70 / D/20 less than 3.0).
- 4 Gradation Test: Tests shall be done by combined hydrometer and wet sieving in compliance with ASTM D 422 after destruction of organic matter by ignition.

- B. The Soils Testing Laboratory and/or Landscape Architect shall review the test results and approve / disapprove the suitability for use on the project.

2.5 COMPOST

- A. Compost, weed free for amending planting medium shall be a stable, humus – like material produced from the aerobic decomposition of organic residues. The residues, if biosolids, shall consist of compost meeting MA DEP Type 1 requirements, or approved equal. The compost shall be a dark brown to black color and be capable of supporting plant growth with appropriate management practices in conjunction with addition of fertilizer and other amendments as applicable, with no visible free water or dust, with no unpleasant odor, weed free, and meeting the following criteria as reported by the producer.
1. The ratio of carbon to nitrogen shall be in the range of 10:1 to 25:1.
 2. Stability shall be assessed by either a CO₂ evolution test or a re-heating test. Protocols for each are specified by the coalition of Northeastern Governor's Source Reduction Task Force (CONEG) in their 1966 report, "Model Procurement Specifications for Source Separated Compost". For the CO₂ test, the compost respiration shall be no more than 5mg CO₂-C/gBVS day. For re-heating using the Dewar self-heating test, the maximum heat rise shall be no greater than 20 degrees C above room temperature (20 to 25 degree C).
 3. Pathogens/Metals/Vector Attraction reduction shall meet 40 CFR Part 503 rule, Table 3, page 9392, Vol. 58 No. 32, and Commonwealth of Massachusetts 310 CMR 32.00 (for applications to soils with human activity).
 4. Organic Content, pH and Salinity testing and chemical analysis shall be by the Soils Testing Laboratory which is the West Experiment Station at Univ. Mass, Amherst. For Nutrient analysis. Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Aluminum, Magnesium, Lead, Soluble Salts, Cation Exchange Capacity, soil reaction (pH), and buffer pH.
 - a. Organic Content shall be at least 40 percent (dry weight). One hundred percent of the material shall pass a ½" / 10mm (or smaller) screen. Debris such as metal, glass, plastic, wood (other than residual chips), asphalt or masonry shall not be visible and shall not exceed one percent dry weight. Organic content shall be determined by weight loss on

ignition for particles passing a number 10 sieve according to procedures performed by the Soil Testing Lab. which is the West Experiment Station at Univ. Mass., Amherst as follows:

- 1). A 50-cc sub-sample of the screened and mixed compost is ground to pass the number 60 sieve.
 - 2). Two to three grams (+/- 0.001g) of ground sample, dried to a constant weight at 105 degrees C is placed into a muffle furnace.
 - 3). The temperature is slowly raised (5C/minute) to 300C.
 - 4). The sample is removed to an oven to equilibrate at 105C and the weight is taken.
 - 5). Organic matter is calculated as loss on ignition.
 - b. pH: the pH shall be between 5.5 and 8.0 as determined from a 1:1 soil – distilled water suspension using a glass electrode pH meter American Society of Agronomy Methods of Soil Analysis, Part 2, 1986.
 - c. Salinity: Soluble salts shall not exceed 2.0 mmhos/cm (dS/m).
 - d. Screened Compost: Compost shall be screened to 1/2" / 10mm maximum particle size and shall contain not more than 3 percent material finer than 0.002mm as determined by hydrometer test on ashed material.
5. Compost Certification:
- a The Compost shall be certified with a screening profile by Woods End Laboratory of Maine as mature, stable, compost. Provide this laboratory with a copy this specification for compost and samples as require by them.
 - 1) Woods End Research Laboratory
P.O. Box 297
Mt. Vernon, Maine, 02352
Tel: (207) 293 2457
6. Nutrient Content Determination of the Compost:
- a Note: This shall be done according to procedures performed by the Soils Testing Laboratory, which is the Soil and Plant Tissue Laboratory West Experiment Station at the University of Massachusetts, Amherst.
 - 1) Provide the Soil Testing Laboratory with a copy of this compost specification and samples of the compost.
- B. The Project Soils Consultant shall review the test results and approve / disapprove the suitability for use on the project.
- 2.6 COMMERCIAL FERTILIZER SUPPLIERS AND MIX BLENDEERS:
- A. Sierra Chemical Co. (408 – 263 – 8080).
 - B. W. R. Grace and Co. (800 – 527 – 1893).
 - C. Or Equal.
- 2.7 ACCESSORIES
- A. Water: Clean, fresh and potable. Transport as required.
- 2.8 SOIL AMENDMENTS: The following additives, such as but not limited to, shall be added to the topsoil(s) as applicable depending on the recommendations of the Soils Testing Reports unless otherwise specified herein or otherwise required otherwise by the Soils Testing Report.

- A. Other amendments, if required, by the Soils Testing Report. (S).
- 2.9 ORGANIC COMPONENTS: The following additives shall be used as applicable depending on the recommendations of the Soils Testing Report(s).

A. Peat Moss:

1. Type: Finely shredded, brown in color, suitable for horticultural purposes and frequently referred to in the trade as "greenhouse" or "coarse grind".
2. Measurement: Measure peat in air-dry condition, containing not more than 35% moisture by weight on an "as-received" basis. Ash content shall not exceed 10%.
3. Physical Properties:

<u>Percent Passing</u>	<u>Sieve Size</u>
95-100	9.51 mm (3/8 in.)
0- 40	500 micron (#35, 32 mesh)

4. Organic Content (dry weight basis): 90-100%
5. Chemical Properties:
Nitrogen (dry weight basis): 0.6-3.0%
Salinity/Soluble Salts: Saturation extract conductivity 0.0-3.0 millimhos/cm @ 25 degrees C.
pH: 3.0-4.5

B. Nitrogen-Treated Sawdust:

1. Type: Derived from fir or cedar wood sawdust.
2. Physical Properties:

<u>Percent Passing</u>	<u>Sieve Size</u>
95-100	6.35 mm. (1/4 in.)
80-100	2.38 mm. (#8, 8 mesh)
0- 30	500 micron (#35, 32 mesh)
3	Chemical Properties:

Nitrogen content (dry weight basis):
Wood of Fir/Cedar 0.56 - 0.84%
Iron content (dry weight basis): 0.08% iron as metallic, minimum.
Salinity/Soluble salts: Maximum 3.5 millimhos/cm 25 degrees C. as determined by saturation extract method.
Ash (dry weight basis): 0 - 6.0 percent maximum.

4. Treating Nitrogen Process: Sawdust pre-treating shall be done as follows if pre-treated sawdust is not available. Thoroughly bulk-blend any of the following available sawdust types with the amendment specified:

	Urea Formaldehyde
<u>Sawdust</u>	<u>Per Cubic Yard</u>

Hardwood	4 lbs.
Fir or Cedar	4-1/2 lbs.

2.10 CHEMICAL COMPONENTS: The following additives shall be used as applicable depending on the recommendations of the soils testing report(s).

- A. Standard commercial pre-mixed and balanced pre-plant or lawn fertilizers that meet the recommendations of the Soils Testing Report(s).
- B. Ground Limestone: Agricultural limestone containing not less than 85% of total carbonates, ground to such fineness that 50% will pass #100 sieve and 90% will pass #20 sieve.
- C. Dolomite Lime: Agricultural grade mineral soil conditioner containing 35% minimum magnesium carbonate and 49% minimum calcium carbonate, 100% passing #65 sieve. "Kaiser Dolomite 65 AG" by Kaiser, Inc. or accepted equal.
- D. Gypsum: Agricultural grade product containing 80% minimum calcium sulfate.
- E. Iron Sulfate (Ferric or Ferrous): Supplied by a commercial fertilizer supplier, containing 20% to 30% iron and 35% to 40% sulphur.
- F. Sulphate of Potash: Agricultural grade containing 50% to 53% of water-soluble potash.
- G. Single Superphosphate: Commercial product containing 20% to 25% available phosphoric acid.
- H. Ammonium Sulphate: Commercial product containing approximately 21% ammonia.
- I. Ammonium Nitrate: Commercial product containing approximately 34% ammonia.
- J. Calcium Nitrate: Agricultural grade containing 15-1/2% nitrogen.
- K. Ureaform: Granular commercial product containing 38% nitrogen, and minimum 27% water insoluble nitrogen (WIN).
- L. I.B.D.U. (Iso Butylidene Diurea): Commercial product containing 31% nitrogen.
- M. Soil Sulfur: Agricultural grade sulfur containing a minimum of 96% sulfur.
- N. Iron Sequestrene: Geigy Iron Sequestrene 330 Fe, by Ciba-Geigy Corporation, (919) 292-7100, containing approximately 10% iron.
- O. Potassium Nitrate: Agricultural grade containing approximately 13% nitrogen (N) and 44% potash (K2O).
- P. Trace Elements: FRIT Industries product 503 Micromax manufactured by Grace/Sierra or equal.
- Q. Bone Meal: A fine ground, steam-cooked, packing house bone with a minimum analysis of (23) percent phosphoric acid and (1) percent nitrogen.
 - 1. Bone meal shall be used for all bulbs in amounts as required by the Soils Lab.

PART 3 - EXECUTION

3.1 SOIL MOISTURE CONTENT – ON-GRADE

- A. General: Do not work soil when moisture content is so great that excessive compaction will occur, nor when it is so dry that dust will form in the air or that clods will not break readily, nor when it is frozen. Apply water, if necessary, to bring soil to an optimum moisture content for tilling and planting.

3.2 SUBGRADE VERIFICATION – ON GRADE

- A. Verify that subgrades for installation of the Plant Backfill Mix in lawns and/ or planting beds requiring plant backfill mix have been established and approved under rough grading in Section 312000 Earth Moving Do not do any subgrade work on unapproved subgrades.

- B. Report all variations for correction immediately and only when notified that the correction has been made shall the Contractor proceed.

3.3 CLEARING AND CULTIVATION OF LAWN AND PLANTING AREAS – ON GRADE

- A. Refer to the Drawings for locations of hydroseeded lawn areas, and planting areas.
- B. Clearing: Clear all lawn and planting areas of stones ½ inch diameter and larger, weeds, debris and other extraneous materials prior to soil preparation work.

3.4 SCARIFICATION OF SUBGRADE IN ORDER TO MITIGATE COMPACTION CAUSED BY CONSTRUCTION OPERATIONS:

- A. Coordinate the following scarification work to eliminate compaction with the site Earth Moving Specifications done as a result of construction Operations when located in lawn and planting areas on grade which are as shown on the Drawings.
- B. *Deep Scarification of Subgrade:* Deep Scarification of Subgrade shall to be performed in former paved areas and/or in heavily compacted areas such as, but not limited to, construction parking areas (on grade), material stockpile areas, temporary roadways, construction areas, and areas around the building, other construction areas and/or as located upon the site. The entire subgrade below all woody plant beds, including perennials and meadow grasses shall be loosened to a minimum depth of 18 – inches and plant beds to the depth shown in the details.
- C. *Shallow Scarification of Subgrade:* Shallow Scarification of Subgrade shall to be performed in proposed sod/seed lawn areas and/or in lightly compacted areas such as, but not limited to, temporary parking areas (on grade), short term material stockpile areas, and other construction areas as located upon the site. The entire subgrade at lawns or meadow grasses shall be loosened to a minimum depth of 6 – inches as shown in the details.
- D. Immediately prior to placing any topsoil and any amending required for the subsoil, the entire subgrade shall be loosened to the required depths using the teeth of a backhoe or other suitable equipment. No rubber-tired equipment or heavy equipment, except for a small bulldozer shall pass over the subsoils (subgrade) after they have been loosened. If the Contractor plans to utilize such lawn and/or planting areas for any use of heavy equipment or storage, this work should be carried out prior to beginning the process of loosening soils or fill in that area, or it will have to be re-scarified and meet this specification requirement.
- E. Restore to the approved subgrades. Remove any materials and or debris, which will hinder the subgrade amending and/or lawns or planting.
- F. Subgrade Compaction: Using a wide-track bulldozer size D-5 or smaller, the Contractor shall compact the scarified subgrade to 84% - 88% compaction ASTM 698 Standard Proctor.
- G. COMPACTION MITIGATION FIELD VERIFICATION: The Contractor shall provide a minimum of 10 shovel dug test pits to the full depth of the mitigation, where located per the direction of the Landscape Architect, in order for the Landscape Architect to review whether the work has been done as required. Backfill the pits after the review(s).
 - 1. The Contractor shall correct any unacceptable compaction mitigation as required by the Landscape Architect.

3.5 SUBSOIL AMENDING – ON GRADE (if required by the approved Soils Testing Report)

- A. The subsoil shall be amended if required in the Approved Soils Testing Laboratory Report.
 - 1. Restore the subgrade to the approved grades, as necessary, before subsoil amending.
 - 2. Remove any materials and or debris, which will hinder the subgrade amending. Amend the Subgrade as required in the approved Soils Testing Report.
 - 3. Amend the Subgrade as required in the approved Soils Testing Report, and restore the subgrade to the approved grades as necessary.

3.6 COARSE SAND INSTALLATION – ON GRADE

- A. Install where indicated on the drawings.

- B. Install in 6 inch lift(s) maximum to the depth(s) required for each application
- 3.7 CLEARING, SPREADING, DEPTH OF APPROVED PLANT BACKFILL MIX IN LAWN AREAS
 - A. Clearing: Clear all lawn areas of stones ½ inch diameter and larger, weeds, debris and other extraneous materials prior to spreading Plant Backfill Mix.
 - B. Install Plant Backfill Mix in all lawn areas on grade where shown on the Drawings.
 - C. Spread Plant Backfill Mix to a 6 inch depth.
 - D. Correct all settlement at any time with Plant Backfill Mix to maintain the finish grade(s).
 - E. Amendments for Plant Backfill Mix for lawns on grade:
 - 1. After spreading Plant Backfill Mix, spread the amendments and /or fertilizers for the Plant Backfill Mix as required by the approved Soils Tests Report.
 - 2. Finish grade of the lawns disturbed by the amending process, shall be restored immediately.
 - F. Fine Grading: See Section 312219 Finish Grading.
- 3.8 PLANT BACKFILL MIX(S) INSTALLATION IN PLANT BEDS – ON GRADE
 - A. Plant Bed and Planting Areas Overview Sequence: Compaction mitigation, any subgrade amending, if required, by the Soil Test Report, and installation of any Coarse Sand shall be approved prior to spreading of the Plant Backfill Mix(s).
 - B. Verify that the finish grade for the plant backfill mix and the bed layout have been approved.
 - 1. Sod lawn areas shall receive 12" minimum of imported topsoil mix.
 - 2. All contiguous plant beds shall receive 18" minimum of imported topsoil mix.
 - 3. Report all variations for correcting immediately. Do not proceed with any work in this Section on uncorrected or unapproved subgrades.
 - 4. Make any adjustments required in the grading before proceeding with the work as directed by the Landscape Architect.
 - C. Installation of Approved Plant Backfill Mix(s) on grade:
 - 1. Plant Bed Layout – See Section 329300 Planting for requirements.
 - a) Layout: When layout is approved, excavate for plant beds to the depth shown on the drawings and remove and dispose any excess subgrade material.
 - b) Subgrade Amending: Install any subgrade amending if required by the approved Soils Test report.
 - c) Scarification of the subgrade of the excavated plant beds: Rip or cultivate subgrade to a depth required on the drawings just prior to spreading Plant Backfill Mix.
 - d) Clearing: Clear all the scarified plant bed subgrade areas of stones ½ inch diameter and larger, weeds, debris and other extraneous materials prior to installing Plant Backfill Mix on grade.
 - e) Install Coarse Sand only where shown on the drawings to the depths indicated over a scarified subgrade.
 - 1) Install in 6 – inch lifts maximum.
 - f) Plant Backfill Mix on Grade Installation: Install Plant Backfill Mix(s) in all on grade plant bed areas of the project. See Section 329300 – Planting for planting requirements.
 - 1) Spread Plant Backfill Mix for plant beds as shown on the details and Drawings. Plant Backfill Mix shall be spread in lifts not greater than 12 – inches and compact to a density between 76% and 80% standard Proctor Maximum dry

Density. No wheeled vehicles shall pass over areas after scarification of subgrade, except for vehicles having low ground pressure tires.

- 2) Correct all settlement, at any time, with Plant Backfill Mix(s) to maintain the finish grade(s).
- g) Fine Grading: See Section 322219 Finish Grading.
- h) Installation of Fertilizer Tablets, as a supplement, for all plants planted in Plant Backfill Mix on grade.
- 1) Refer to Section 329300 Planting for this work that is done at the time of planting for each individual plant.

3.9 FIELD QUALITY CONTROL

- A. Tests: Right is reserved to take samples at any time of amended landscape soils, backfill mixes, and light weight soil mixture for testing for conformity to Specifications.
1. If materials pass, payment for testing shall be by the Owner.
 2. If materials do not pass, payment for testing shall be by the Contractor
 3. Rejected Materials: Remove and legal dispose off site at Contractor's cost. Pay cost of testing of materials, not meeting Specifications.

END OF SECTION 329113

SECTION 329300
PLANTING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Examine all Contract Documents for requirements affecting the work of this Section whether or not such work is specifically mentioned in this section.
- C. This section contains information that applies to all work performed under the contract and is hereby made a part of each specification section.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Tree, shrub, groundcover, perennial and bulb installation.
 - 2. Sampling and testing of loam borrow.
 - 3. Modifying, screening, placing, spreading and grading of loam borrow.
 - 4. Modifying, screening, placing, spreading and grading of existing, on-site topsoil.
 - 5. Providing all other sampling, testing, supplying, placing, spreading and grading of planting soils and erosion control as required by this Section.
 - 6. Fertilizing, mulching, trimming, guying and edging.
 - 7. Maintenance of installed plant material.
 - 8. Warranty.
- B. Related Work: The following Sections contain requirements that relate to this Section:
 - 1. Section 312310 – EXCAVATION AND BACKFILLING for establishment of rough grade.
 - 2. Section 328400 - IRRIGATION.
 - 3. Section 329113 – SOIL PREPARATION.
 - 4. Section 017419 - CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT AND DISPOSAL.
 - 5. Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS.

1.3 REFERENCES

- A. American Joint Committee on Horticultural Nomenclature Publication: Standardized Plant Names.
- B. ANSI Z60.1 - American Standard for Nursery Stock.
- C. ASTM D2607 - Classification of Peats, Mosses, Humus and Related Products.
- D. FS 0-F-241 - Fertilizers, Mixed, Commercial.

1.4 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

1.5 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.
- C. Submit complete list of plant material growers 4 weeks prior to digging of plants. List is to include names of individuals to contact, phone numbers, addresses and latest possible date for completion of tagging.
- D. Submit proposed planting schedule, indicating dates for each type of landscape work during normal seasons for such work in area of site. Correlate with specified maintenance periods to provide maintenance from date of substantial completion. Once accepted, revise dates only as approved in writing, after documentation of reasons of delay.
- E. Submit schedule of arrival of "specimen plant material".
- F. Submit instructions for continuing Owner maintenance. Include pruning and trimming methods and types, application frequency and recommended coverage of fertilizer; and water requirements for year-round care of installed plants. Document is to be in bound 8 1/2" x 11" format. Submit prior to expiration of required maintenance period(s).
- G. Submit for approval a proposed maintenance procedure and schedule of the storage of plant materials. Trees, shrubs, groundcover and perennials stored on and off site shall be maintained by watering, fertilizing, mulching, and spraying for infestation and disease to maintain these plants in a healthy condition. Plants stored off site shall be available for inspection by the Landscape Architect.
- H. Samples of each of the following:
 - 1. 5 lb (2 kg) of mulch for each type required for the Project, in labeled plastic bags.
 - 2. Existing On-Site Topsoil: Sample and test existing on-site topsoil. The Contractor shall sample the existing loam soils of the construction site in the following manner:
 - a. The Contractor shall provide a one cubic foot representative sample per each 1,000 cubic yard on-site stockpile of existing topsoil for testing. All stockpile sampling shall be per ASTM D 75 and Appendixes for securing samples from stockpiles.
 - 1. Ten (10) locations per one acre of the site as directed by the Landscape Architect.
 - b. Preparation of Samples: Contractor shall place these soil slices into a large, clean plastic container and mix thoroughly. Contractor shall take one cup of soil mixture and dry it at room temperature (do not dry samples in an oven or on a stove or radiator). Once soil is dry, place soil in sandwich size zip-type plastic bag and close it tightly. Label each sample on outside of bag, identifying sample by soil type and acre. Provide an approved site plan showing locations of stockpiles cross referenced to soil samples and test results.
 - 3. Loam Borrow: The Contractor shall provide a one cubic foot representative sample per each 1,000 cubic yard (750 cubic meter) proposed stockpile of loam borrow for testing. All stockpile sampling shall be per ASTM D 75 and Appendixes for securing samples from stockpiles.
 - a. Testing will be at the Contractor's expense. Contractor shall deliver all samples to testing laboratories via overnight courier and shall have the testing report sent directly to the Landscape Architect. Perform all tests for gradation, organic content, soil chemistry and pH by UMASS Soil and Plant Tissue Laboratory, West

Experiment Station, North Pleasant Street, University of Massachusetts, Amherst, MA 01003, (413) 545-2311. Testing reports shall include the following tests and recommendations. Contractor shall deliver samples to testing laboratories and shall have the testing report sent directly to the Landscape Architect from the Soil and plant Tissue Laboratory. Testing reports shall include the following tests and recommendations.

- i. Mechanical gradation (sieve analysis) shall be performed and compared to the USDA Soil Classification System. Sieve analysis shall be by combined hydrometer and wet sieving using sodium hexametaphosphate as a dispersant in compliance with ASTM D 422 after destruction of organic matter by H₂O₂. To facilitate review and approval of sieve analysis, provide a computer generated gradation curve from UMASS Soil & Plant Tissue Laboratory.
 - ii. Percent of organics shall be determined by the loss on ignition of oven-dried samples. Test samples minus #10 material shall be oven-dried to a constant weight at a temperature of 450 degrees Fahrenheit (232 degrees Centigrade).
 - iii. Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, extractable Aluminum, Lead, Zinc, Cadmium, Copper, Soluble Salts, and pH and buffer pH. A Conductivity Meter shall be used to measure Soluble Salts in 1:2 soil/water (v/v). Except where otherwise noted, nutrient tests shall be for available nutrients.
 - iv. Soil analysis tests shall show recommendations for soil additives to correct soils deficiencies as necessary, and for additives necessary to accomplish planting work as specified.
4. Peat Moss: Submit a one cubic foot sample and supplier's certification of contents.
5. Limestone: Submit supplier's certification that the limestone being supplied conforms to these Specifications.
6. Acidulant: Submit supplier's certification that the acidulant being supplied conforms to these Specifications.
7. Fertilizer:
 - a. Submit product data of planting fertilizer and certificates showing composition and analysis. Submit fertilization rates for fertilizer product based upon soil testing, analysis, and recommendations.
 - b. Submit the purchasing receipt showing the total quantity purchased for the project prior to installation.
8. Gypsum: Submit manufacturer's product data and 2 pound (1 kilogram) sample.
9. All additives needed to amend a specific soil in order to meet these specifications.
10. Mycorrhizal Fungal Inoculant:
 - a. Submit manufacturer's product data certifying that inoculant being supplied conforms to these Specifications.
 - b. Submit the purchasing receipt showing the total quantity purchased for the Project prior to installation.
 - c. Submit empty packets of fungal spore inoculant to the Landscape Architect for verification of use.
11. Tree Staking System: Submit manufacturer's product data of system.
- I. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Landscape Architects and Owners, and other information specified.

1.6 QUALITY ASSURANCE

- A. Prior to being approved, the successful bidder will be required to submit to the Landscape Architect a statement of qualifications listing the names of contact references for at least three jobs of similar scope that have been completed in the last five years. Attention is called to the fact that the installation will not be awarded to a firm that does not possess the required technical expertise and construction organization.
- B. Allow Landscape Architect option of traveling to growers facility to select trees from available stock.
- C. Allow four weeks, after receipt of list of growers, to finish tagging trees.
- D. Trees dug prior to tagging by Landscape Architect are subject to rejection.
- E. Landscape Architect will confirm the trees satisfy the requirements of ANSI Z60.1 and all special conditions stated in project manual and drawings.
- F. Measure trees and shrubs according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches (150mm) above ground for trees up to 4-inch (100-mm) caliper size, and 12 inches (300-mm) above ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.
- G. Unacceptable trees will not be tagged and a different Grower will be selected by landscape contractor at no expense to Owner. A second tagging trip will then be scheduled.
- H. Decision by Landscape Architect to forego tagging trip does not release landscape contractor from responsibility of obtaining plant material which meets standards and conditions stated in project manual and drawings.
- I. Minimum three years experience installing plant material of this type required of Installer.
- J. Minimum five years experience specializing in growing and cultivating the specified material is required by of Grower.

1.7 REGULATORY REQUIREMENTS

- A. Comply with regulatory requirements for fertilizer and herbicide composition.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Plant material is to be covered with tarpaulin during transport.
- B. Deliver soil conditioners and fertilizer in unopened waterproof bags showing weight, chemical analysis, and name of manufacturer. Keep materials in dry storage away from contaminants.
- C. Provide freshly dug trees and shrubs. Do not prune prior to delivery unless otherwise approved by Landscape Architect. Do not bend or bind tie trees or shrubs in such a manner as to damage bark, break branches, or destroy natural shape. Do not drop balled and burlapped stock during delivery. Protect plants until planted to prevent damage to root balls or desiccation of leaves.
- D. Deliver trees and shrubs after preparations for planting have been completed and plant immediately. If planting is delayed more than six hours after delivery, set trees and shrubs in shade, protect from weather and mechanical damage, and keep roots moist by covering with mulch, burlap or other acceptable means of retaining moisture.
- E. Provide water to staged material as required to keep root balls moist.
- F. Do not remove container-grown stock from containers until planting time.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Do not install plant life when ambient temperatures may drop below 30 degrees F or above 90 degrees F.
- B. Do not install plants when wind velocity exceeds 30 mph.

- C. Planting shall be done when the ground is not frozen, snow covered, or in an otherwise unsuitable condition for planting.
- D. Conduct planting operations for Trees, shrubs and groundcover during recommended planting seasons. Preferable planting season is March 15 to May 30 and September 15 to November 15, inclusive.
- E. Conduct planting operations for perennials during recommended planting seasons. Preferable planting season is May 1 – October 1.
- F. At the landscape contractor's option and full responsibility, planting operations may be conducted under unseasonable conditions without additional compensation.

1.10 JOB CONDITIONS

- A. Locate above grade and underground utilities and perform Work in manner which will avoid damage. Hand excavate in areas where underground utilities may exist.
- B. Maintain grade stakes set by others until removal is mutually agreed upon by concerned parties.
- C. Notify Landscape Architect, before proceeding, when conditions detrimental to plant growth are encountered, such as rubble fill or adverse drainage conditions.
- D. Install plants after final grades are established unless otherwise approved by Landscape Architect.

1.11 SEQUENCING AND SCHEDULING

- A. Coordinate the Work of this Section with installation of underground utilities and remainder of Work associated with this Project.
- B. Proceed with and complete landscape work as rapidly as portions of site become available, working within seasonal limitations.

1.12 WARRANTY

- A. Provide a warranty on Work of this Section for a minimum one year including one continuous growing season. Commence warranty on date identified in the Certificate of Substantial Completion. Inspection of the planting work to determine its completion for beginning the guarantee period will be made by the Landscape Architect upon written notice requesting such inspection by the landscape contractor at least seven days prior to the anticipated date. Trees, shrubs, groundcover and perennials shall be alive and healthy at time of inspection before approval to start the guarantee period will be given.
- B. Any plants showing signs of stress shall be maintained until they display a healthy growing condition.
- C. Inspection of the planting to determine its acceptance will be made at the conclusion of the guarantee period by the Landscape Architect. Plants will not be accepted unless they are alive and healthy. The landscape contractor shall replace plants which are dead, or in the opinion of the Landscape Architect are in an unhealthy or unsightly condition, or have lost their natural shape due to dead branches, excessive pruning, inadequate or improper maintenance, or other causes due to the landscape contractor's negligence with same size and species as specified. Plant in the next growing season, with a new warranty commencing on date of replacement. Replacement costs will be borne by Landscape Contractor.
- D. All bulbs shall be guaranteed to bloom vigorously the first respective blooming season after planting. Bulbs that do not bloom shall be replaced. Replacement costs shall be borne by the Landscape Contractor.

1.13 MAINTENANCE SERVICE

- A. Maintenance Services: Performed by installer.

- B. Maintain plant life immediately after placement for a minimum of one growing season and until plants are well established and exhibit a vigorous growing condition.
- C. Maintenance to include:
 - 1. Cultivation and weeding plant beds and tree pits.
 - 2. Application of herbicides for weed control in accordance with manufacturer's instructions. Remedy damage resulting from use of herbicides.
 - 3. Application of pesticides in accordance with manufacturer's instructions. Remedy damage from use of pesticides.
 - 4. Watering sufficiently to saturate root system.
 - 5. Trimming and pruning, including removal of clippings and dead or broken branches.
 - 6. Disease control.
 - 7. Maintaining accessories. Adjust, repair or replace accessories when damaged.
 - 8. Restoring planting saucers.
 - 9. Resetting plant material to proper grades or vertical position.

1.14 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than sizes indicated; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than sizes indicated.
- D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- E. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- F. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
- G. Finish Grade: Elevation of finished surface of planting soil.
- H. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- I. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- J. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- K. Planting Area: Areas to be planted.
- L. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

- M. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- N. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- O. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- P. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- Q. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- R. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- S. Soil-Testing Laboratory Qualifications: An independent or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

PART 2 - PRODUCTS

2.1 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2-PRODUCTS of Section 018113 – Sustainable Design Requirements.

2.2 TREES, SHRUBS, GROUND COVER AND BEDDING PLANTS

- A. Plant material to be nursery grown stock conforming to ANSI Z60.1.
- B. Publication for Standardized Plant Names will govern nomenclature issues.
- C. Plans will supersede planting material schedule where a discrepancy in quantity occurs.
- D. Provide plant material which is well branched and formed, sound, vigorous, healthy, and free from disease, sun-scald, windburn, abrasion, and harmful insects, eggs, larvae and such defects as knots sun scald, injuries, abrasions and disfigurement, and shall have healthy, normal, and unbroken root systems.
- E. Provide symmetrically developed plant material, of uniform habit with straight boles and free from objectionable disfigurements. Tree leader shoots shall not be cut or broken.
- F. Where formal arrangements or consecutive order of trees or shrubs are shown, select stock for uniform height and spread, and label with number to assure symmetry in planting.
- G. Provide vigorous ground covers and vines with number and length of runners and clump size specified and proper age for the grade of plants specified. Use only vines and ground cover plants well established in removable containers, integral containers, or formed homogeneous soil sections.
- H. Plants shall have been grown in the same or colder climatic zone of this project.
- I. Provide plants according to measurements indicated. Measure sizes before pruning and with branches in normal position. Plants larger in size than specified may be used as approved.
- J. Spray plants, budding into leaf or having soft growth, with an anti-desiccant at the nursery or collecting field before digging.
- K. The Contractor shall furnish all plants shown on the Contract Documents, as specified, and in quantities listed on the PLANT LIST. No substitutions will be permitted, without

written approval by the Landscape Architect. All plants shall be nursery grown unless specifically authorized to be collected as noted on the PLANT LIST.

- L. If, at any time during the performance of the Contract, any plant shows signs of graft incompatibility, as determined by the Landscape Architect, then the tree or shrub and all other similarly grafted plants of the same Genus/Species/Variety shall be rejected and removed from the site.

2.3 LOAM - GENERAL

- A. The Contractor shall provide sufficient loam borrow to complete all loaming operations required of the Contract Documents. Loam borrow shall be obtained from one of the following sources:
 1. On-site topsoil stripped, stockpiled and paid for under the work of the Division 31 Section, EARTH MOVING, of this Specification and meeting the requirements of this Division 32 Section, PLANTS.
 2. A commercial processing facility specializing in the manufacturing of loam.
 3. On-site granular material stripped and stockpiled on the site may be used as the basis for an on-site, manufactured loam. Submit method and schedule of manufacturing process to the Landscape Architect for review and approval.
 4. All sources shall be acceptable provided that, after testing and the addition of necessary soil additives specified in this Division 32 Section, PLANTS, the loam borrow meets the following specifications.

2.4 LOAM

- A. Loam borrow for planting trees, shrubs, groundcover and vines, and perennials shall be one of the following sandy loams; "course sandy loam", "sandy loam", and "fine sandy loam": determined by mechanical analysis (ASTM D 422) and based on the "USDA Classification System" and as defined in this Section. It shall be of uniform composition, without admixture of subsoil.

It shall be free of stones greater than one and one-quarter inches (31 mm), lumps, plants and their roots, debris and other extraneous matter as determined by the Landscape Architect. Planting soil for trees, shrubs, groundcover and vines, and perennials shall have the following grain size distribution for material passing the #10 (2.0 mm) sieve:

<u>Millimeter</u>	<u>Percent Passing by Weight</u>	
	<u>Maximum</u>	<u>Minimum</u>
2	-----	100
1	100	80
0.5	87	67
0.25	78	48
0.10	68	30
0.05	55	22
0.002	7	2

1. Maximum size shall be one and one quarter inches largest dimension. The maximum retained on the #10 sieve shall be 25% by weight of the total sample.
2. The ratio of the particle size for 80% passing (D₈₀) to the particle size for 30% passing (D₃₀) shall be 6.0 or less. (D₈₀/D₃₀ < 6.0)
3. Top 18 inches (450 mm) of areas planted with tree and shrub as described in the Division 2 Section, PLANTING, of this Specification:

- a. pH: 5.5 through 6.5 for non-acid loving plants
 - b. pH: 4.5 through 5.5 for *Ericaceae* and other acid-loving plants
 - c. Organic Content 4.0 - 6.0 percent as determined by the loss on ignition of oven-dried samples passing #10 sieve (Muffle furnace temperature: 450 +/- 10 degrees C for 8 hours)
 4. Below 18 inches (450 mm) in tree and shrub beds when details call for depths of loam borrow to exceed 18 inches (450 mm):
 - a. pH: 5.5 through 6.5 for non-acid loving plants
 - b. pH: 4.5 through 5.5 for *Ericaceae* and other acid-loving plants
 - c. Organic Content 1.0 - 3.0 percent as determined by the loss on ignition of oven-dried samples passing #10 sieve (Muffle furnace temperature: 450 +/- 10 degrees C for 8 hours)
 5. Loam borrow shall be pH adjusted for particular planting applications and shall be adjusted prior to delivery to the Project sites as recommended by UMASS Soil & Plant Tissue Laboratory test results.
 - a. When pH of loam borrow is equal to or greater than 7 use aluminum sulfate to adjust pH downward to required levels.
 - b. When pH of loam borrow is less than 7 use either sulfur or ferrous sulfate to adjust pH downward to required levels.
 - c. When pH of loam borrow must be raised to the required levels use limestone.
 - d. Regardless of amendment Contractor chooses to use, Contractor, not the Owner, shall be responsible for obtaining specified pH by seeding and/or planting time.
 - B. Loam borrow shall be free of plants and their roots, debris and other extraneous matter. It shall be uncontaminated by salt water, foreign matter and substances harmful to plant growth. The electrical conductivity (EC2) of a 1:2 soil-water suspension shall be equal to or less than 1.0 milliohms/cm. (Test minus sieve #4 material.) Loam borrow shall not have levels of extractable aluminum greater than 200 parts per million except for *Ericaceae* and other acid-loving plants. Cation Exchange Capacity (CEC) shall be greater than or equal to 12.
 - C. On-site topsoil stripped, stockpiled, and paid for under the work of the Division 32 Section, EARTH MOVING, may be re-used if, with or without amending or blending with other material, it meets the above requirements. On-site topsoil and amendments shall be tested in accordance with requirements for loam borrow and submittals shall be made for review and acceptance as specified, performed and paid for under this Division 32 Section, PLANTS. The Contractor shall provide additional loam borrow as required to complete the required work.
 - D. All loam borrow proposed for use shall be tested for conformance to the specifications.
 - E. The Landscape Architect reserves the right to reject on or after delivery to the project site any material which does not, in his opinion, meet these specifications.
- 2.5 SOIL AMENDMENT MATERIALS
- A. Shrub and Tree Fertilizer: Tightly compressed, slow release planting tablets. Provide 50% of Nitrogen as water insoluble. The following or equal is acceptable:
 1. AGRIFORM Planting Tablets by:
The Scott's Company
1-800-492-8255

- B. Ground Cover Fertilizer: FS-0-F-241, Type 1, Class 1 with fifty percent of the elements derived from organic sources. Use fertilizer with N.P.K. ratio of 1:2:1 for Ground Cover Beds and 2:1:1 for Bedding Plant Beds.
- C. Peat Moss: Shredded, loose, sphagnum moss peat conforming to ASTM D2607; free of lumps, roots, inorganic material or acidic materials; minimum of 85 percent organic material measured by oven dry weight; 4 to 5 pH range; moisture content of 30 percent.
- D. Sphagnum Peat Moss: Sphagnum peat moss shall be imported Canadian Sphagnum peat moss, brown, low in content of woody materials, and be free of mineral matter harmful to plant life. Peat shall have an acid reaction of about 4.5 pH, and have a water absorbing capacity of 1100 to 2000 percent by weight. Peat moss shall be thoroughly pulverized before use. No native or sedge peats shall be approved.
- E. Water: Clean, fresh and free of substances or matter which could inhibit vigorous growth of plants.
- F. Herbicide: Comply with all applicable State and Federal Laws.
- G. Pesticide: Comply with all applicable State and Federal Laws.
- H. Mycorrhizal fungal inoculant: shall be live spores packaged in plastic packets. At a minimum each packet of inoculant shall contain the following:
 - 1. Live spores of VA Endomycorrhizal fungi: Vesicular-Arbuscular mycorrhizae fungi, minimum of 8 species.
 - 2. Live spores of Ectomycorrhizal fungi: including *Pisolithus tinctorius*.
 - 3. Mycorrhizal fungal inoculant shall be manufactured by Plant Health Care Incorporated, 440 William Pitt Way, Pittsburgh, PA 15238, telephone: (800) 421-9051; Horticultural Alliance, 2946 Louise Street, Sarasota, FL 34237, (800) 628-6373; BioPlex Organics, 2213 Huber Drive, Manheim, PA 17545 (800) 441-3573, or approved equal.

2.6 STAKING, GUYING, AND ANCHORING MATERIALS

- A. Root ball anchor system for trees planted above structure shall be equal to "Platipus Plati-Mat Eyebolt System, model number "RF1RP" (for trees up to 3" caliper) as manufactured by Platipus Anchors, Inc. www.platipus-anchors.com, E: trees@platipus.us, P: 866.752.8478.
 - 1. System shall include all components necessary for complete installation.
- B. Root ball anchor system for trees planted on terra firma shall be equal to "Platipus Plati-Mat Drive Anchor System, model number "RF1P" (for trees up to 3" caliper) as manufactured by Platipus Anchors, Inc. www.platipus-anchors.com, E: trees@platipus.us, P: 866.752.8478.
 - 2. System shall include all components necessary for complete installation.

2.7 MULCH MATERIALS

- A. Bark Mulch: Shredded, dark brown/black, native hemlock mulch free of growth or germination inhibiting ingredients. Mulch shall be high quality, double-ground, premium bark mulch of 70 percent hemlock bark with the balance spruce and pine bark. Mulch shall have been aged for a minimum of six months and not longer than two years. Bark mulch shall be shredded to a uniform size; free of dirt, debris and foreign matter; with pieces no thicker than 1/4 in (6 mm). Mulch must be free of stringy material or chunks over 3 inches (75 mm) in size and shall not contain, in the judgment of the Landscape Architect, an excess of fine particles. Submit sample for the Landscape Architect's approval.
- B. Stone Mulch: Stone mulch shall be water washed peastone, grey in color, with rounded edges, free from organic materials, surface coatings, or other deleterious materials. Stone mulch shall not be limestone. Submit sample for the Landscape Architect's approval. Stone mulch shall conform to the following gradations:

<u>Sieve Size</u>	<u>Percent Passing (by Weight)</u>
1/2 inch (12.5 mm)	100
3/8 inch (9.50 mm)	85-100
No. 4 (4.75 mm)	20-50
No. 8 (2.36 mm)	0-15

2.8 MISCELLANEOUS MATERIALS

- A. Filter Fabric: Filter fabric shall be Mirafi 100X, or approved equal.
- B. Anti-Desiccant: Emulsion type, film-forming agent, designed to permit transpiration but retard excessive loss of moisture from plants. Deliver in manufacturer's fully identified containers and mix in accordance with manufacturer's instructions.

2.9 WATER

- A. The Contractor shall be responsible to furnish his own supply of water to the site at no extra cost. If possible, the Owner shall furnish the Contractor upon request with an adequate source and supply of water at no charge. However, if the Owner's water supply is not available or not functioning, the Contractor shall be responsible to furnish adequate supplies at his own cost. All work injured or damaged due to the lack of water, or the use of too much water, shall be the Contractor's responsibility to correct. Water shall be free from impurities injurious to vegetation.

2.10 LANDSCAPE EDGINGS

- A. Steel Edging: Standard 1/4" commercial-steel edging, rolled edge, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Border Concepts, Inc.
 - b. Collier Metal Specialties, Inc.
 - c. Russell, J. D. Company (The).
 - d. Sure-Loc Edging Corporation.
 - 2. Edging Size: as shown on Drawings.
 - 3. Stakes: Tapered steel, a minimum of 12 inches (300 mm) long.
 - 4. Accessories: Standard tapered ends, corners, and splicers.
 - 5. Finish: as shown on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.
 - 2. Test drainage of plant beds and pits by filling with water twice in succession. Notify Landscape Architect of conditions permitting the retention of water in planting beds for more than twenty-four (24) hours.

3. Prior to the excavation of planting pits, or placing tree stakes, the landscape contractor shall ascertain the location of utility lines, electric cables and conduits, so that proper precautions may be taken not to disturb or damage subsurface improvements. Should obstructions be found, the landscape contractor shall promptly notify the Landscape Architect.
 4. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 5. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 6. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

- A. Seasons for Planting:
1. Spring: Deciduous materials - March 21 through May 1; Evergreen materials - April 15 through June 1.
 2. Fall: Deciduous materials - October 1 through December 1; Evergreen materials - August 15 through October 15.
- B. Plant Material Inspection:
1. At least one month prior to the expected planting date, the Contractor shall request that the Landscape Architect provide a representative to select and tag stock to be planted under this Division 32 Section, PLANTS. The Contractor shall pay for the transportation, subsistence and overnight accommodations, if necessary, for the Landscape Architect during the period of time required to select and tag the plant material.
 2. The Contractor shall be responsible to certify the availability of quality plants in specified sizes from his/her sources of supply prior to requesting that the Landscape Architect make plant source inspections. In the event that plants at the inspection location are found to be unavailable or of insufficient size, the Contractor shall be liable to reimburse the Owner for all costs of the Landscape Architect's hourly services which are incurred during unproductive inspection trips.
 3. Unless specifically designated otherwise, a representative of the Contractor shall accompany the Landscape Architect on all plant material selection field trips.
 4. All trees for the project shall be individually tagged for approval with the Landscape Architect's seals, and no trees shall be accepted for delivery to the site without such seals. Representative samples only of shrubs and ground cover plants may be tagged or marked for approval as an "Approved Typical Sample" and shipped to the site. Any shrub or groundcover plant that arrives at the construction site that does not meet the Approved Typical Sample will be rejected by the Landscape Architect.
 5. Plants to be inspected shall be in locations and conditions that allow direct and unobscured inspection by the Landscape Architect. Container grown or balled and burlapped shrubs shall be pulled from holding blocks by the nurseryman for scrutiny by the Landscape Architect at no additional cost to the Owner. Harvested trees held in storage shall not have branches tied up. Harvested trees shall not have trunks obscured by burlap, cardboard trunk protection, or other devices that would otherwise obscure inspection. In the event that branches are tied up, trunks are obscured by burlap or cardboard trunk protection, or root flares hidden by burlap and twine and the Landscape Architect cannot inspect root flares, trunks or branching habit, the

Contractor shall bear all responsibility and costs associated with tree rejection at a later date during the course of the Contract.

6. Inspection and approval of plants at the source shall not impair the right of subsequent inspection and rejection upon delivery to the site, or during the progress of the work if the Landscape Architect finds that plants do not meet the requirements of the PLANT LIST or this Contract, have declined noticeably due to handling abuse, lack of maintenance, or other causes. Cost of replacements, as required, shall be borne by the Contractor.

3.3 LAYOUT

- A. Stake tree and shrub locations with 3/4" x 2" x 18" wood stakes driven into the soil at center points of plants. Paint tops of stakes representing tree locations a color different from the stakes locating shrubs. Landscape contractor may stake continuous uninterrupted straight runs of shrubs at each end. Outline ground cover beds.
- B. Mark all underground utilities.
- C. Notify Landscape Architect, in writing, of portions of plant material which have been staked. Allow one week for Landscape Architect to review and adjust stake locations.
- D. Plants which are planted prior to landscape contractor receiving Landscape Architect's approval of staking and bed outlines are subject to being relocated at no cost to Owner.

3.4 PLANTING AREA ESTABLISHMENT

- A. Loosen subgrade of planting areas to a minimum depth of 6 inches (150 mm). Remove stones larger than 2 inches (50 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 1. Apply fertilizer directly to subgrade before loosening.
 2. Thoroughly blend planting soil off-site before spreading.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer.
 3. Spread planting soil to a depth of 12 inches (300 mm) but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately one-half the thickness of planting soil over loosened subgrade. Mix thoroughly into top 4 inches (100 mm) of subgrade. Spread remainder of planting soil.
- B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- D. Application of Mycorrhizal Fungi: Broadcast dry product uniformly over prepared soil at Manufacturer's recommended application rate.

3.5 EXCAVATION FOR INDIVIDUAL TREES AND SHRUBS

- A. Planting Pits: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
 1. Excavate approximately three times as wide as ball diameter for balled and burlapped stock.

2. Excavate at least 12 inches (300 mm) wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
5. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
6. Maintain supervision of excavations during working hours.
7. Keep excavations covered or otherwise protected after working hours.

3.6 PLANTING - GENERAL

- A. Shrub masses, hedges, groundcover and perennial beds shall be entirely excavated edge to edge and backfilled with specified backfill mixture; they shall not be treated as individual planting pits.
- B. Remove all sticks, stones, roots and other objectionable materials during tilling operations larger than one inch in diameter.
- C. Damage to paving, sidewalks or other materials shall be removed and replaced at the landscape contractor's expense and to the satisfaction of the Landscape Architect.
- D. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
- E. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- F. Setting Plants: Handle balled and burlapped and container-grown plants by ball or container. Set plants and hold in plumb position until sufficient soil has been firmly placed around roots or ball. Set plants in relation to surrounding grade so that they are even with depth at which they were grown in nursery, collecting field, or container.
- G. Place fertilizer prior to backfilling and in accordance with the manufacturer's recommendations. Ground cover plants may be planted after mulch is in place. Take care to avoid contaminating mulch with planting soil.
- H. Backfill excavations for balled and burlapped stock with planting soil mixture to approximately half the depth of the ball and then tamp and water. Carefully remove, open or fold back burlap and tying materials. Completely remove plastic wrap before the placement of backfill. Finish backfilling and tamp. Form earth saucers around isolated plants of size ample enough to hold at least 2-1/2 gallons for shrubs or 5 gallons for trees. Do not use planting stock if ball is cracked or broken before or during planting operation.
- I. Bulbs shall be planted in the locations and at the spacing indicated on the Drawings. Plant bulbs at the depths and orientation recommended by the Supplier. Do not remove the leaves until after they have lost their green color. Remove leaves by cutting.

3.7 TREE, SHRUB, AND VINE PLANTING

- A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

- C. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare [1 inche (25 mm) above adjacent finish grades.
 - 1. Use approved planting soil for backfill.
 - 2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 - 4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
 - 5. Continue backfilling process. Water again after placing and tamping final layer of soil.
 - D. Set container-grown stock plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above adjacent finish grades.
 - 1. Use approved planting soil for backfill.
 - 2. Carefully remove root ball from container without damaging root ball or plant.
 - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 - 4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
 - 5. Continue backfilling process. Water again after placing and tamping final layer of soil.
 - E. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.
- 3.8 GROUND COVER AND PERENNIAL PLANTING
- A. Set out and space ground cover and perennials as indicated in even rows with triangular spacing.
 - B. Use approved planting soil for backfill.
 - C. Dig holes large enough to allow spreading of roots.
 - D. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes.
 - E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
 - F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
 - G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.
- 3.9 FERTILIZATION, WATERING AND MULCHING
- A. Trees, Shrubs. Ground Cover and perennials: Fertilize according to manufacturer's recommendations.

- B. Watering: Provide uniform coverage which will not cause erosion or damage to the finished surface. Water sufficiently to penetrate the planting bed to a depth of 4 inches.
- C. Mulch within 24 hours after planting. Spread to uniform thickness of 2 inches.

3.10 EDGING INSTALLATION

- A. Edging: Install edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 36 inches (760 mm) apart, driven below top elevation of edging.

3.11 PLANT SUPPORT

- A. Tree Anchors: Size anchors based on tree caliper size. Install per manufacturer's instructions.

3.12 PRUNING AND REPAIR

- A. Plants shall be neatly pruned and or clipped to preserve the natural character of the plants (with exception to clipped shrub hedges); in a manner appropriate to the particular requirements of each plant and to the satisfaction of the Landscape Architect. Unless otherwise directed by Landscape Architect, do not cut tree leaders; remove only injured or dead branches.
- B. Remove broken or badly bruised branches with a clean cut. All pruning shall be done with sharp tools in accordance with instructions of the Owner. Accidental damage to trees occurring during the course of planting operations which is not so great as to necessitate removal of a branch or replacement of a plant shall promptly be treated in accordance with recognized horticultural practices.
- C. Do not apply pruning paint to wounds.

3.13 MAINTENANCE

- A. Maintenance shall begin immediately after each plant is planted and shall continue for a minimum 60-day Monitoring Period and until Final Acceptance.
- B. Maintenance shall consist of keeping the plants in a healthy growing condition and shall include but is not limited to watering, weeding, cultivating, pruning, re-mulching, tightening and repairing of guys, straightening of trees to a plumb position, removal of dead material, resetting plants to proper grades or upright position, and maintaining the planting saucer.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.
- D. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- E. During the maintenance period, any decline in the condition of plantings shall require the Contractor to take immediate action to identify potential problems and undertake corrective measures. If required, the Contractor shall engage professional arborists and/or horticulturalists to inspect plant materials and to identify problems and recommend corrective procedures. The Landscape Architect shall be immediately advised of such actions. Inspection and recommendation reports shall be submitted to the Landscape Architect.

3.14 ACCEPTANCE

- A. Upon completion of all planting work, the Contractor shall request in writing that the Landscape Architect formally inspect the planting work.
- B. If plant materials and workmanship are acceptable, the Landscape Architect will issue a written Certificate of Conditional Acceptance to the Contractor.

- C. Following the issuance of the Certificate of Conditional Acceptance to the Contractor, the Contractor shall maintain the plants for a minimum 30 day Monitoring Period. At the end of the Monitoring Period, the plant material will be inspected by the Landscape Architect to determine whether or not all planting work has been performed to the requirements of this Division 32 Section, PLANTS.
- D. Acceptance Standards at end of the Monitoring Period: If plant material is reviewed when it is in full leaf, leaves shall be plump with water with a shape indicative of the species and shall be free of insect, pest and disease damage. Twigs shall have living cambium for their full length. Twigs and branches shall have a full bud set for their full length, including terminal buds. Trunks and branches shall be free of frost cracks; sun scald; damage due to insects, pests, and disease; structural defects; and damage resulting from machinery or tools. Plant material inspected and reviewed when the plants are not in full leaf shall have twigs, branches and trunks meeting the above requirements. All plants regardless of the season of review shall have a minimum of 75 percent healthy, balanced branching structure with a healthy terminal leader(s) with viable terminal bud(s).
- E. If any number of plants do not meet these Acceptance Standards at the time of inspection, or if in the Landscape Architect's opinion, workmanship is unacceptable, written notice will be given by the Landscape Architect to the Contractor in the form of a punch list, which itemizes necessary planting replacements and/or other deficiencies to be remedied. The Contractor's responsibility for maintenance of all plants shall be extended until replacements are made or other deficiencies are corrected. All plants that do not meet these Acceptance Standards shall be removed from the project within seven days of receipt of punch list. Replacements shall conform in all respects to the Specifications for new plants and shall be planted in the same manner.
- F. Following the correction of all Punch List deficiencies, the Contractor shall request in writing that the Landscape Architect formally inspect the planting work. If plant materials and workmanship are acceptable, the Landscape Architect will issue a written Certificate of Final Acceptance to the Contractor.

3.15 WARRANTY

- A. The date of the Certificate of Final Acceptance shall establish the commencement of the required one-year guarantee and establishment period for planting work.
- B. At the end of the guarantee and establishment period, a final inspection will be held to determine whether any plant material replacements are required. Each plant shall be plumb, shall have a character that is natural for its species as determined by the Landscape Architect, and shall conform to the Acceptance Standards described in this Division 32 Section, PLANTS. Plants found to be unacceptable shall be removed promptly from the site and replaced according to this Division 32 Section, PLANTS. A final inspection will be made after the replacement plants have lived through one year.
- C. At the end of the one-year guarantee and establishment period, remove all tree stakes, guys, or anchors installed on trees during the course of the work of this contract.
- D. All replacements shall be plants of the same kind and size specified in the PLANT LIST. The cost shall be borne by the Contractor, except for possible replacements due to vandalism or neglect on the part of others.

3.16 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

- C. After installation and before Substantial Completion remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.17 DISPOSAL

- A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION

SECTION 334000
STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specifies requirements for furnishing and installing the site storm drainage utilities system, as indicated on the Drawings and as specified herein.
- B. The work shall include but not be limited to the following:
 - 1. Construction of the site storm drainage system, including underdrains, headwalls, flared end sections, underground stormwater detention facilities, and all appurtenances necessary to make a complete functioning system.
 - 2. Connection of building drains from a point ten feet (10 ft.) outside building or structure foundations.
 - 3. Construction of 'Dedicated Drainage Systems' on the site shall conform to the Maine State Plumbing Code.
- C. Work performed under this Section shall be subject to the General Conditions, Supplementary Conditions and Division 01 General Requirements of the Contract Documents.

1.02 REFERENCE STANDARDS

- A. References herein are made to the following Standards:
 - 1. American Society for Testing and Materials (ASTM):
 - A48 Standard Specification for Gray Iron Castings
 - A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 - C32 Standard Specification for Sewer and Manhole Brick
 - C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
 - C62 Standard Specification for Building Brick
 - C76 Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
 - C139 Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
 - C144 Standard Specification for Aggregate for Masonry Mortar
 - C150 Standard Specification for Portland Cement
 - C207 Standard Specification for Hydrated Lime for Masonry Purposes

- C270 Standard Specification for Mortar for Unit Masonry
- C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
- C478 Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
- C990 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
- D2665 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
- D3034 Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
- D3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
- D4884 Standard Test Method for Strength of Sewn or Bonded Seams of Geotextiles
- F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- F667 Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings
- F2418 Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers
- 2. American Association of State Highway and Transportation Officials (AASHTO):
 - M 274-87 Standard Specification for Steel Sheet, Aluminum Coated (Type 2), for Corrugated Steel Pipe
 - M 36 Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
 - M 252-09 Standard Specification for Corrugated Polyethylene Drainage Pipe
 - M 294-17 Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in)
- 3. American National Standards Institute (ANSI):
 - A21.50 Thickness Design of Ductile Iron Pipe
 - A21.51 Ductile-Iron Pipe, Centrifugally Cast
- 4. American Water Works Association (AWWA):
 - C150 Thickness Design of Ductile Iron Pipe
 - C151 Ductile-Iron Pipe, Centrifugally Cast

1.04 SUBMITTALS

- A. Shop drawings or descriptive literature, or both, showing dimensions, joint and other details of all materials proposed for the work. Shop drawings shall be submitted to the Engineer for approval prior to ordering material.
- B. As-Built Drawings
 - 1. The Contractor shall take measurements during construction of:
 - a. Horizontal location of all drainage structures. Horizontal location shall be by survey location using the same coordinate system as the Project, or three (3) (minimum) ties to nearby permanent structures.
 - b. Elevations of all inverts using Project Benchmarks.
 - 2. As-Built Drawings shall be submitted to the Engineer upon completion of the work.
 - 3. As-Built Drawings shall be complete and shall indicate the true measurement and location, horizontal and vertical, of all new drainage system construction. As-Built drawings shall include a minimum of three (3) ties showing the distance to each catch basin and manhole from fixed permanent objects. As-Built Drawings shall also contain any additional information required by the municipality and shall be stamped with the seal of a licensed Land Surveyor or licensed Professional Engineer.

1.05 QUALITY ASSURANCE

- A. Work shall comply with the Maine State Plumbing Code.

1.06 COORDINATION AND VERIFICATION

- A. Coordinate the work with the termination of storm drain connections at buildings and connections to municipal systems, and trenching operations.
- B. Prior to ordering materials, the Contractor shall field verify the location, elevations and size of all, existing pipe utility lines to remain, and proposed utility connections to existing utility systems.; any conflicts shall be reported to the Engineer for resolution.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be adequately protected from damage during transit. Pipes shall not be dropped.
 - 1. All pipe and other appurtenances shall be inspected prior to installation and any found to be defective from any cause, including damage caused by handling, and determined by the Engineer to be unrepairable, shall be replaced at no cost to the Owner.
 - 2. Storage and handling of pipes, manholes, catch basins, oil-grit separators, treatment units and other system appurtenances shall be in accordance with the manufacturer's recommendations.

1.08 INSPECTION

- A. The manufacturer/supplier is responsible for the provision of all test requirements specified for each type of pipe. In addition, any pipe may be inspected at the plant for compliance with these specifications by an independent testing laboratory selected and paid by the Owner. The Contractor shall require the manufacturer's cooperation in these inspections.
- B. Inspection of the pipe may also be made after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements, even though pipe samples may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the site at once by the Contractor.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All materials for storm drainage utilities system shall be new and unused.

2.02 REINFORCED CONCRETE PIPE (RCP)

- A. RCP shall comply with the requirements of ASTM C76. All pipe 18 inches and smaller shall be Class V. All other pipe shall be Class III unless indicated otherwise on the Drawings.
 - 1. Joints for the RCP shall be the tongue and groove or bell and spigot type with rubber gasket conforming to ASTM C443.
 - 2. Flared end pipe sections shall be constructed in conformance with ASTM C76, Class V requirements, and shall be supplied by the same manufacturer as the pipe.

2.06 FILTER FABRIC

- A. Filter Fabric for Underdrains shall be Mirafi 140N or approved equivalent.
- B. Filter Fabric for Flared End Sections and Headwalls with Stone Protection shall be Mirafi 140N, or approved equivalent.

2.07 HIGH DENSITY CORRUGATED POLYETHYLENE (HDPE) PIPE

- A. HDPE pipe and fittings shall be smooth interior, and meet the requirements of ASTM D3350. Four-inch through 10-inch diameter HDPE pipe shall meet the requirements of AASHTO M 252. Twelve-inch through 60-inch diameter HDPE pipe shall meet the requirements of AASHTO M 294, Types S.
- B. Standard Fitting connections shall be fabricated to sizes shown on the Drawings.

- C. Pipe joints and fittings shall conform to the requirements of AASHTO M 252 or AASHTO M 294. Pipe joints shall be Bell and Spigot soil tight joints and gaskets shall meet the requirements of ASTM F477. Fittings shall also be soil tight and gasketed.
- D. Where indicated on the Drawings, HDPE pipe shall be slotted or perforated by the manufacturer prior to delivery to the job site. Coupling bands shall conform to the manufacturer's specifications. Couplers shall cover not less than one corrugation on each section of pipe.

2.08 POLYVINYL CHLORIDE (PVC) PIPE

- A. PVC pipe and fittings shall comply with the requirements of ASTM D3034, rated SDR 35; and ASTM D2665 for Schedule 40 and Schedule 80 pipe and fittings. Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D3034 classification.

2.09 DUCTILE IRON (DI) PIPE

- A. DI pipe shall be designed in accordance with ANSI A21.50/AWWA C150 and manufactured in accordance with ANSI A21.51/AWWA C151.
- B. DI pipe shall be thickness Class 52, furnished in 18-foot or 20-foot nominal lengths.

2.10 DRAIN MANHOLES

- A. Precast Concrete
 - 1. Manholes shall be 48-inch minimum inside diameter, precast concrete units, 4,000 psi minimum compressive strength, with eccentric cone section tapering to 24-inch diameter and monolithic base section meeting the requirements of ASTM C478. All structures shall be designed for HS-20 loading and shall be sufficient diameter to accept the pipe penetrations indicated on the Drawings.
 - 2. Precast unit joint seals shall be preformed butyl rubber O-ring type seals meeting the requirements of ASTM C990.
 - 3. Openings for pipe and materials to be embedded in the walls of the manholes sections for joint seals shall be cast in the sections at the required locations during manufacture. Sections with incorrectly cast and patched pipe openings will be rejected.
 - 4. Openings shall be cast into the manhole sections to receive entering pipes during manufacture. The openings shall be sized to provide a uniform 2-inch maximum annular space between the outside of the pipe wall and the opening in the riser for RCP. The openings shall be sized to accommodate flexible boot connections for all other pipe materials.
 - 5. Manhole pipe openings shall be solidly filled with non-shrink mortar for RCP.
 - 6. Manhole pipe connections for all other pipe materials shall be flexible boots as manufactured by Press-Seal, Trelleborg, A-Lok or approved equivalent.

B. Unit Masonry Construction:

1. Brick shall be sewer brick conforming to ASTM C32, Grade MS or approved equivalent.
2. Concrete block shall be solid block conforming to ASTM C139.
3. Mortar shall conform to ASTM C270, Type M. Mortar shall be composed of Portland cement, hydrated lime, and sand in the proportions of 1 part cement to 1/4 part hydrated lime to 3-1/2 parts sand by volume.
4. Cement shall be Type I or II Portland cement conforming to ASTM C150. Where masonry is exposed to salt water, Type II shall be used.
5. Hydrated lime shall be Type S conforming to ASTM C207.
6. Sand for masonry mortar shall conform to the gradation requirements of ASTM C144.

- C. Steps for manholes shall be steel reinforced copolymer polypropylene plastic steps with at least a 14-inch wide stepping surface conforming to ASTM C478 and ASTM A615.

2.11 DRAIN MANHOLE FRAMES AND COVERS

- A. Manhole frame and cover shall be grey iron casting conforming to ASTM A48, heavy duty, with the word "DRAIN" embossed on the cover. Letter size shall be three inches (3 in.). Frame and cover shall have a minimum clear opening of 24 inches and have a minimum weight of 475 pounds.

2.12 CATCH BASINS AND DROP INLET

- A. Precast catch basins and drop inlets shall be manufactured in accordance with ASTM C478, 4,000 psi minimum compressive strength) to the diameters and depths shown on the Drawings. All structures shall be designed for HS-20 loading. Precast unit joints shall be sealed with butyl rubber in accordance with ASTM C990.
- B. Where required for hood, a slot and opening shall be cast in the catch basin wall for mounting the cast iron hood over the outlet pipe.
- C. Openings at top of concrete structures where curb inlets are indicated shall be 24 inches by 27 inches.
- D. When approved by the Engineer, catch basins and drop inlets may be constructed with brick or concrete block walls and poured reinforced concrete bases as an alternative to precast concrete units.
1. Brick and concrete block and other materials shall as specified under Drain Manholes.

2.13 CATCH BASIN FRAMES AND GRATES

- A. Catch basin frame and grates shall be cast iron, conforming to ASTM A48, Class 30. Where located in accessible ways, grate openings shall meet the requirements of federal, state, and local regulations adopted under the Americans with Disabilities Act (ADA).

2.14 CATCH BASIN HOODS

- A. Catch basin oil and debris traps (i.e., hoods, eliminators, etc.) shall be manufactured by the following, or approved equivalent:
 - 1. 'Eliminator' by Ground Water Rescue, Inc.
 - 2. 'Hood' by Neenah Foundry Company

2.20 SILT SACKS AND SEDIMENT CONTROL DEVICES

- A. Silt Sacks and Sediment Control Devices shall be as manufactured by ACF Environmental, Inc.; or approved equivalent.
- C. Material shall be a polypropylene geotextile fabric with strength per ASTM D4884.

PART 3 - EXECUTION

3.01 GENERAL

- A. Contractor shall verify the location, size invert and type of existing pipes at all points of connection prior to ordering new utility materials.
- B. All pipe shall be laid accurately to the lines and grades indicated on the Drawings and in conformance with the pipe manufacturer's recommendations.
- C. As soon as the trench is excavated to the normal grade of the bottom of the trench, the Contractor shall immediately place the bedding material in the trench. The pipe shall be firmly bedded in the compacted bedding material accurately to the lines and grades shown on the Drawings.
- D. Laying Pipe
 - 1. Each length of pipe shall be laid with firm, full and even bearing throughout its entire length, in a prepared trench. Pipe shall be laid with bells up grade unless otherwise approved by the Engineer.
 - 2. Every length of pipe shall be inspected and cleaned of all dirt and debris before being laid. The interior of the pipe and the jointing seal shall be free from sand, dirt and trash. Extreme care shall be taken to keep the bells of the pipe free from dirt and rocks so that joints may be properly lubricated and assembled. No pipe shall be trimmed or chipped to fit.
 - 3. No length of pipe shall be laid until the proceeding lengths of pipe have been thoroughly embedded in place, to prevent movement or disturbance of the pipe alignment.
 - 4. Bedding shall be notched under pipe bells and joints where required to provide for uniform bearing under entire length of pipe.

- E. Optimum moisture content of bedding material shall be maintained to allow required compaction density.
- F. Where an existing pipe is to be extended, the same type of pipe shall be used, unless otherwise approved by the Engineer.
- G. Only full lengths of pipe shall be used in the installation except that partial lengths of pipe may be used at the entrance to structures, and to accommodate the required locations of service connection fittings.
- H. All pipes entering drainage structures shall be cut flush with the inside face of the structure, and the cut ends of the pipe surface within the structure shall be properly rounded and finished so that there will be no protrusion, ragged edges or imperfections that would impede the hydraulic characteristics of the stormwater flow. The method of cutting and finishing shall be subject to the approval of the Engineer.
- I. The Contractor shall protect the installation at all times during construction. Movement of construction equipment, vehicles, and loads over and adjacent to any pipe shall be performed at the Contractor's risk.
- J. At all times when pipe laying is not in progress, all open ends of pipes shall be closed by approved temporary watertight plugs. If water is in the trench when work is resumed, the plug shall not be removed until the trench has been dewatered and all danger of water entering the pipe eliminated.

3.02 RELATIONSHIP TO WATER MAINS

- A. When a drain pipe crosses above or below a water pipe, the following procedures shall be utilized:
 - 1. *Horizontal Separation:* Whenever possible drains shall be laid at a minimum of 5 feet horizontally from any existing or proposed water main. Should local conditions prevent a lateral separation of 5 feet, a drain may be laid closer than 5 feet to a water main if:
 - a. It is laid in a separate trench, or if
 - b. It is laid in the same trench with the water mains located at one side on a bench of undistributed earth, and if
 - c. In either case the elevation of the top (crown) of the drain is at least 12 inches below the bottom (invert) of the water main.
 - 2. *Vertical Separation:* Whenever drains must cross under water mains, the drain shall be laid at such an elevation that the top of the pipe is at least 12 inches below the bottom of the water main. When the elevation of the drain cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint pipe for a distance of 10 feet on each side of the drain. One full length of water main should be centered over the drain so that both joints will be as far from the sewer as possible.
 - 3. When it is impossible to obtain the horizontal and vertical separation stipulated above, both the water main and drain shall be constructed of mechanical-joint cement lined

ductile iron pipe or other equivalent based on water tightness and structural soundness. Both pipes shall be pressure tested by an approved method to assure water tightness.

3.03 EXCAVATION AND BACKFILLING FOR PIPES

- A. The type of materials to be used in bedding and backfilling and the method of placement shall conform to the requirements of Section 310000 – EARTHWORK, the details shown on the Drawings and the following.
- B. Embedment materials are those used for bedding, haunching and initial backfill around pipes as illustrated on the Drawings.
 - 1. All embedment materials should be free from lumps of frozen soil or ice when placed. Embedment materials should be placed and compacted at optimum moisture content
- C. Trench Bedding: Material must be provided to insure proper line and grade is maintained. Unsuitable or unstable materials shall be undercut and replaced with a suitable bedding material, placed in 6-inch lifts. Other methods of stabilization, such as geotextiles may be appropriate and their use must be approved by the Engineer or Owner's Representative.
 - 1. Provide a stable and uniform bedding for the pipe and any protruding features of its joints and/or fittings. The middle of the bedding equal to 1/3 of the pipe outside diameter should be loosely placed, with the remainder compacted to a minimum of 95 percent Modified Proctor Density.
- D. Haunching: Proper haunching provides a major portion of the pipe's strength and stability. Exercise care to insure placement and compaction of the embedment material in the haunches. For larger diameter pipes (pipes greater than 30-inch diameter), embedment materials should be worked under the haunches by hand. Haunching materials shall be placed and compacted in 6-inch maximum lifts, compacted to 95 percent Modified Proctor Density.
- E. Initial Backfill: The initial backfill shall be from the springline to 24 inches above the pipe to provide protection for the pipe from construction operations during placement of the final backfill and protect the pipe from stones or cobbles in the final backfill. Compact initial backfill per Section 310000 - EARTHWORK.
 - 1. Flooding or jetting as a procedure for compaction are not allowed.
- F. Final Backfill: The final backfill should be the same material as the proposed embankment or surface finishes. Generally, the excavated material may be used as final backfill. Placement should be as specified for the embankment. In lieu of a specification, the final backfill should be placed in 12-inch maximum lifts and compacted to a minimum 95 percent modified proctor density to prevent excessive settlement at the surface. Compaction should be performed at optimum moisture content.
- G. Vehicular and Construction Loads: During construction, avoid heavy equipment loads (greater than 40,000 lbs. per axle) over the pipe. Additional temporary cover should be placed over the pipe for heavy construction load crossings. Hydrohammers or hoe-pak

compactors may not be used over the pipe until at least 48 inches of cover have been provided.

3.04 PRECAST DRAIN MANHOLES, CATCH BASINS, AND DROP INLETS

- A. Drain Manholes, Catch Basins, and Drop Inlets shall be constructed at the locations and to the lines, grades, dimensions and design shown on Drawings or as required by the Engineer.
- B. Precast Concrete Units shall be installed in a manner that ensures watertight construction. All leaks in precast concrete structures shall be sealed. If required, precast concrete structures shall be repaired or replaced to obtain watertight construction.
- C. Stubs shall be short pieces of pipe cut from the bell ends of the pipe. Stubs shall be plugged with brick masonry unless otherwise approved by the Engineer.
- D. Drain Manhole inverts shall conform accurately to the size of the adjoining pipes.
 - 1. Drain Manhole inverts shall be constructed of 3,500 psi concrete as shown the Drawings.
 - 2. Inverts shall be laid out in smooth diameter curves of the longest possible radius to provide uniform flow channels.
 - 3. Invert shelves shall be graded with a 1 inch drop per one foot length sloped from the manhole walls.
- E. Drain Manhole steps shall be accurately positioned and embedded in the concrete when the section is cast. Precast reinforced concrete manhole sections shall be set vertical, with sections and steps in true alignment.
- F. All holes in sections used for their handling shall be thoroughly plugged with rubber plugs made specifically for this purpose, or with mortar. The mortar shall be one part cement to 1-1/2 parts sand, mixed slightly damp to the touch, hammered into the holes until it is dense and an excess of paste appears on the surface, and finished smooth and flush with the adjoining surfaces.
- G. Precast sections shall be level and plumb with approved joint seals. Water shall not be permitted to rise over newly made joints until after inspection and acceptance. All joints shall be watertight.
- H. Openings which have to be cut in the sections in the field shall be carefully made to prevent damage to the riser. Damaged risers will be rejected and shall be replaced at no additional cost to the Owner.

3.05 CHANGE IN TYPE STRUCTURES

- A. Where indicated on the Drawings, existing subsurface drain structures shall be converted to the new structure types in the following manner:
 - 1. Catch Basins to Manholes
 - a. Fill basin sump with 3,000 psi concrete and create new inverts at the elevations and sizes indicated and in accordance with specifications and details for new drain manholes.
 - b. Provide and adjust to grade new drain manhole frame and cover.
 - c. Stockpile existing frame and grade per Owner's directions.
 - 2. Manholes to Catch Basins or Drain Inlets
 - a. Where a sump is indicated on the Drawings, replace existing manhole structure with new precast concrete catch basin structure.
 - b. Where a sump is not indicated on the Drawings, replace existing frame and cover with new frame and grate and adjust to grade per these specifications and details for new catch basins.
 - c. Stockpile existing manhole frame and cover per Owner's directions.

3.06 BRICK MASONRY

- A. Brick masonry structures shall be watertight. all leaks in brick masonry structures shall be sealed. all brick masonry shall be laid by skilled workmen.
- B. All beds on which masonry is to be laid shall be cleaned and wetted properly. Brick shall be wetted as required to be damp, but free of any surface water when placed in the work. Bed joints shall be formed of a thick layer of mortar which shall be smoothed or furrowed slightly. Head joints shall be formed by applying a full coat of mortar on the entire brick end, or on the entire side, and then by shoving the mortar covered end or side of the brick tightly against the bricks laid previously. The practice of buttering at the corners of the brick and then throwing the mortar or crappings in the empty joints will not be permitted. Dry or butt joints will not be permitted. Joints shall be uniform in thickness and approximately 1/4 inch thick.
- C. Brickwork shall be constructed accurately to the required structure dimensions and tapered at the top to the dimensions of the flanges of the cast-iron frames, as shown on the Drawings.
- D. Joints on the inside face of walls shall be tooled slightly concave with an approved jointer when the mortar is thumbprint hard. The mortar shall be compressed with complete contact along the edges to seal the surface of the joints.
- E. All castings to be embedded in the brickwork shall be accurately set and built-in as the work progresses.
- F. Water shall not be allowed to flow against brickwork or to rise on the masonry for 60 hours after it has been laid, and any brick masonry damaged in this manner shall be replaced as directed at no additional cost to the Owner. Adequate precautions shall be taken in freezing weather to protect the masonry from damage by frost.

3.07 CONCRETE MASONRY UNITS

- A. Concrete masonry units shall be soaked in water before laying. As circular concrete block walls are laid-up, the horizontal joints and keyways shall be flushed full with mortar. As rectangular blocks are laid-up, all horizontal and vertical joints shall be flushed full with mortar. Plastering of the outside of block structures will not be required. No structure shall be backfilled until all mortar has completely set.

3.08 MANHOLE STEPS

- A. Steps shall be installed into the precast walls during manufacture.
- B. Steps in brick masonry and concrete units shall be installed as the masonry courses are laid.

3.09 CASTINGS

- A. Cast-iron frames for grates and covers shall be well bedded in cement mortar and accurately set to the proposed grades.
- B. All voids between the bottom flange and the structure shall be completely filled to make a watertight fit. A ring of mortar, at least one-inch (1 in.) thick and pitched to shed water away from the frame shall be placed over and around the outside of the bottom flange. The mortar shall extend to the outer edge of the masonry all around its circumference and shall be finished smooth. No visible leakage will be permitted.
- C. Structures within the limits of bituminous concrete pavement shall be temporarily set at the elevation of the bottom of the binder course. After the binder course has been compacted, the structures shall be set at their final grade. Backfill necessary around such structures after the binder course has been completed shall be made with 3,500 psi concrete.

3.10 CONNECTIONS TO EXISTING FACILITIES

- A. The Contractor shall make all required connections of the proposed drainage system into existing drainage system, as indicated on the Drawings.
- B. Connections into existing drainage system facilities shall be performed in accordance with the requirements of the Owner of the facility. The Contractor shall comply with all such requirements, including securing of all required permits, and paying the costs thereof.

3.11 MANHOLE CONNECTIONS

- A. Manhole pipe connections for precast manhole bases shall be a tapered hole filled with non-shrink waterproof grout for RCP. Manhole connections shall be flexible boot cast into the manhole wall for HDPE, PVC, and DIP. The stainless-steel clamp shall be protected from corrosion with a bitumastic coating.

3.12 CLEANING

- A. The Contractor shall clean the entire drainage system of all debris and obstructions. Cleaning shall include removal of all formwork from structures, concrete and mortar droppings, construction debris, and dirt. The system shall be thoroughly flushed clean, and the Contractor shall furnish all necessary hose, pumps, pipe and other equipment that may be required for this purpose. No debris shall be flushed into existing drains, storm recharge chambers, storm drains and/or streams.

3.13 TESTING

- A. Testing shall be done with a mandrel with a minimum length that is greater than the pipe diameter, and a minimum diameter of 90 percent of the pipe diameter. If the mandrel cannot be pulled through the pipe after seven (7) days of completed trench backfill, the pipe line shall be deemed unacceptable and the pipe lines shall be removed and replaced.
- B. The Contractor shall make all necessary repairs or replacements required to permanently provide an open and structurally sound drainage system capable of supporting the anticipated loading from all sources throughout the year.

3.14 FINAL INSPECTION

- A. Upon completion of the work, and before final acceptance by the Engineer, the entire drainage system shall be subjected to a final inspection in the presence of the Engineer. The work shall not be considered as complete until all requirements for line, grade, cleanliness, mandrel tests, and other requirements have been met.

END OF SECTION 334000

SECTION 334020
WARNING AND TRACER TAPE

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. This Section covers the furnishing, handling, and installation of warning and tracer tape, as called for on the Drawings.

1.02 SUBMITTALS

- A. In accordance with requirements of General Specifications, submit the following:
 - 1. One set of manufacturer's literature on the materials, colors and printing specified herein, shall be submitted to the Engineer for review.

1.03 LAWS AND REGULATIONS

- A. Work shall be accomplished in accordance with regulations of local, county, state and federal agencies or utility company standards as they apply.

PART 2 – PRODUCT

2.01 ACCEPTABLE MANUFACTURERS

- A. Tape shall be manufactured by: Terra-Tape and Terra-Tape D by Reef Industries, Houston, TX; or approved equal.

2.02 TAPE

- A. Warning and tracer tape shall be at least 6 inches wide.
- B. Tracer tape for non-ferrous pipe or conduit shall be constructed of a metallic core bonded to plastic layers. The metallic tracer tape shall be a minimum 5-mil thick and shall be located at a depth as indicated on the drawings.
- C. Warning tape for ferrous pipe or conduit shall consist of multiple bonded plastic layers. The non-metallic tracer tape shall elongate at least 500% before breaking.
- D. The tape shall bear the wording (or approved equivalent): 'BURIED DRAIN LINE BELOW' (with 'DRAIN' replaced by 'WATER', 'SEWER', 'ELECTRICAL', 'GAS', 'TELEPHONE', or 'CHEMICAL' as appropriate), continuously repeated every 30 inches to identify the pipe.

- E. Tape colors shall be as follows as recommended by the American Public Works Association (APWA):

Electric	Red
Gas and Oil	Yellow
Communications	Orange
Water	Blue
Sewer and Drain	Green
Chemical	Red (not APWA)

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Warning and tracer tape shall be installed above the pipe or conduit it is to identify at depths as indicated on the Drawings.
- B. Follow the manufacturer's recommendations for installation.

END OF SECTION 334020