PROJECT MANUAL

FOR

PROCESS WATER LAGOON IMPROVEMENTS

UTE WATER CONSERVANCY DISTRICT

2190 H 1/4 Road
P.O. Box 460
Grand Junction, CO 81502

PROJECT NUMBER D01-26

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PROCESS WATER LAGOON IMPROVEMENTS

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PART ONE

BIDDING REQUIREMENTS

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INVITATION TO BID

The Ute Water Conservancy District will **receive sealed bids** at the Administration Office located at 2190 H 1/4 Rd, Grand Junction, Colorado 81505, **until 2:00 P.M. on Friday, March 20, 2026** for the **Process Water Lagoon Improvements**. The project consists of construction of two concrete lagoon structures with underdrain systems, a pump station, approximately 930 linear feet (LF) of 12-inch C900 PVC force main, approximately 1,760 LF of 24" PS46 PVC pipe, site grading, and other miscellaneous work as described in the Contract Documents.

Ute Water's **General Conditions of the Contract dated January 2021** may be obtained online at our website (http://www.utewater.org/specifications) at no cost. Contract documents, which include the Project Manual and accompanying full-scale drawings, can be downloaded at (http://www.utewater.org/utewaterprojects).

A **pre-bid meeting** will be held on **Wednesday, March 4, 2026 at 1:00 P.M.** at the Water Treatment Plant (WTP) located at 3975 Rapid Creek Road, Palisade, Colorado. Attendance at the meeting **IS** mandatory.

Ute Water's office will stamp the date and mark the time received on all bids. Bids received after the date and time indicated on the Invitation to Bid will not be considered. The Ute Water Conservancy District is not responsible for delays occasioned by the US Postal Service or any other means of delivery employed by Bidder.

A five percent (5%) Bid Bond **will** be required, as well as a one hundred percent (100%) Performance and Payment Bonds to guarantee the faithful performance of the contract. It is required that the surety issuing such bonds have an attorney-in-fact or a principal doing business in Colorado. This information must be included on the bond statement.

The Ute Water Conservancy District reserves the right to reject any and all bids, to postpone the award for thirty (30) days, to delete certain items from the Proposal, and to award the Contract to the lowest responsible bidder.

The Ute Water Conservancy District may reject any bid not in compliance with all prescribed bidding procedures and requirements and, may reject any and all bids upon finding that it is in the District's best interest to do so.

Contractor shall be licensed as required by the State of Colorado and local governments or municipalities.

UTE WATER CONSERVANCY DISTRICT
Dave Payne
Assistant General Manager
Phone: (970) 256-2855

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INFORMATION FOR BIDDERS

1. PROJECT DATA AND REQUIREMENTS

a. Project Name: **PROCESS WATER LAGOON IMPROVEMENTS**

b. Project Location: **Mesa County, Colorado,**
3975 Rapid Creek Road, Palisade, Colorado

c. Project Owner: **Ute Water Conservancy District**
2190 H 1/4 Road
Grand Junction, Colorado 81505

d. Project Starting and Completion Times:
A Notice of Award will be issued to the successful bidder within ten (10) working days following the bid opening. The Notice to Proceed will be issued upon coordinating the construction schedule and receipt of the required contract documents including Payment and Performance Bonds.
Substantial Completion: October 31, 2027
Final Completion: November 30, 2027

e. Liquidated Damages: Liquidated damages shall apply against the Contractor and accrue to the Ute Water District at the rate of two hundred dollars ($200.00) per day for each and every day that the project remains uncompleted beyond the time period outlined above, unless extended in accordance with the General Conditions of the Contract, Paragraph GC-52.

f. Schedule of Prices: Work is offered in one schedule on a unit and lump sum price basis. Each Item is to be bid. No substitutions, alternate or partial bids are allowed, except as provided for by the schedule of prices or by written addenda from the Engineer.

g. Ute Water Districts Project Manager: The project coordinator on this project is -
Dave Payne
Assistant General Manager
Phone: (970) 256-2855

h. Statement of Bidders Qualifications: The Low Bidder may be required to submit a statement of qualifications on a form provided by the Ute Water District.

i. Retainage: To insure the proper performance of this Contract, the Ute Water District shall retain five percent (5%) of the amount of each progress payment until five percent (5%) of the contract award is retained. Thereafter, if in the opinion of Ute Water, the Contractor is making satisfactory progress in the work, no additional amount shall be retained. The retained portion of the Contract amount shall be

retained until final completion and acceptance of all work covered by this Contract.

j. Bid Bond: A Bid Bond in the amount of five percent (5%) of the bid will be required for this project.

k. Performance and Payment Bonds: Prior to execution of the Contract, the Bidder shall furnish separate bonds covering the faithful performance of the Contract, and the payment of all obligations arising there under, each in an amount equal to one hundred percent (100%) of the Contract sum. The cost of furnishing such bonds shall be included in the price proposal. The surety issuing such bonds shall be licensed to issue bonds in the State of Colorado.

l. Basis of Award: See Section 15 of the Instruction to Bidders.

m. Documents Required with Bid:

- Completed Bid Proposal (P-1 to 6), including:
  - Schedule of Prices (P-4)
  - Bidder Certification (P-5)
  - Acceptance of Bid (P-6)
- Signed Addendum(s)
- Completed Bid Bond (BB-1 and 2)

INSTRUCTIONS to BIDDERS

1. DEFINED TERMS:
   Terms used in these Instructions to Bidders are defined in the General Conditions of the Contract. The term "Successful Bidder" means the lowest, qualified, responsible Bidder to whom Owner (on the basis of Owner's evaluation as hereinafter provided) makes an award.

2. COPIES OF BIDDING DOCUMENTS:
   2.1 Complete sets of the Bidding Documents for the deposit sum, if any, stated in the Advertisement of Invitation may be obtained from Engineer (unless another issuing office is designated in the Advertisement or Invitation to Bid).
   2.2 Complete sets of Bidding Documents shall be used in preparing Bids, neither Owner nor Engineer assume any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.
   2.3 Owner and Engineer in making copies of Bidding Documents available on the above terms do so only for the purpose of obtaining Bids on the Work and do not confer a license or grant for any other use.

3. EXAMINATION OF CONTRACT DOCUMENTS AND SITE:
   3.1 Before submitting a Bid, each Bidder must: (a) examine the Contract Documents thoroughly, (b) visit the site to become familiar with local conditions that may in any manner affect cost, progress or performance of the Work, (c) become familiar with federal, state and local laws, ordinances, rules and regulations that may in any manner affect cost, progress or performance of the Work, and (d) study and carefully correlate Bidder's observations with the Contract Documents.
   3.2 Reference is made to the Special Conditions for the identification of those reports of investigations and tests of subsurface and latent physical conditions at the site or otherwise affecting cost, progress or performance of the work which have been relied upon by Engineer in preparing the Drawings and Specifications. Owner will make copies of such reports available to any Bidder requesting them. These reports are not guaranteed as to accuracy or completeness, nor are they part of the Contract Documents. Before submitting a Bid, each Bidder will, at its own expense make such additional investigations and tests as the Bidder may deem necessary to determine his Bid for performance of the Work in accordance with the time, price and other terms and condition of the Contract Documents.
   3.3 On request, Owner will provide each Bidder access to the site to conduct such investigations and tests as each Bidder deems necessary for submission of his Bid.
   3.4 The lands, upon which the Work is to be performed, rights-of-way for access thereto and other lands designated for use by Contractor in performing the Work are identified in the Special Conditions, or Drawings.
   3.5 The Submission of a Bid will constitute an incontrovertible representation by the Bidder that he has complied with every requirement of this Article 3 and that the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performance of the Work.

4. INTERPRETATIONS:
   All questions about the meaning or intent of the Contract Documents shall be submitted to Engineer (or Owner's project manager) in writing. Replies will be issued by Addenda mailed or delivered to all parties recorded by Engineer (or Owner's project manager) as having received the Bidding Documents. Questions received less than five (7) calendar days prior to the date for opening of Bids will not be answered. Only questions answered by formal written Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

5. BID SECURITY:

5.1 Bid Security shall be made payable to the Owner in an amount of five percent (5%) of the Bidder's maximum Bid price and in the form of a certified or bank check or a Bid Bond (in form attached) issued by a Surety meeting the requirements of paragraph GC-13 of the General Conditions.

5.2 The Bid Security of the Successful Bidder will be retained until such Bidder has executed the Agreement and furnished the required Contract Security, whereupon it will be returned. If the successful Bidder fails to execute and deliver the Agreement and furnished the required contract Security within ten (10) calendar days of the Notice of Award, the Owner may annul the Notice of Award and the Bid Security of that Bidder will be forfeited. The Bid Security of any Bidder whom the Owner believes to have a reasonable chance of receiving the award may be retained by Owner for thirty (30) calendar days after the Bid opening. Bid Security of other Bidders will be returned within ten (10) calendar days of the Bid opening.

6. CONTRACT TIME:

The number of days within which, or the date by which the work is to be completed. The Contract Time will be included in the Information for Bidders and in the Agreement.

7. PREBID SUBMITTAL:

Whenever it is indicated in the Drawings or specified in the Specifications that a substitution or "or equal" item of material or equipment may be furnished or used by Contractor if acceptable to Engineer, a prebid application for such acceptance must be submitted to the Engineer at least seven (7) calendar days prior to bid opening. Written replies will be issued to the requesting party. Only written replies will be binding.

8. SUBSTUTE MATERIAL AND EQUIPMENT:

The Contract if, awarded, will be on the basis of material and equipment described in the Drawings or specified in the Specifications or as approved in a prebid submittal. Whenever it is indicated in the Drawings or specified in the Specifications that a substitute or "or-equal" item of material or equipment may be furnished or used by Contractor if acceptable to Engineer, application for such acceptance will not be considered by Engineer until after the Contractor has received a Notice to Proceed, except as set forth in paragraph 7 - Prebid Submittals. The procedure for submittal of any such application by Contractor and consideration by Engineer is set forth in paragraph GC-25 of the General Conditions which may be supplemented in the Special Conditions.

9. SUBCONTRACTORS ETC.:

9.1 If the Special Conditions require the identity of certain Subcontractors and other persons and organizations to be submitted to Owner in advance of the Notice of Award, the apparent Successful Bidder, and other Bidder so requested, will within seven (7) calendar days after the day of the Bid opening submit to Owner a list of all Subcontractors and other persons and organizations (including those who are to furnish the principle items of material and equipment) proposed for those portions of the Work as to which such identifications is so required. Such list shall be accompanied by an experience statement with pertinent information as to similar projects and other evidence of qualification for each such Subcontractor, person and organization if requested by Owner. If Owner or Engineer after due investigation has reasonable objection to any proposed subcontractor, other person or organization, either may before giving the Notice of Award request the apparent Successful Bidder to submit an acceptable substitute without and increase in Bid Price. If the apparent Successful Bidder declines to make any such substitution, the contract shall not be awarded to such Bidder, but his declining to make any such substitution will not constitute grounds for sacrificing his Bid Security. Any Subcontractor, other person or organization so listed and to whom Owner or Engineer does not make written objection prior to the giving of the Notice of

Award will be deemed acceptable to Owner and Engineer.

9.2 In Contracts where the Contract Price is on the bases of cost-of-the-work Plus a Fee, the apparent Successful Bidder, prior to the Notice of Award, shall identify in writing to Owner those portions of the Work that such Bidder proposes to subcontract and after the Notice of Award may only subcontract other portion of the Work with Owner's written consent.

9.3 No Contractor shall be required to employ any Subcontractor, other person or organization against whom he has reasonable objection.

9.4 The Contractor (Successful Bidder) must perform at least sixty percent (60) of the Contract Work with its own personnel.

10. PROPOSAL:

10.1 The Proposal is attached hereto; additional copies may be obtained from Engineer or Owner.

10.2 Proposals must be completed in ink or by typewriter. The Bid Price of each item on the form must be stated. In case of conflict between unit price and total price, unit prices will take precedence.

10.3 Proposals by corporations must be executed in the corporate name by the president or a vice-president (or other corporate officer accompanied by evidence of authority to sign) and the corporate seal must be affixed and attested by address and state of incorporation shall be shown below the signature.

10.4 Proposals by partnerships must be executed in the partnership name and signed by a partner, whose title must appear under the signature and the official address of the partnership must be shown below the signature.

10.5 All names must be typed or printed below the signature.

10.6 The Proposal shall contain an acknowledgement of receipt of all Addenda (the numbers of which shall be filled in on the Bid Form).

10.7 The address to which communications regarding the Proposal must be shown.

11. SUBMISSION OF BIDS:

Bids shall be submitted at the time and place indicated in the Invitation to Bid and shall be included in an opaque sealed envelope, marked with the Project title and name and address of the Bidder and accompanied by the Bid Security and other required documents. Any bid not so submitted may be considered nonconforming by the Engineer. If the Bid is sent through the mail or other delivery system the sealed envelope shall be enclosed in a separate envelope with the notation "BID ENCLOSED" on the face thereof.

12. MODIFICATION AND WTTHDRAWEL OF BIDS:

12.1 Bids may be modified or withdrawn by an appropriate document duly executed (in the manner that a Bid must be executed) and delivered to the place where Bids are to be submitted at any time prior to the opening of Bids.

12.2 If within twenty-four (24) hours after Bids are opened, any Bidder files a duly signed written notice with Owner and promptly thereafter demonstrates to the reasonable satisfaction of Owner that there was a material and substantial mistake in the preparation of his Bid, that Bidder may withdraw his Bid and the Bid security will be returned. Thereafter, that Bidder will be disqualified from rebidding the Work.

13. OPENING OF BIDS:

13.1 When Bids are opened publicly, they will be read aloud, and an abstract of the amounts of the base Bids and major alternates (if any) will be made available after the opening of Bids.

13.2 When Bids are opened privately, an abstract of the same information will be made available to Bidders within seven (7) calendar days after the Bid opening.

14. BIDS TO REMAIN OPEN:

All Bids shall remain open for thirty (30) calendar days after the day of the Bid opening, but Owner may in his sole discretion release any Bid and return the Bid Security prior to that date.

15. AWARD OF CONTRACT:

15.1 Owner reserves the right to reject any and all Bids, to waive any and all informalities and to negotiate contract terms with the Successful Bidder. The Owner reserves the right to disregard all nonconforming nonresponsive or conditional Bids. Discrepancies between words and figures will be resolved in favor of words. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum. Discrepancies between unit prices and total price will be resolved in favor of the unit price.

15.2 In evaluating Bids, Owner shall consider the qualifications of the Bidders, whether or not the Bids comply with the prescribed requirements, and alternates and unit prices if requested in the Bid forms. It is Owner's intent to accept alternates (if any are accepted) in the order in which they are listed in the Bid form but Owner may accept them in any order or combination.

15.3 Owner may consider the qualifications and experience of Subcontractors and other persons and organizations (including those who are to furnish the principal items of material or equipment) proposed for those portions of the Work as to which the identity of Subcontractors and other persons and organizations must be submitted as provided in the Special Conditions. Operating costs, maintenance considerations, performance data and guarantees of materials and equipment may also be considered by Owner.

15.4 Owner may conduct such investigations as he deems necessary to assist in the evaluation of any Bid and to establish the responsibility, qualifications and financial ability of the Bidders, proposed Subcontractors and other persons and organizations to do the Work in accordance with the Contract Documents to Owner's satisfaction within the prescribed time.

15.5 Owner reserves the right to reject the Bid of any Bidder who does not pass any such evaluation to Owner's satisfaction.

15.6 If the contract is to be awarded, it will be awarded to the lowest Bidder whose evaluation by Owner indicates to Owner that the award will be in the best interests of the Project.

15.7 If the contract is to be awarded, Owner will give the Successful Bidder a Notice of Award within ten (10) calendar days after the day of the Bid opening.

16. PERFORMANCE AND OTHER BONDS:

16.1 Paragraph GC-13 of the General Conditions and the Special Conditions set forth Owner's requirements as to performance and other Bonds. When the Successful Bidder delivers the executed agreement to Owner, it shall be accompanied by the required Contract Security.

16.2 Prior to execution of the Contract, the Bidder shall furnish separate bonds covering the faithful performance of the Contract and the payment of all obligations arising there under, each in an amount equal to one hundred percent (100%) of the Contract sum. The cost of the furnishing of such bonds shall be included in the Bid. The surety issuing such bonds shall be licensed to issue bonds in the State in which the work occurs.

17. SIGNING OF AGREEMENT:

When Owner gives a Notice of Award to the Successful Bidder, it will be accompanied by at least two (2) unsigned counterparts of the Agreement and all other Contract Documents. Within ten (10) calendar days thereafter, Contractor shall sign and deliver at least two (2) counterparts of the Agreement to Owner with all other Contract Documents attached. Within twenty (20) calendar days thereafter, Owner will deliver at least one (1) fully signed counterpart to Contractor.

PROPOSAL

Ute Water Conservancy District
2190 H 1/4 Road
P.O. Box 460
Grand Junction, Colorado 81502

TO ALL BIDDERS:

The Bidding Documents include the proposed Contract Documents, consisting of the Invitation to Bid, Information for Bidders, Instructions to Bidders, this Proposal including bid forms, other sample bidding and contract forms, the proposed Contract of Agreement between the Ute Water Conservancy District and Contractor, Supplemental Specifications, Supplemental General Conditions, Standard Specifications for Water Line Construction which consists of Conditions of Contract (General and other conditions) and Technical Specifications, Full Size Drawings, and all addenda issued prior to the opening of the Bids.

The undersigned declares that this Proposal is in all respects fair and without fraud and that it is made without collusion with any representative of the Owner.

THE BIDDER, BY MAKING A BID, REPRESENTS THAT:

1. The Bidder has examined and understands the Bidding Documents and the Bid is made in accordance therewith.

2. The Bidder has personally visited the site, become familiar with local conditions under which the proposed work is to be performed, has determined the extent, character and location of the proposed work, the nature and type of excavation to be done, the location and condition of existing streets and roadways giving access to the site of the work, the topography of the site of the work, and has correlated the Bidder's personal observations with the requirements of the proposed Contract Documents.

3. The Bidder is satisfied that the conditions of the work and materials as included herein is brief and is intended to identify the said quantities with the detailed requirements of the proposed Contract Documents.

INTERPRETATION OR CORRECTION OF BIDDING DOCUMENTS:

1. The Bidder shall carefully study and compare the Bidding Documents and shall examine the site and local conditions, and shall at once report to the Engineer errors, inconsistencies or ambiguities discovered.

2. Bidders and Sub-bidders requiring clarification or interpretation of the Bidding Documents shall make a written request which shall reach the Engineer a minimum of five (5) days prior to the date for receipt of Bids.

THE BID:

The Bidder does hereby propose to furnish all pipe materials including valves (unless indicated to be Owner supplied), fittings, fire hydrants, bolts, gaskets, saddles, polyethylene encasing or wrapping materials, and all temporary water lines for water service; all required backfill material, traffic control, tools, equipment, and appliances, and to perform all labor and work necessary to construct and complete the project entitled:

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and all specified work appurtenant thereto including pressure testing and disinfection, and in connection with this project for the Owner within the time limit specified, and in accordance with the drawings, specifications and contract change order documents for the sums set forth in the following schedule of prices.

The Owner will furnish all the required compaction testing. Contractor must contact Geotechnical Engineering firm at least 48 hours in advance of starting work. Owner will provide name of Geotechnical Engineering firm.

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BID SCHEDULE

Lump Sum Items

A. Bidder will complete the Work in accordance with the Contract Documents for the following lump sum (stipulated) price(s), together with any Unit Prices indicated in Paragraph 3.02:

Bid Item #1, Mobilization & Demobilization	$_____
Bid Item #2, Erosion Control	$_____
Bid Item #3, Demolition	$_____
Bid Item #4, Site Grading	$_____
Bid Item #5, Dewatering Lagoons	$_____
Bid Item #6, Pump Station	$_____

Unit Price Items

A. Bidder will perform the following Work at the indicated unit:

Item No.	Description	Unit	Estimated Quantity	Bid Unit Price	Bid Price
7	12” C900 PVC Force Main	LF	930	$	$
8	12” DIP Fittings	EA	7	$	$
9	12” Gate Valves	EA	1	$	$
10	3” DR-11 HDPE Water Line	LF	1,220	$	$
11	3” Gate Valve	EA	1	$	$
12	1.5” Yard Hydrant	EA	2	$	$
13	24” PS46 PVC Pipe	LF	1,760	$	$
14	24” DIP Fittings	EA	54	$	$
15	24” MJ Plug Valve	EA	5	$	$
16	Concrete Manhole	EA	4	$	$

B. Bidder acknowledges that:

1. each Bid Unit Price includes an amount considered by Bidder to be adequate to cover Contractor’s overhead and profit for each separately identified item, and

2. estimated quantities are not guaranteed, and are solely for the purpose of comparison of Bids, and final payment for all Unit Price Work will be based on actual quantities, determined as provided in the Contract Documents.

Total Bid Price (Lump Sum and Unit Prices)

Total Bid Price (Total of all Lump Sum and Unit Price Bid Items)	$

This Bid was prepared for the below listed Contractor.

CONTRACTOR_____

Name:_____ Title:_____

Signature_____ Date:_____

The undersigned Bidder agrees that, if awarded the Contract, it will commence work immediately upon receipt of written Notice to Proceed and that it will complete the work within the specified number of days set forth in the Information for Bidders.

BIDDER CERTIFICATION:

The undersigned Bidder certifies that:

(a) The Bidder has examined the site of the work;

(b) The Bidder understands the manner of payment for the cost of the project;

(c) All work to be in compliance with Ute Water Conservancy Districts Standard Specifications;

(d) The Bidder has received and duly considered the following Addenda to the specifications and the following revisions or additions to the plans:

Addenda: No. _____ to No. _____, inclusive.

Plan Revision Sheets: Nos. _____

Plan Addition Sheets: Nos. _____

The undersigned Bidder certifies that it is licensed as required by the State of Colorado and local governments or municipalities.

ACCEPTANCE OF BID (AWARD):

The undersigned Bidder agrees that on written acceptances of this bid, it will immediately execute a formal contract agreement with the Ute Water Conservancy District in the form attached hereto, and that if it will provide an acceptable Performance and Payment Bond.

It is the intent of the Ute Water Conservancy District to award the Contract to the lowest responsible Bidder, provided the Bid has been submitted in accordance with the requirements of the Bidding Documents and does not exceed the funds available. Ute Water Conservancy District shall have the right to waive informalities or irregularities in a Bid received and to accept the Bid which, in the District's judgment, is in the District's best interests.

In submitting this Bid, it is understood the Ute Water Conservancy District reserves the right to reject any and all Bids, to adjust the scope of the work within reasonable limits, and to postpone award for a reasonable time.

Dated on this _____ day of_____, 2026

Name of Firm:

_____

Address:

_____

Signature: _____

Title: _____

Telephone No.: _____

IRS ID No. _____

FAX No.: _____

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BID BOND

KNOWN ALL MEN BY THESE PRESENTS, that we, _____ _____ _____(_____ an individual, _____ a partnership, _____ a corporation) incorporated in the State of _____ as Principal, and _____ (incorporated in the State of _____), as Surety, are held and firmly bound unto the Ute Water Conservancy District (hereinafter called "District") in the penal sum of _____ dollars ($_____), lawful money of the United states, for the payment which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has submitted a bid for:

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WHEREAS, the District has required as a condition for receiving said Bid that the Principal deposit with the District either a certified check equivalent to not less than five percent (5%) of the amount of said Bid or in lieu thereof furnish a Bid bond for said amount conditioned that in event of failure to execute the proposed Contract for such construction and the required Performance and Payment Bonds if the Contract be awarded to the Bidder, that said sum be paid immediately to the District as Liquidated Damages and not as a penalty for the Principal's failure to perform.

NOW, THEREFORE, if the principal shall, within the period specified therefore, on the attached prescribed forms presented to the Bidder for signature, enter into a written Contract with the District in accordance with said Bid as accepted, and give Performance and Payment Bonds with good and sufficient Surety, or Sureties, as may be required upon the forms prescribed by the District, for the faithful performance and the proper fulfillment of said Contract, specified, or upon the payment to the District of the sum determined upon herein as Liquidated Damages, and not as a penalty in event the Principal fails to enter into said Contract and give Performance and Payment Bonds within the time specified, then this obligation shall be void and of no effect, otherwise to remain in full force and effect.

IN WITNESS WHEREOF, the above bound parties have executed this instrument under their several seals the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative pursuant to authority of its governing board.

Signed and sealed this ____ day of _____, 2026

Principal:_____

Signed:_____ (seal)

Title:_____

Surety: _____

Signed:_____ (seal)

Title:_____

INSTRUCTIONS FOR COMPLETING BID BOND

1. The full Legal name and residence of each individual party to the bond must be inserted in the first paragraph.
2. If the Principal is a partnership, the name of all partners must be inserted in the first paragraph which must recite that they are partners composing the partnership (to be named), and all partners must execute the bond as individuals.
3. The state of incorporation of each corporate party to the bond must be inserted in the first paragraph and the bond must be executed under the corporate seal of said party attested by its secretary or other appropriate officer.
4. Attach a copy of the power-of attorney for the Surety's agent.

STATEMENT OF BIDDERS QUALIFICATIONS
(Low Bidder May Be Required To Submit)

All questions must be answered and the data given must be clear and comprehensive. This statement must be notarized. If necessary, questions may be answered on separate attached sheets. The Bidder may submit additional information if desired.

1. Name of Bidder: _____

2. Permanent main office address: _____
_____

3. When organized:
_____

4. If a corporation, where incorporated: _____

5. How many years have you been engaged in the contracting business under your present firm or trade name?
_____

6. Have you ever failed to complete any contract awarded to you?
[ ] Yes [ ] No If so, why?
_____
_____
_____

7. Have you ever defaulted on a contract? [ ] Yes [ ] No
If so, why?
_____
_____
_____
_____

8. General character of projects performed by your company:

_____
_____
_____
_____
_____

9. Contracts on hand: (Schedule these, showing amount of each contract and the appropriate anticipated dates of completion.)

_____
_____
_____
_____

10. List significant projects recently completed by your company, stating the approximate cost for each , and the month and year completed.

_____
_____
_____

11. List construction projects completed by your company which are similar in nature to this project:

_____
_____
_____
_____
_____

12. List major equipment proposed for use in performing the Work. Identify whether equipment is currently owned, or would be purchased or rented by the Bidder.

_____
_____
_____
_____

13. Provide background and experience of the principal members of your organization, including the officers:

_____
_____
_____
_____

14. Credit available: $_____

15. Give bank reference:

_____
_____

16. Will you, upon request, fill out a detailed financial statement and furnish any other information that may be required by the Ute District? [ ] Yes [ ] No

17. Provide a list of at least five references:

Project Title:_____
Contract Agency: _____
Person in Charge: _____
Position Title: _____
Phone No.: _____
Address:_____
_____
$ Amt. for Bidder's Portion of Work:_____

Project Title:_____
Contract Agency: _____
Person in Charge: _____
Position Title: _____
Phone No.: _____
Address:_____
_____
$ Amt. for Bidder's Portion of Work:_____

Project Title:_____
Contract Agency: _____
Person in Charge: _____
Position Title: _____
Phone No.: _____
Address:_____
_____
$ Amt. for Bidder's Portion of Work:_____
Project Title:_____
Contract Agency: _____

Person in Charge: _____
Position Title: _____
Phone No.: _____
Address:_____
_____
$ Amt. for Bidder's Portion of Work:_____

18. The undersigned hereby authorizes and requests any person, firm or corporation to furnish any information requested by the Ute Water District to verify statements provided in this Statement or Bidder's Qualifications. Dated at _____ this _____ day of _____, 20_____

_____
(Name of Bidder)

By:_____

Title:_____

STATE OF COLORADO)
) ss.
COUNTY OF _____)

_____ being duly sworn deposes and says that he or she is _____ of_____
(Name of Organization)

and that the answers to the foregoing questions and all statements therein are true and correct.

SUBSCRIBED AND SWORN TO BEFORE ME this _____day of _____, 20_____.

_____
(Notary Public)

My commission expires _____20_____

PART 2

CONTRACT FORMS

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AGREEMENT

THIS AGREEMENT, dated the ____ day of _____by and between **UTE WATER CONSERVANCY DISTRICT,** (hereinafter called **District**) and _____ (hereinafter called **Contractor**).

DISTRICT and CONTRACTOR, in consideration of the mutual covenants hereinafter set forth, agree as follows:

ARTICLE 1 - WORK

CONTRACTOR shall complete all Work as specified or indicated in the Contract Proposal.

The DISTRICT hereby agrees to furnish the services of a qua lified soils testing firm for monitoring the compaction requirements as described in the Specifications for the Work.

The CONTRACTOR hereby agrees to furnish all pipe materials, except those specifically indicated to be provided by Owner, including all fittings, valves, valve boxes, fire hydrant assemblies and service connection assemblies and shall also furnish labor, equipment, pipe bedding, pipe zone and pipe trench backfill materials, temporary service lines and all surface restoration materials including replacement of asphalt concrete, damaged or relocated structures, fences, signs or utilities, maintenance of tempo rary AC pavement cold patching until hot mixed AC pavement is available, if that becomes necessary, and shall furnish the required traffic control and be responsible for all required utility locates and to perform all Work shown on the drawings and described in the specifications for the project entitled:

PROCESS WATER LAGOON IMPROVEMENTS

The Work under this Contract shall include those items named on the Proposal Sheet attached to this agreement and shall be in accordance with the requirements and provisions of the Contract Document as defined in the General Conditions of the Contract, which Contract Documents are enclosed herewith, and are hereby made a part of this Agreement.

The CONTRACTOR also agrees to comply with all applicable state laws, municipal ordinances, standard specifications, and rules and regulations of all authorities having jurisdiction over the construction.

ARTICLE 2 - CONTRACT TIMES

2.1 A Notice of Award will be issued to the successful bidder within ten working days following the bid opening. The Notice to Proceed will be issued upon coordinating the construction schedule and receipt of the required contract documents including performance and payment bonds.

2.2 **Substantial Completion** by: October 31, 2027
Final Completion by: November 30, 2027

2.3 **Liquidated Damages.** DISTRICT and CONTRACTOR recognize that time is of the essence of this Agreement and that DISTRICT will suffer financial loss if the Work is not completed within the times specified in paragraph 2.2 above, plus any extensions therefore allowed. They also recognize the delays, expense and difficulties involved in proving the actual loss suffered by the DISTRICT if the Work is not completed on time. Accordingly, instead of requiring such proof, the DISTRICT and CONTRACTOR agree that as liquidated damages for delay (but not as a penalty) CONTRACTOR shall pay DISTRICT **TWO HUNDRED dollars and no cents ($200.00)** for each and every day that expires after the time specified in paragraph 2.2 for Substantial Completion until Work is substantially complete.

In addition to the liquidated damages above, the CONTRACTOR shall reimburse the ENGINEER for the cost incurred for inspection and project management services required beyond the set time limit. If CONTRACTOR fails to reimburse the ENGINEER directly, the cost will be deducted from the CONTRACTOR'S final pay request by the DISTRICT.

ARTICLE 3 - CONTRACT PRICE

DISTRICT shall pay CONTRACTOR for completion of the Work in accordance with the Contract and amount in current funds, the total amounts determined by the lump sum and unit prices listed in the Proposal. Based on the estimated quantities and the stated unit prices, the total Contract price is _____dollars and _____ cents **($_____).**

Progress payments shall be made in accordance with Article XI- MEASUREMENT PAYMENT AND ACCEPTANCE of the General Conditions of the Contract. As provided in the General Conditions, estimated quantities are not guaranteed, and determinations of actual quantities and classification are to be made by ENGINEER and or DISTRICT as provided in the General Conditions. Partial payments shall not be regarded as final acceptance of any portion of the Work.

ARTICLE 4 - CONTRACTOR'S REPRESENTATIONS

In order to induce the DISTRICT to enter into this Agreement, CONTRACTOR makes the following representations:

4.1 CONTRACTOR has examined and carefully studied the Contract Documents and the other related data identified in the Bidding Documents including "technical data".

4.2 CONTRACTOR has visited the site and become familiar with and is satisfied as to the general local and site conditions that may affect cost, progress, performance or furnishing of the Work.

4.3 CONTRACTOR is familiar with and is satisfied as to all federal, state and local Laws and Regulations that may affect cost, progress, performance and furnishing of the Work.

4.4 CONTRACTOR has carefully studied all reports of explorations and tests of subsurface conditions at or contiguous to the site and all drawings of physical conditions in or relating to existing surface or subsurface at or contiguous to the site which have been identified in the Contract Documents. CONTRACTOR acknowledges that such reports and drawings are not Contract Documents and may not be complete for CONTRACTOR'S purpose. CONTRACTOR acknowledges the DISTRICT and or ENGINEER do not assume responsibility for the accuracy or completeness of information and data shown or indicated in the Contract Documents with respect to Underground Facilities at or contiguous to the site. CONTRACTOR has obtained and carefully studied (or assumes responsibility for having done so) all such additional supplementary examinations, investigations, explorations, tests, studies and data concerning conditions (surface, subsurface and Underground Facilities) at or contiguous to the site or otherwise which may affect cost, progress, performance or furnishing of the Work or which relate to any aspect of the means, methods , techniques, sequences and procedures of construction to be employed by CONTRACTOR and safety precautions and programs incident thereto. CONTRACTOR does not consider that any additional examinations, investigations, explorations, tests, studies or data are necessary for the performance and furnishing of the Work at the Contract Price, within the Contract Times and in accordance with the other terms and conditions of the other terms and conditions of the Contract Documents.

4.5 CONTRACTOR is aware of the general nature of work to be performed by the DISTRICT and others at the site that relates to the Work as indicated in the Contract Documents.

4.6 CONTRACTOR has correlated the information known to CONTRACTOR, information and observations obtained from visits of the site, reports and drawings identified in the Contract Documents and all additional examinations, investigations, explorations, tests, studies and data with the Contract Documents.

4.7 CONTRACTOR has given ENGINEER and or DISTRICT written notice of all conflicts, errors, ambiguities or discrepancies that CONTRACTOR has discovered in the Contract Documents and written resolution thereof by the ENGINEER and or DISTRICT is acceptable to CONTRACTOR, and the Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

ARTICLE 5 - CONTRACT DOCUMENTS

The Contract Documents, which comprise the entire agreement between the DISTRICT and CONTRACTOR, are attached to this Agreement, made a part hereof, and consist of the

following: Invitation to Bid, Information for Bidders, Instruction to Bidders, Proposal, Bid Bond, this Agreement, Performance Bond, Payment Bond, Addenda No.__ through __, Notice of Award, Notice to Proceed, Supplemental General Conditions, (which consists of the Conditions of the Contract (General and other Conditions) and Technical Specifications), and Full Size Construction Drawings.

ARTICLE 6 - MISCELLANEOUS

6.1 Terms used in this Agreement which are defined in Article 1 of the General Conditions will have the meanings indicated in the General Conditions.

6.2 DISTRICT and CONTRACTOR each binds itself, its partners, successors, assigns and legal representatives in respects to all covenants, agreements and obligations contained in the Contract Documents.

6.3 Any provision or part of the Contract Documents held to be void or unenforceable under any Law of Regulation shall be deemed stricken, and all remaining provision shall continue to be valid and binding upon the DISTRICT and CONTRACTOR, who agree that the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

6.4 This Agreement shall be binding on all parties hereto and their respective heirs, executors, administrators, successors, and assigns.

IN WITNESS WHEREOF, DISTRICT and CONTRACTOR have executed or caused to be executed by their duly authorized representatives, this agreement in Two (2) copies, each of which shall be deemed an original. One counterpart each has been delivered to DISTRICT and CONTRACTOR.

(DISTRICT) UTE WATER CONSERVANCY DISTRICT

Name:_____ Name:_____

Signature:_____ Signature:_____

Title: _____ Title:_____

Address for giving notices:

Ute Water Conservancy District
2190 H ¼ Road, P.O. Box 460
Grand Junction, Colorado 81502

(CONTRACTOR)

_____

Name: _____ Name:_____

Signature:_____ Signature:_____

Title: _____ Title: _____

Address for giving notices:

_____

_____

_____

_____

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Construction performance bond

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable.

CONTRACTOR (Name and Address):

SURETY (Name and Principal Place of Business);

OWNER (Name and Address):

CONSTRUCTION CONTRACT
Date (Not earlier than Construction Contract Date):
Amount:
Modifications to this Bond Form:

CONTRACTOR AS PRINCIPAL
Company: (Corp. Seal)

Signature:_____
Name and Title

CONTRACTOR AS PRINCIPAL
Company: (Corp. Seal)

Signature:_____
Name and Title

SURETY
Company: (Corp. Seal)

Signature:_____
Name and Title

SURETY
Company: (Corp. Seal)

Signature:_____
Name and Title

1. The Contractor and the Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.
2. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except to participate in conferences as provided in Subparagraph 3.1.
3. If there is no Owner Default, the Surety's obligation under this Bond shall arise after:
   3.1. The Owner has notified the Contractor and the Surety at its address described in Paragraph 10 below, that the Owner is considering declaring a Contractor Default and has requested and attempted to arrange a conference with the Contractor and the Surety to be held not later than fifteen days after receipt of such notice to discuss methods of performing the Construction Contract. If the Owner, the Contractor and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement shall not waive the Owner's right, if any, subsequently to declare a Contractor Default; and
   3.2. The Owner has declared a Contractor Default and formally terminated the Contractor's right to complete the contract. Such Contractor Default shall not be declared earlier than twenty days after the Contractor and the Surety have received notice as provided in Subparagraph 3.1; and
   3.3. The Owner has agreed to pay the Balance of the Contract Price to the Surety in accordance with the terms of the Construction Contract or to a contractor selected to perform the Construction Contract in accordance with the terms of the contract with the Owner.
4. When the Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:
   4.1. Arrange for the Contractor, with consent of the Owner, to perform and complete the Construction Contract; or
   4.2. Undertake to perform and complete the Construction Contract itself, through its agents or through independent contractors; or
   4.3. Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and the contractor selected with the Owner's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Paragraph 6 in excess of the Balance of the Contract Price incurred by the Owner resulting from the Contractor's default; or
   4.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor and with reasonable promptness under the circumstances:
      1. After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, tender payment therefore to the Owner; or
      2. Deny liability in whole or in part and notify the Owner citing reasons therefore.
5. If the Surety does not proceed as provided in Paragraph 4 with reasonable promptness, the Surety shall be deemed to be in default on this Bond fifteen days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Subparagraph 4.4, and the Owner refuses the payment tendered or the Surety has denied liability, in whole or in part, without further notice the Owner shall be entitled to enforce any remedy available to the Owner.
6. After the Owner has terminated the Contractor's right to complete the Construction Contract, and if the Surety elects to act under Subparagraph 4.1, 4.2, or 4.3 above, then the responsibilities of the Surety to the Owner shall not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety shall not be greater than those of the Owner under the Construction Contract. To the limit of the amount of this Bond, but subject to commitment by the Owner of the Balance of the Contract Price to mitigation of costs and damages on the Construction Contract, the Surety is obligated without duplication for:
   6.1. The responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;
   6.2. Additional legal, design professional and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph4; and
   6.3. Liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.
7. The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, or successors.
8. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders and other obligations.
9. Any Proceedings, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and shall be instituted within two years after Contractor Default or within two years after the Contractor ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this Paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.
10. Notice to the Surety, the Owner or the Contractor shall be mailed or delivered to the address shown on the signature page.
11. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted here from and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory bond and not as a common law bond.
12. Definitions:
    12.1. Balance of the Contract Price: The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made, including allowance to the Contractor of any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.
    12.2. Construction Contract: The agreement between the Owner and the Contractor identified on the signature page, including al Contract Documents and changes thereto.
    12.3. Contractor Default: Failure of the Contractor, which has neither been remedied nor waived, to perform or otherwise to comply with the terms of the Construction Contract.
    12.4. Owner Default: Failure of the Owner, which has neither been remedied nor waived, to pay the Contractor as required by the Construction Contract or to perform and complete or comply with the other terms thereof.

Construction PAYMENT bond

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable.

CONTRACTOR (Name and Address):

SURETY (Name and Principal Place of Business);

OWNER (Name and Address):

CONSTRUCTION CONTRACT
Date (Not earlier than Construction Contract Date):
Amount:
Modifications to this Bond Form:

CONTRACTOR AS PRINCIPAL
Company: (Corp. Seal)

Signature:_____
Name and Title

CONTRACTOR AS PRINCIPAL
Company: (Corp. Seal)

Signature:_____
Name and Title

SURETY
Company: (Corp. Seal)

Signature:_____
Name and Title

SURETY
Company: (Corp. Seal)

Signature:_____
Name and Title

1. The Contractor and the Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to the Owner to pay for labor, materials and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference.
2. With respect to the Owner, this obligation shall be null and void if the Contractor:
   2.1. Promptly makes payment, directly or indirectly, for all sums due Claimants, and
   2.2. Defends, indemnifies and holds harmless the Owner from all claims, demands, liens or suits by any person or entity who furnished labor, materials or equipment for use in the performance of the Construction Contract, provided the Owner has promptly notified the Contractor and the Surety (at the address described in Paragraph 12) of any claims, demands, liens or suits and tendered defense of such claims, demands liens or suits to the Contractor and the Surety, and provided there is no Owner Default.
3. With respect to Claimants, this obligation shall be null and void if the Contractor promptly makes payment, directly or indirectly, for all sums due.
4. The Surety shall have no obligation to Claimants under this Bond until:
   4.1. Claimants who are employed by or have a direct contract with the Contractor have given notice to the Surety (at the address described in Paragraph 12) and sent a copy, or notice thereof, to the Owner, stating that a claim is being made under this Bond and, with substantial accuracy, the amount of the claim.
   4.2. Claimants who do not have a direct contract with the Contractor:
   1. Have furnished written notice to the Contractor and sent a copy, or notice thereof, to the Owner, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials were furnished or supplied or for whom the labor was done or performed; and
   2. Have either received a rejection in whole or in part from the Contractor, or not received within 30 days of furnishing the above notice any communication from the Contractor by which the Contractor has indicated the claim will be paid directly or indirectly; and
   3. Not having been paid within the above 30 days, have sent a written notice to the Surety (at the address described in Paragraph 12) and sent a copy, or notice thereof, to the Owner, stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to the Contractor.
5. If a notice required by Paragraph 4 is given by the Owner to the Contractor or to the Surety, that is sufficient compliance.
6. When the Claimant has satisfied the conditions of Paragraph 4, the Surety shall promptly and at the Surety's expense take the following actions:
   6.1. Send an answer to the Claimant, with a copy to the Owner, within 45 days after receipt of the claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed.
   6.2. Pay or arrange for payment of any undisputed amounts.
7. The Surety's total obligation shall not exceed the amount of this Bond, and the amount of this Bond shall be credited for any payments made in good faith by the Surety.
8. Amounts owed by the Owner to the Contractor under the Construction Contract shall be used for the performance of the Construction Contract and to satisfy claims, if any, under any Construction Performance Bond. By the Contractor furnishing and the Owner accepting this Bond, they agree that all funds earned by the Contractor in the performance of the Construction Contract are dedicated to satisfy obligations of the Contractor and the Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.
9. The Surety shall not be liable to the Owner, Claimants or others for obligations of the Contractor that are unrelated to the Construction Contract. The Owner shall not be liable for payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligations to make payments to, give notices on behalf of, or otherwise have obligations to claimants under this Bond.
10. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders and other obligations.
11. No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the location in which the work or part of the work is located or after the expiration of one year from the date (1) on which the Claimant gave the notice required by Subparagraph 4.1 or Clause 4.2(3), or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this Paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.
12. Notice to the Surety, the Owner or the Contractor shall be mailed or delivered to the address shown on the signature page. Actual receipt of notice by Surety, the Owner or the Contractor, however accomplished, shall be sufficient compliance as of the date received at the address shown on the signature page.
13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted here from and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. The intent is, that this Bond shall be construed as a statutory bond and not as a common law bond.
14. Upon Request by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor shall promptly furnish a copy of this Bond or shall permit a copy to be made.
15. DEFINITIONS
   15.1. Claimant: An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials or equipment for use in the performance of the Contract. The intent of this Bond shall be include without limitation in the terms "labor, materials or equipment" that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental equipment used in the Construction Contract, architectural and engineering services required for performance of the work of the Contractor and Contractor's subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials or equipment were furnished.
   15.2. Construction Contract: The agreement between the Owner and the Contractor identified on the signature page, including al Contract Documents and changes thereto.
   15.3. Owner Default: Failure of the Owner, which has neither been remedied nor waived, to pay the Contractor as required by the Construction Contract or to perform and complete or comply with the other terms thereof.

TECHNICAL SPECIFICATIONS

UWCD PROCESS WATER LAGOON IMPROVEMENTS

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APPENDIX A: GEOTECHNICAL REPORT

SECTION 01 11 00
SUMMARY OF WORK

PART 1 GENERAL

1.01 PROJECT

A. Project Name: UWCD Process Water Lagoon Improvements

B. Owner's Name: Ute Water Conservancy District.

C. Engineer's Name: SGM, Inc..

D. The Project consists of the construction of two concrete dewatering lagoons for drying of the WTP's treatment process waste streams, associated site piping, and a new pump station for recycled water return to the WTP.

1.02 CONTRACTOR'S RESPONSIBILITIES

A. Supervision
   1. Supervise and direct the Work and be solely responsible for the means and methods, techniques, and procedures of construction.
   2. Employ and maintain on the Work a qualified Superintendent who shall be designated in writing by Contractor as the Contractor's representative at the site.
      a. Superintendent shall have full authority to act on behalf of Contractor and all communications given to the Superintendent shall be as binding as if given to Contractor.
      b. Superintendent shall be present on the site at all times supervise and coordinate the Work.
      c. Superintendent shall not be changed except with the consent of the Engineer, unless the Superintendent has proven to be unsatisfactory to the Contractor or is no longer employed by the Contractor.

B. Subcontracting
   1. Subcontractors may be utilized on those parts of the Work which are typically performed by, or require, a specialty Subcontractor.
   2. Subcontracted work in excess of amounts set forth in the contract will not be awarded without prior written approval of the Owner.
   3. Contractor shall be fully responsible to Owner for the acts and omissions of Subcontractors and/or persons either directly or indirectly employed by them, just as Contractor is fully responsible for the acts of persons directly employed by it.

1.03 CONTRACTOR USE OF SITE AND PREMISES

A. Owner controls all lands upon which the Work is to take place. Contractor shall confine all construction activities within Owner’s property and construction limits, unless Contractor obtains a permit or written permission from the owner(s) of property outside of these areas. Said permit or written permission shall be secured and paid for by Contractor at no extra cost to Owner and a copy shall be provided to Engineer. Any damage to property, either inside or outside the limits of the easements provided by Owner, shall be the responsibility of Contractor. Contractor shall bear all costs necessary to repair, replace or restore any property damaged.

B. Preserve and protect public and private property, trees, fences, monuments, underground structures, etc., on and adjacent to the site of the Work.

C. Protect all land monuments and property corners from disturbance or damage until the Engineer, Owner, or their designated representative has witnessed or referenced. Do not remove them until directed by the Engineer, Owner, or their designated representative.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 20 00
MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Measurement and payment criteria applicable to Work performed under a unit price payment method.

B. Defect assessment and non-payment for rejected work.

C. Schedule of lump sum and unit price Bid Items.

1.02 COSTS INCLUDED

A. Unit Prices included on the Bid Form shall include full compensation for all required labor, products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of an item of the Work; overhead and profit.

B. Lump Sum Prices included on the Bid Form shall include full compensation for all required labor, products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of that portion of Work; overhead and profit.

1.03 UNIT QUANTITIES SPECIFIED

A. Quantities indicated in the Bid Form are for bidding and contract purposes only. Quantities and measurements of actual Work authorized, completed, and accepted will determine the payment amount.

B. No claim for damages, loss of anticipated profits, or otherwise, due to differences between the actual Work quanities and the Bid quantities will be allowed.

C. Contractor or Owner may request negotiation of the Unit Price for an item if:
   1. The extended price of a particular Unit Price item amounts to 5 percent or more of the Contract Price (based on estimated quantities at the time of Contract formation)
   2. The variation in the quantity of that particular Unit Price item of actually furnished or performed by Contractor differs by more than 25 percent from the estimated quantity of such item indicated in the Agreement.
   3. Contractor's unit costs to perform the item of Unit Price Work have changed materially and significantly as a result of the quantity change.

D. The adjustment in unit price will account for and be coordinated with any related changes in quantities of other items of Work, and in Contractor's costs to perform such other Work, such that the resulting overall change in Contract Price is equitable to Owner and Contractor.

E. Adjusted unit prices will apply to all units of that item.

F. If provided, quantities associated with Lump Sum items are for information only. The Contractor is to verify the actual quantities required to complete the Work for Lump Sum items.

G. No payment will be made for a bid item if the entire item is unused.

1.04 MEASUREMENT OF QUANTITIES

A. Measurement methods delineated in the individual specification sections complement the criteria of this section. In the event of conflict, the requirements of the individual specification section govern.

B. Take all measurements and compute quantities. Measurements and quantities will be verified by Owner.

C. Assist by providing necessary equipment, workers, and survey personnel as required.

D. Measurement Devices:
   1. Weigh Scales: Inspected, tested and certified by the applicable state Weights and Measures department within the past year.
   2. Platform Scales: Of sufficient size and capacity to accommodate the conveying vehicle.

3. Metering Devices: Inspected, tested and certified by the applicable state department within the past year.

E. Measurement by Weight: Concrete reinforcing steel, rolled or formed steel or other metal shapes will be measured by handbook weights. Welded assemblies will be measured by handbook or scale weight.

F. Measurement by Volume: Measured by cubic dimension using mean length, width and height or thickness.

G. Measurement by Area: Measured by square dimension using mean length and width or radius.

H. Linear Measurement: Measured by linear dimension, at the item centerline or mean chord.

I. Stipulated Price Measurement: Items measured by weight, volume, area, or linear means or combination, as appropriate, as a completed item or unit of the Work.

1.05 PAYMENT

A. Payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities of Work that is incorporated in or made necessary by the Work and accepted by the Owner, multiplied by the unit price.

B. Payment will not be made for any of the following:
   1. Products wasted or disposed of in a manner that is not acceptable.
   2. Products determined as unacceptable before or after placement.
   3. Products not completely unloaded from the transporting vehicle.
   4. Products placed beyond the lines and levels of the required Work.
   5. Products remaining on hand after completion of the Work.
   6. Loading, hauling, and disposing of rejected Products.

1.06 DEFECT ASSESSMENT

A. Replace Work, or portions of the Work, not complying with specified requirements.

B. If, in the opinion of Owner, it is not practical to remove and replace the Work, Owner will direct one of the following remedies:
   1. The defective Work may remain, but the unit price will be adjusted to a new unit price at the discretion of Owner.
   2. The defective Work will be partially repaired to the instructions of the Owner, and the unit price will be adjusted to a new unit price at the discretion of Owner.

C. The individual specification sections may modify these options or may identify a specific formula or percentage price reduction.

D. The authority of Owner to assess the defect and identify payment adjustment is final.

1.07 SCHEDULE OF BID ITEMS

A. Bid Item #1 - Mobilization & Demobilization
   1. No separate measurement for payment will be made for any labor, equipment, and materials required for this item. The lump sum price will include all of the Contractor's costs. This bid item includes, but is not limited to:
      a. Furnishing, installing and removing temporary fencing and construction markers around project work areas and any other fencing/security items as deemed necessary by the Contractor.
      b. Establishing and removing the Contractor's offices, buildings, and other necessary facilities.
      c. Obtaining, complying with, and transferring permits.
      d. Providing environmental controls for the life of the project.
      e. Providing required bonds and insurance.
      f. Preparing and maintaining the project schedule.
      g. Delivering and removing the Contractor's equipment, supplies, and excess materials, and cleaning up the site.

h. Restoring the project site to pre-project conditions.
i. Preparing and securing approvals of submittals.
j. Preparing record drawings.
k. Preparing and providing copies of stormwater and other required reports.
l. Providing all other related and necessary labor, equipment, and materials to complete the work.

2. Payment Basis:
   a. Lump Sum
   b. The first partial pay request shall include not more than 75% of this Bid amount; 25% of this Bid amount shall be paid on the final pay request.

B. Bid Item #2 - Erosion Control
1. No separate measurement for payment will be made for any labor, equipment, and materials required for this item. The lump sum price will include all of the Contractor's costs. This bid item includes, but is not limited to:
   a. All labor, material and equipment required for the installation of erosion control best management practices (BMPs).
2. Payment Basis
   a. Lump Sum

C. Bid Item #3 - Demolition
1. No separate measurement for payment will be made for any labor, equipment, and materials required for this item. The lump sum price will include all of the Contractor's costs. This bid item includes, but is not limited to:
   a. All labor, material and equipment required for demolition of items identified in the Design Drawings.
   b. Includes demolition of site fencing.
   c. Includes demolition of the existing concrete wingwall.
   d. Includes demolition of the existing concrete weir walls in the Lagoons 4 and 5 effluent structures.
   e. Includes disposal of demolished items.
2. Payment Basis
   a. Lump Sum

D. Bid Item #4 - Site Grading
1. No separate measurement for payment will be made for any labor, equipment, and materials required for this item. The lump sum price will include all of the Contractor's costs. This bid item includes, but is not limited to:
   a. All labor, material and equipment required for grading of the site.
   b. Includes initial and finished grading for the Access Road.
   c. Includes initial and finished grading for the driveway areas surrounding Lagoons 6 and 7.
   d. Includes importing and installing Class 6 roadbase as shown in Desgin Drawings.
2. Payment Basis
   a. Lump Sum

E. Bid Item #5 - Dewatering Lagoons
1. No separate measurement for payment will be made for any labor, equipment, and materials required for this item. The lump sum price will include all of the Contractor's costs. This bid item includes, but is not limited to:
   a. Associated excavation and subgrade preparation.
   b. All concrete, formwork, etc. associated with the dewatering lagoons.
   c. 6" PVC underdrains .
   d. Sand and gravel filter media.
   e. Weir gates and adjacent platforms.
   f. Handrails.

g. Providing all other related and necessary labor, equipment, and materials to complete the work.
h. Includes pipe transition structure between 24" RCP leaving lagoons 4 and 5 and the new 24" PVC pipe.
i. Includes costs associated with rock excavation. Rocks are expected to be encountered.
j. See geotechnical report for structural backfill recommendations. Onsite materials processed to a 3"-minus gradation can be utilized as structural backfill.
k. Associated electrical equipment and integration.

2. Payment will be based on the percentage of completed and accepted work.
3. Payment Basis:
   a. Lump Sum

F. Bid Item #6 - Pump Station
1. No separate measurement for payment will be made for any labor, equipment, and materials required for this item. The lump sum price will include all of the Contractor's costs. This bid item includes, but is not limited to:
   a. Associated excavation and subgrade preparation.
   b. All concrete, formwork, etc. associated with the pump station.
   c. Interior process piping.
   d. Pumps and Motor Control Centers.
   e. Building including masonry, roofing system, and HVAC.
   f. Bridge crane and hoist.
   g. Associated coatings.
   h. Includes costs associated with rock excavation. Rocks are expected to be encountered.
   i. See geotechnical report for structural backfill recommendations. Onsite materials processed to a 3"-minus gradation can be utilized as structural backfill.
   j. Associated electrical equipment and integration.
   k. Providing all other related and necessary labor, equipment, and materials to complete the work.
2. Payment will be based on the percentage of completed and accepted work.
3. Payment Basis:
   a. Lump Sum

G. Bid Item #7 - 12” C900 PVC Force Main
1. This bid item is for the supply and installation of new 12” C900 PVC force main as described in the project documents. This bid item includes, but is not limited to:
   a. All labor, materials and equipment involved with the supply and installation of new 12” diameter C900 PVC force main, including pipe bedding, backfilling,pressure testing and tracer wire, complete and in place.
   b. Includes costs associated with rock excavation. Rocks are expected to be encountered.
   c. See geotechnical report for structural backfill recommendations. Onsite materials processed to a 3"-minus gradation can be utilized as structural backfill.
2. Payment Basis:
   a. Linear Feet

H. Bid Item #8 - 12” DIP Fittings
1. This bid item is for the supply and installation of the 12" DIP fittings associated with the new 12” C900 PVC force main as described in the project documents. This bid item includes, but is not limited to:
   a. All labor, materials and equipment involved with the supply and installation of new 12” DIP fittings including megalugs.
   b. Includes 12" wall pipes at the pump station.
2. Payment Basis:

a. Per Each

I. Bid Item #9 - 12” Plug Valves
   1. This bid item is for the supply and installation of the 12" plug valve associated with the new 12” C900 PVC force main as described in the project documents. This bid item includes, but is not limited to:
      a. All labor, materials and equipment involved with the supply and installation of new 12” plug valves including megalugs.
   2. Payment Basis:
      a. Per Each

J. Bid Item #10 - 3" DR-11 HDPE Water Line
   1. This bid item is for the supply and installation of new 3" DR-11 HDPE Water Line as described in the project documents. This bid item includes, but is not limited to:
      a. All labor, materials and equipment involved with the supply and installation of new 3” diameter DR-11 HDPE water line, including pipe bedding, backfilling, pressure and bacteriological testing, and tracer wire, complete and in place.
      b. Includes costs associated with rock excavation. Rocks are expected to be encountered.
      c. See geotechnical report for structural backfill recommendations. Onsite materials processed to a 3"-minus gradation can be utilized as structural backfill.
   2. Payment Basis:
      a. Linear Feet

K. Bid Item #11 - 3” Gate Valves
   1. This bid item is for the supply and installation of the 3" gate valve associated with the new 3” HDPE water line as described in the project documents. This bid item includes, but is not limited to:
      a. All labor, materials and equipment involved with the supply and installation of new 3” gate valves including restraints and fittings to make connections.
   2. Payment Basis:
      a. Per Each

L. Bid Item #12 - 1.5" Yard Hydrant
   1. This bid item is for the supply and installation of the 1.5" yard hydrants associated with the new 3” HDPE water line as described in the project documents. This bid item includes, but is not limited to:
      a. All labor, materials and equipment involved with the supply and installation of new 1.5” yard hydrants including the hydrant specified in the project documents, pipe tapping saddle, corporation stop, and backfilling.
   2. Payment Basis:
      a. Per Each

M. Bid Item #13 - 24" PS46 PVC Pipe
   1. This bid item is for the supply and installation of new 24" PS46 PVC pipe associated with the lagoons inlet and outlet piping as described in the project documents. This bid item includes, but is not limited to:
      a. All labor, materials and equipment involved with the supply and installation of the 24" PS46 PVC pipe associated with the lagoons inlet and outlet piping including pipe bedding, backfilling, pressure testing, and tracer wire, complete and in place.
      b. Includes costs associated with rock excavation. Rocks are expected to be encountered.
      c. See geotechnical report for structural backfill recommendations. Onsite materials processed to a 3"-minus gradation can be utilized as structural backfill.
   2. Payment Basis:
      a. Linear Feet

N. Bid Item #14 - 24” DIP Fittings

1. This bid item is for the supply and installation of the 24" DIP fittings associated with the new 24" lagoons inlet and outlet piping as described in the project documents. This bid item includes, but is not limited to:
    a. All labor, materials and equipment involved with the supply and installation of new 24” DIP fittings including megalugs.
    b. Includes 24" wall pipes at the lagoon inlets/outlets and pump station.
2. Payment Basis:
    a. Per Each

O. Bid Item #15 - 24" Plug Valves
1. This bid item is for the supply and installation of the 24" plug valves associated with the new 24" lagoons inlet and outlet piping as described in the project documents. This bid item includes, but is not limited to:
    a. All labor, materials and equipment involved with the supply and installation of new 24” plug valves including megalugs.
2. Payment Basis:
    a. Per Each

P. Bid Item #16 - Concrete Manhole
1. This bid item is for the supply and installation of new concrete manholes as described in the project documents. This bid item includes, but is not limited to:
    a. All labor, materials and equipment involved with the supply and installation of new 5' diameter concrete manholes.
    b. Includes either pre-cast or cast-in-place manhole bases.
    c. Includes associated pipe work for tie-ins.
    d. Includes costs associated with rock excavation. Rocks are expected to be encountered.
    e. See geotechnical report for structural backfill recommendations. Onsite materials processed to a 3"-minus gradation can be utilized as structural backfill.
2. Payment Basis:
    a. Per Each

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 24 13
VALUE ENGINEERING

PART 1 GENERAL

1.01 VALUE ENGINEERING

A. The Contractor is encouraged to develop and offer proposals for improved construction techniques, alternative materials, and other innovations. Proposals must provide a project comparable to the original design either at lower cost, improved quality, or both. Proposals that lower the quality of the intended project will be rejected. Bid prices shall not be based on the anticipated approval of a Value Engineering Change Proposal (VECP). Proposals shall be submitted only by the successful bidder after contract award. If a VECP is rejected, the work shall be completed per the Contract at contract bid prices. Any delay to the project due to a VECP submittal and review shall be considered within the Contractor's control and will be nonexcusable with the exception of those delays that are approved as part of the VECP.

B. Contractor must submit in writing to Engineer, and for review by Owner, value engineering change proposals (VECPs) for modifying Drawings, Specifications, or other requirements of the Contract Documents for the sole purpose of reducing total cost of construction. The cost reduction proposals shall not impair in any manner the essential functions or characteristics of the project, including, but not limited to, service life, economy of operation, ease of maintenance, desired appearance or design, and safety standards. The attached Exhibit (at the end of this specification section) is to be utilized for documentation and submission of the proposed modifications and is to be completed by the contractor prior to the workshop.

C. Owner has the sole authority to accept or reject cost reductions proposed by Contractor.

D. VECPs shall contain the following information:
   1. A description of both existing Contract requirements for performing Work and proposed changes.
   2. An itemization of Contract requirements that must be changed if the proposal is adopted.
   3. A detailed estimate of the cost of performing the Work under the existing Contract and under the proposed change.
   4. A statement of time within which Owner must make a decision thereon, if applicable.
   5. Contract items of Work affected by proposed changes, including any quantity variation attributable thereto.

E. Contractor shall submit VECPs to the Engineer in PDF or other format acceptable to the Engineer, who will share and discuss the VECPs with the Owner and inquire with the Contractor as needed. Approved VECPs will be signed by the Owner and Engineer and returned to the Contractor.

F. Contractor shall continue to perform Work in accordance with requirements of the Contract Documents, and shall not proceed with approved VECP work, until an executed Field Order, Work Change Directive or Change Order incorporating a VECP has been issued.

1.02 MEASUREMENT AND PAYMENT

A. Net cost savings on VECPs that are less than $25,000 can be kept by the Contractor. Net cost savings greater than $25,000 shall be split equally between the Contractor and Owner.

B. For all VECPs, the incentive payment shall be calculated as follows:

   (gross cost of deleted work) - (gross cost of added work) = (gross savings)

   (gross savings) - (Contractor's engineering costs) - (Owner's engineering costs) = (net savings)

   Any net savings less than $25,000 can be kept by the Contractor.

   If the net savings are greater than $25,000 then the amount over $25,000 will be shared equally with Owner and calculated as follows:

   (net savings) - $25,000 = shared savings

   Contractor's total incentive = (shared savings) /2 + $25,000

The Contractor's engineering costs will be reimbursable only for outside consultant costs that are verified by certified billings. Owner's engineering costs shall be actual consultant costs billed to Owner and extraordinary inhouse personnel labor costs. Project personnel assigned to the field office or who work on the project on a regular basis shall not be included in Owner's portion of the cost.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

EXHIBIT - VALUE ENGINEERING FORM

[Project Name]	AREA
[Project Code]	IDEA NO.
	ITEM
Original Concept:	
Proposed Concept:	
Advantages: Reduced capital cost	
Risks/Disadvantages:	

Notes:			
	Cost Summary		
	Alternative 1	Alternative 2	Alternative 3
Initial Costs - Original			
Initial Costs - Proposed			
Initial Savings			
Net Annual Costs - Original			
Net Annual Costs - Proposed			
Annual O & M Savings			
Total Annual Savings			
Present Worth - Savings (P/A, 7%, 20 yr.)			

SECTION 01 25 00
SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedural requirements for proposed substitutions.

1.02 DEFINITIONS

A. Substitutions: Changes from Contract Documents requirements proposed by Contractor to materials, products, assemblies, and equipment.
   1. Substitutions for Cause: Proposed due to changed Project circumstances beyond Contractor's control.
      a. Unavailability.
      b. Regulatory changes.
   2. Substitutions for Convenience: Proposed due to possibility of offering substantial advantage to the Project.
      a. Substitution requests offering advantages solely to the Contractor will not be considered.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
   1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
   2. Agrees to provide the same warranty for the substitution as for the specified product.
   3. Agrees to provide same or equivalent maintenance service and source of replacement parts, as applicable.
   4. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
   5. Waives claims for additional costs or time extension that may subsequently become apparent.
   6. Agrees to reimburse Owner and Engineer for review or redesign services associated with re-approval by authorities.

B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.

C. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.

D. Limit each request to a single proposed substitution item.
   1. Submit an electronic document, combining the request form with supporting data into single document.

3.02 SUBSTITUTION PROCEDURES DURING CONSTRUCTION

A. Submittal Form (after award of contract):
   1. Submit substitution requests by completing the form in Section 00 63 25; see this section for additional information and instructions. Use only this form; other forms of submission are unacceptable.

B. Submit request for Substitution for Cause within 14 days of discovery of need for substitution, but not later than 14 days prior to time required for review and approval by Engineer, in order to stay on approved project schedule.

C. Submit request for Substitution for Convenience within 14 days of discovery of its potential advantage to the project, but not later than 14 days prior to time required for review and approval by Engineer, in order to stay on approved project schedule.
   1. In addition to meeting general documentation requirements, document how the requested substitution benefits the Owner through cost savings, time savings, greater energy conservation, or in other specific ways.
   2. Document means of coordinating of substitution item with other portions of the work, including work by affected subcontractors.
   3. Bear the costs engendered by proposed substitution of:
      a. Owner's compensation to the Engineer for any required redesign, time spent processing and evaluating the request.
      b. Other construction by Owner.
      c. Other unanticipated project considerations.

D. Substitutions will not be considered under one or more of the following circumstances:
   1. When they are indicated or implied on shop drawing or product data submittals, without having received prior approval.
   2. Without a separate written request.
   3. When acceptance will require revisions to Contract Documents.

3.03 RESOLUTION

A. Engineer may request additional information and documentation prior to rendering a decision. Provide this data in an expeditious manner.

B. Engineer will notify Contractor in writing of decision to accept or reject request.

3.04 ACCEPTANCE

A. Accepted substitutions change the work of the Project. They will be documented and incorporated into work of the project by Change Order, Construction Change Directive, Architectural Supplementary Instructions, or similar instruments provided for in the Conditions of the Contract.

3.05 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. Include completed Substitution Request Forms as part of the Project record. Include both approved and rejected Requests.

END OF SECTION

SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General administrative requirements.

B. Submittals for review, information, and project closeout.

C. Number of copies of submittals.

D. Requests for Information (RFI) procedures.

E. Submittal procedures.

1.02 GENERAL ADMINISTRATIVE REQUIREMENTS

A. Comply with requirements of Section 01 70 00 - Execution and Closeout Requirements for coordination of execution of administrative tasks with timing of construction activities.

B. Make the following types of submittals to Engineer:
   1. Requests for Information (RFI).
   2. Requests for substitution.
   3. Shop drawings, product data, and samples.
   4. Test and inspection reports.
   5. Design data.
   6. Manufacturer's instructions and field reports.
   7. Applications for payment and change order requests.
   8. Progress schedules.
   9. Coordination drawings.
   10. Correction Punch List and Final Correction Punch List for Substantial Completion.
   11. Closeout submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 REQUESTS FOR INFORMATION (RFI)

A. Definition: A request seeking one of the following:
   1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than one place in Contract Documents.
   2. A resolution to an issue which has arisen due to field conditions and affects design intent.

B. Whenever possible, request clarifications at the next appropriate project progress meeting, with response entered into meeting minutes, rendering unnecessary the issuance of a formal RFI.

C. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
   1. Prepare a separate RFI for each specific item.
      a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
      b. Do not forward requests which solely require internal coordination between subcontractors.
   2. Prepare in a format and with content acceptable to Owner.
   3. Combine RFI and its attachments into a single electronic file.

D. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.

1. Include in each request Contractor's signature attesting to good faith effort to determine from Contract Documents information requiring interpretation.
2. Unacceptable Uses for RFIs: Do not use RFIs to request the following::
   a. Approval of submittals (use procedures specified elsewhere in this section).
   b. Approval of substitutions (see Section - 01 60 00 - Product Requirements)
   c. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Conditions of the Contract).
   d. Different methods of performing work than those indicated in the Contract Drawings and Specifications (comply with provisions of the Conditions of the Contract).
3. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.
4. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, Contract Documents, with no additional input required to clarify the question. They will be returned without a response, with an explanatory notation.
   a. The Owner reserves the right to assess the Contractor for the costs (on time-and-materials basis) incurred by the Engineer, and any of its consultants, due to processing of such RFIs.

E. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
1. Official Project name and number, and any additional required identifiers established in Contract Documents.
2. Owner's, Engineer's, and Contractor's names.
3. Discrete and consecutive RFI number, and descriptive subject/title.
4. Issue date, and requested reply date.
5. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).
6. Annotations: Field dimensions and/or description of conditions which have engendered the request.
7. Contractor's suggested resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.

F. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.

G. RFI Log: Prepare and maintain a tabular log of RFIs for the duration of the project.
1. Indicate current status of every RFI. Update log promptly and on a regular basis.
2. Note dates of when each request is made, and when a response is received.
3. Highlight items requiring priority or expedited response.
4. Highlight items for which a timely response has not been received to date.
5. Identify and include improper or frivolous RFIs.

H. Review Time: Engineer will respond and return RFIs to Contractor within seven calendar days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 3:00 PM will be considered as having been received on the following regular working day.
1. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.

I. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the project. If in Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.

1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended one is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.
2. Do not extend applicability of a response to specific item to encompass other similar conditions, unless specifically so noted in the response.
3. Upon receipt of a response, promptly review and distribute it to all affected parties, and update the RFI Log.
4. Notify Engineer within seven calendar days if an additional or corrected response is required by submitting an amended version of the original RFI, identified as specified above.

3.02 SUBMITTAL SCHEDULE

A. Submit to Engineer for review a schedule for submittals in tabular format.
   1. Submit at the same time as the preliminary schedule specified in Section - 01 32 16 - Construction Progress Schedule.
   2. Coordinate with Contractor's construction schedule and schedule of values.
   3. Format schedule to allow tracking of status of submittals throughout duration of construction.
   4. Arrange information to include scheduled date for initial submittal, specification number and title, submittal category (for review or for information), description of item of work covered, and role and name of subcontractor.
   5. Account for time required for preparation, review, manufacturing, fabrication and delivery when establishing submittal delivery and review deadline dates.
      a. For assemblies, equipment, systems comprised of multiple components and/or requiring detailed coordination with other work, allow for additional time to make corrections or revisions to initial submittals, and time for their review.

3.03 SUBMITTALS FOR REVIEW

A. When the following are specified in individual sections, submit them for review:
   1. Product data.
   2. Shop drawings.
   3. Samples for selection.
   4. Samples for verification.

B. Submit to Engineer for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.

C. Samples will be reviewed for aesthetic, color, or finish selection.

D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 78 00 - Closeout Submittals.

3.04 SUBMITTALS FOR INFORMATION

A. When the following are specified in individual sections, submit them for information:
   1. Design data.
   2. Certificates of Compliance.
   3. Certified Test Reports.
   4. Inspection reports.
   5. Manufacturer's instructions.
   6. Manufacturer's field reports.
   7. Other types indicated.

B. Submit for Engineer's knowledge as contract administrator or for Owner.

3.05 SUBMITTALS FOR PROJECT CLOSEOUT

A. Submit Correction Punch List for Substantial Completion.

B. Submit Final Correction Punch List for Substantial Completion.

C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 01 78 00 - Closeout Submittals:
   1. Project record documents.
   2. Operation and maintenance data.
   3. Warranties.
   4. Bonds.
   5. Other types as indicated.

D. Submit for Owner's benefit during and after project completion.

3.06 NUMBER OF COPIES OF SUBMITTALS

A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.

B. Samples: Submit the number specified in individual specification sections; one of which will be retained by Engineer.
   1. After review, produce duplicates.
   2. Retained samples will not be returned to Contractor unless specifically so stated.

3.07 SUBMITTAL PROCEDURES

A. General Requirements:
   1. Use a separate transmittal for each item.
   2. Submit separate packages of submittals for review and submittals for information, when included in the same specification section.
   3. Transmit using approved form.
      a. Use form included at the end of this Section.
      b. Use Contractor's form, subject to prior approval by Engineer.
   4. Sequentially identify each item. For revised submittals use original number and a sequential alphabetical suffix.
   5. Submittal numbering:
      a. First character identifies type of submittal:
         1) "D" for drawings (shop, working, layout)
         2) "S" for samples
         3) "M" for manual or miscellaneous
         4) "P" for plan or schedule
      b. Next six digits identify the Specification section number.
      c. Next three digits, starting with 001, sequentially identify each separate item submitted under each Specification section number.
      d. Last character identifies the submittal iteration. The first submission is labeled "A" and resubmissions are labeled starting with "B".
      e. An example of a submittal number would be D-033000-008-B, which indicates a shop drawing submittal pertaining to Cast-in-Place Concrete Section 03 30 00 that is the eighth submittal under this Section and is the second submission of this particular shop drawing.
   6. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
   7. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
      a. Submittals from sources other than the Contractor, or without Contractor's stamp will not be acknowledged, reviewed, or returned.
   8. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties, and is of the benefit to the project.
      a. Send submittals in electronic format via email to Engineer as agreed upon at Preconstruction Meeting.

9. Schedule submittals to expedite the Project, and coordinate submission of related items.
    a. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.
        1) Upon review of Contractor's submittal schedule, Engineer may request a reasonable amount of additional days for a limited number of large submittals or in a limited number of cases where the Contractor plans to furnish multiple submittals in a short period of time.
        2) Reasonable time for Engineer's review of required re-submissions shall not entitle the Contractor to a change in Contract Times.
    b. For sequential reviews involving Engineer's consultants, Owner, or another affected party, allow an additional 7 days.
    c. For sequential reviews involving approval from authorities having jurisdiction (AHJ), in addition to Engineer's approval, allow an additional 30 days.
10. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
11. Provide space for Contractor and Engineer review stamps.
12. When revised for resubmission, identify all changes made since previous submission.
13. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.
14. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work, and have received prior approval for their use.
15. Submittals not requested will not be recognized or processed.

B. Product Data Procedures:
    1. Submit only information required by individual specification sections.
    2. Collect required information into a single submittal.
    3. Do not submit (Material) Safety Data Sheets for materials or products.
    4. Submit manufacturer's standard schematic drawings:
        a. Modify drawings to delete information that is not applicable to the project.
        b. Supplement standard information to provide additional information applicable to project.
    5. Submit manufacturer's catalog sheets, brochures, diagrams, schedules, performance charts, illustrations, and other standard descriptive data.
        a. Clearly mark each copy to identify pertinent materials, products or models.
        b. Show dimensions and clearances required, performance characteristics and capabilities, wiring diagrams and controls, and any other pertinent data applicable to the project.
    6. Submit manufacturer's certificate of compliance certifying to compliance with specification requirements, applicable reference standards and test data requirements. Include reference to the specification section and paragraph with which the product or materials is intended to comply.

C. Shop Drawing Procedures:
    1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
    2. Identify details by reference to sheet and detail numbers shown on Contract Drawings. Use same symbols used on Contract Drawings to identify shop drawing details wherever practicable.
    3. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.

D. Samples Procedures:
    1. Transmit related items together as single package.
    2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.

3.08 SUBMITTAL REVIEW

A. Submittals for Review: Engineer will review each submittal, and approve, or take other appropriate action. Do not begin work that requires submittals until the Engineer reviews and approves the submittals.

B. Submittals for Information: Engineer will acknowledge receipt and review. See below for actions to be taken.

C. Engineer's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.
   1. Notations may be made directly on submitted items and/or listed on appended Submittal Review cover sheet.

D. Engineer's and consultants' actions on items submitted for review:
   1. Authorizing purchasing, fabrication, delivery, and installation:
      a. "NET", or language with same legal meaning.
      b. "MCN", which means Make Corrections Noted, and that the submittal is approved subject to incorporation of the comments shown on the submittal.
         1) At Engineer's option, submit corrected item, with review notations acknowledged and incorporated.
   2. Not Authorizing fabrication, delivery, and installation:
      a. "A&R", which means Amend and Resubmit.
         1) Resubmit revised item, with review notations acknowledged and incorporated.
         2) Non-responsive resubmittals may be rejected.
      b. "Rejected".
         1) Submit item complying with requirements of Contract Documents.

E. Engineer's and consultants' actions on items submitted for information:
   1. Items for which no action was taken:
      a. "Received", "Noted" ("N"), or "Not Reviewed" ("NR") - to notify the Contractor that the submittal has been received for record only.
   2. Items for which action was taken:
      a. "Reviewed" - no further action is required from Contractor.

F. Engineer’s review is for general conformance with the Contract Documents only, and all work is still subject to the detailed requirements of the Contract Documents.

G. Engineer’s review of submittals does not relieve Contractor's responsibility to coordinate and plan the details of the Work and fulfill the intent and purpose of the Contract Documents, nor the accuracy, proper fit or proper functioning and performance of the Work.

H. Engineer's review of submittals does not relieve Contractor’s responsibility for errors and omissions in submittals, or for deviations in submittals from requirements of the Contract Documents, unless Engineer gives written acceptance of specific deviations.

01 30 00-A SUBMITTAL TRANSMITTAL FORM

(THIS FORM TO BE ENCLOSED WITH ALL SUBMITTALS)

		SEQ. #	
SUBMITTAL DESCRIPTION:		SUBMITTAL #:	
SPECIFICATION SECTION	ROUTING	DATE SENT	DATE REC'D
OWNER:	CONTRACTOR/ENGINEER		
PROJECT:			
CONTRACTOR:			

WE ARE SENDING YOU: ____ ATTACHED
____ UNDER SEPARATE COVER VIA _____
____ SUBMITTALS FOR REVIEW AND COMMENT
____ PRODUCT DATA FOR INFORMATION ONLY

REMARKS:

ITEM	COPIES	DATE	SECTION NO.	DESCRIPTION	REVIEW ACTION (1)	REVIEWER INITIALS	REVIEW COMMENTS ATTACHED

(1) NOTE: NET = NO EXCEPTIONS TAKEN
MCN = MAKE CORRECTIONS NOTES
A&R = AMEND & RESUBMIT
R = REJECTED, DEVELOP REPLACEMENT

CONTRACTOR

CERTIFY EITHER A OR B:

____	A	WE HAVE VERIFIED THAT THE MATERIAL OR EQUIPMENT CONTAINED IN THIS SUBMITTAL MEETS ALL THE REQUIREMENTS, INCLUDING COORDINATION WITH ALL RELATED WORK, SPECIFIED (NO EXCEPTIONS).
____	B	WE HAVE VERIFIED THAT THE MATERIAL OR EQUIPMENT CONTAINED IN THIS SUBMITTAL MEETS ALL THE REQUIREMENTS SPECIFIED, EXCEPT FOR THE ATTACHED REVISIONS.

#	DEVIATION

END OF SECTION

SECTION 01 31 19
PROJECT MEETINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Required meetings through duration of project:
   1. Pre-Construction Conference
   2. Progress Meetings
   3. Pre-Pour Structural Concrete Conference
   4. Pre-Installation Conference
   5. Pre-Paint Conference
   6. Pre-Startup Conference
   7. Substantial Completion Inspection
   8. Final Inspection
   9. Warranty Inspection

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 ATTENDANCE REQUIRED

A. Unless otherwise specified or required by the Owner, the meetings shall be attended by the following:
   1. Owner
   2. Engineer
   3. Contractor
   4. Subcontractors may attend when invited by Owner.

3.02 MEETING RECORDS

A. The Engineer or its designated representative will record minutes of each meeting and furnish copies to the attendees within 5 working days thereafter.

B. If none of the attendees submit written objection to the contents of such minutes within 7 days of receipt, it shall be understood and agreed that all parties accept the minutes as a true record of the meeting.

3.03 MEETING SCHEDULE

A. Meeting dates, times and locations for the various meetings will be agreed upon and recorded at the Pre-Construction Conference, to the extent possible. Subsequent changes to the schedule shall be by agreement between the Owner and the Contractor with written notice to all parties.

3.04 PRE-CONSTRUCTION CONFERENCE

A. Schedule conference after Notice of Award.

B. Location: Water Treatment Plant

C. Facilitated by: Engineer

D. Attendance Required by:
   1. Owner.
   2. Engineer.
   3. Contractor.
   4. Contractor's Superintendent
   5. Subcontractors may attend when invited by Owner or Contractor.

E. Submittals:
   1. Prior to the meeting, the Contractor shall have already submitted the Contract Agreement, Bonds and Certificates of Insurance. The Owner will return signed copies of the Agreement to the Contractor at the meeting. At the meeting, the Contractor shall distribute

and discuss its submitted (or to-be-submitted) Progress Schedule, Schedule of Submittals, Schedule of Values and other preconstruction documents required by the Contract Documents.

F. Agenda Items:
   1. Contract Items:
      a. Contract Documents distribution. Owner will supply copies at meeting (unless Owner and Contractor have agreed to electronic execution/exchange of Contract Documents).
      b. Notice to Proceed (NTP) date. Owner will supply executed NTP to Contractor or discuss its anticipated timeline for doing so.
      c. Applications for Payment process, including medium of applications (electronic or hardcopy), forms, dates and progress reports and schedules to accompany the application.
      d. Contractor's forecast of the dollar value of work to be performed and invoiced each month (i.e. "burn rate" projection).
      e. Field Order, Work Change Directive, and Change Order processing.
      f. Wage Compliance, DBE/MBE and/or EEO Requirements, On the Job Training Program
      g. Requirements of funding agencies.
   2. Project Staff and Communications:
      a. Owner's organization for the project.
         1) Owner's authorized representative(s) who will have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of the Owner.
      b. Engineer, Inspector and their duties.
      c. Contractor's organization for the project.
         1) Contractor's authorized representative(s) who will have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of the Contract.
         2) Subcontractors.
      d. Procedures for handling Shop Drawings, Samples, and other Submittals.
      e. Electronic and digital transmittals.
      f. Communication channels and procedures.
      g. Project sign board.
   3. Scheduling:
      a. Construction schedule including the sequence of critical work.
         1) Contractor shall provide 5 hard copies of the schedule at the meeting.
      b. Progress schedule updates
      c. Project meeting schedule
      d. Pre-survey conference and initiation of surveying activities and control provided by the Owner
      e. Other project conferences schedules
   4. Permits:
      a. Mesa County Building Permit
      b. Mesa County Planning Clearance
      c. CDPHE Section 9 Permitting
      d. Other CDPHE permits/approvals.
      e. Other permit requirements.
   5. Project Execution:
      a. Access and Rights-of-Way provided by Owner.
      b. Site security and Contractor's use of the site.
      c. Safety and First Aid. Contractor to supply resume of his Safety Officer.
      d. Contractor Quality Control and Owner Acceptance (Quality Assurance) testing.

e. Construction equipment and methods proposed by Contractor.
f. Dewatering methods proposed by the Contractor.
g. Maintaining existing facilities operation or utilities service. Advance notice requirements/processes for shutdowns.
h. Construction utilities, permanent utilities and existing utility and railroad requirements.
i. Subsurface Utilities Engineering (SUE) study findings or existing utilities locations.
j. Items requiring early procurement.

6. Other administrative and general matters as needed.

3.05 PROGRESS MEETINGS

A. Weekly construction meetings.
1. Location: Project Site/WTP Office
2. Facilitated by: Engineer
3. Attendance Required by:
   a. Owner
   b. Engineer
   c. Engineer's Representative.
   d. Contractor
   e. Contractor's Superintendent.
4. Submittals prior to the meeting:
   a. Meeting agenda
   b. Look-ahead schedule
5. Agenda Items:
   a. Review of work progress.
   b. Field observations, problems, and decisions.
   c. Identification of problems that impede, or will impede, planned progress.
   d. Review of submittals schedule and status of submittals.
   e. Review of RFIs log and status of responses.
   f. Review of off-site fabrication and delivery schedules.
   g. Planned progress during succeeding work period. (Contractor's 2-week look-ahead schedule).
   h. Effect of proposed changes on progress schedule and coordination.
   i. Other business relating to work.

3.06 CONSTRUCTION COORDINATION MEETINGS

A. Pre-Pour Structural Concrete Conference - prior to any concrete work.
1. Location: Project Site
2. Facilitated by: Engineer
3. Attendance Required by:
   a. Engineer
   b. Engineer's Representative.
   c. Contractor.
4. Agenda Items:
   a. Pre-placement:
      1) Concrete mix design review and approval status.
      2) Plan and specfication requirements.
      3) Rebar placement and inspection.
      4) Formwork.
      5) Joints (construction, expansion and control).
      6) Cleaning of forms and pre-wetting of rebar.
   b. Placement:
      1) Schedule.
      2) Weather.
      3) Contingency plans for weather, breakdowns.

4) Truck and pump access.
5) Water addition.
6) Finishes.
7) Safety.

c. Post-placement:
1) Curing (methods, time, materials).
2) Protection (loading, weather).

d. Testing
1) Aggregate stockpile testing.
2) Sampling locations and methods
3) Concrete process/quality control testing by Contractor or Supplier.
4) Concrete acceptance/quality assurance testing by Owner.
5) Concrete rejection.
6) Batch ticket collection.

e. Other items related to Section 03 30 00 - Cast-in-Place Concrete.

B. Pre-Installation Conference - when required by the Technical Specifications.
1. Location: Project Site
2. Facilitated by: Engineer
3. Attendance Required by:
a. Engineer
b. Engineer's Representative
c. Owner's facility staff
d. Contractor
e. Subcontractors
4. Agenda Items:
a. Equipment, electrical and controls installation.
b. Site conditions
c. Preparation requirements and logistics.
d. Utilities.
e. Installation procedures.
f. Testing requirements/logistics, if applicable.

C. Pre-Paint Conference - prior to any painting, coating or marking.
1. Location: Project Site
2. Facilitated by: Engineer's Representative
3. Attendance Required by:
a. Engineer
b. Engineer's Representative
c. Owner's plant staff
d. Contractor
e. Painting subcontractor
4. Agenda Items:
a. Items requiring painting, coatings, marking or staining.
b. Items not to be painted.
c. Storage, painting and mixing areas.
d. Safety requirements.
e. Colors and textures.
f. Testing, if applicable.
g. Mock-ups, if applicable.
h. Notable surface preparation, ventilation, or curing considerations.

D. Pre-Startup Conference - prior to startup of any equipment component, sub-system or system in accordance with Section 01 45 00 - Quality Control and 01 75 16 - Startup Procedures.
1. Location: Project Site

2. Facilitated by: Engineer's Representative
3. Attendance Required by:
    a. Engineer
    b. Engineer's Representative
    c. Owner's plant staff
    d. Contractor
    e. Startup Engineer
    f. Subcontractors
    g. Equipment manufacturers
4. Agenda Items:
    a. Startup and validation prerequisites.
    b. Startup plan and schedule.
    c. Temporary connections.
    d. Spare parts, chemicals and operating fuels.
    e. Coordination with Owner's plant staff.

E. Other Meetings. Upon appropriate notice to the other parties, other meetings may be called by the Owner or the Contractor. These meetings will be held where and when designated by the Owner for separate contracts nearby, regulatory agencies having jurisdiction or related to the work of this project regarding requirements, coordination and cooperation between parties involved.

3.07 COMPLETION MEETINGS

A. Substantial Completion Inspection - after Contractor has notified Owner and Engineer in writing that the entire Work is substantially complete (except for items specifically listed by Contractor as incomplete).
1. Location: Project Site
2. Facilitated by: Engineer
3. Attendance Required by:
    a. Engineer
    b. Engineer's Representative
    c. Owner
    d. Contractor
    e. Project funding agency representatives

B. Post-Construction Conference - prior to final inspection, testing and startup to discuss and resolve any unsettled matters.
1. Location: Project Site
2. Facilitated by: Engineer
3. Attendance Required by:
    a. Engineer
    b. Engineer's Representative
    c. Owner's plant staff
    d. Contractor
4. Agenda Items:
    a. Test procedure plan
    b. Other documents and spare parts required to be submitted by the Contractor will be reviewed and discrepancies determined
    c. Schedules for final inspection and procedures for the process of final correction of deficiencies.

C. Final Inspection - after Contractor has notified Owner and Engineer in writing that the entire Work or an agreed portion thereof is complete.
1. Location: Project Site
2. Facilitated by: Engineer
3. Attendance Required by:

a. Engineer
b. Engineer's Representative
c. Owner
d. Contractor

D. Warranty Inspection - between 30 and 60 days prior to expiration of Warranty period.
1. Location: Project Site
2. Facilitated by: Engineer
3. Attendance Required by:
a. Engineer
b. Owner
c. Contractor

END OF SECTION

SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preliminary Schedule.

B. Baseline Schedule.

C. Progress Schedule Updates.

D. Weekly Planning Schedule.

E. Revised Schedule.

F. As-Built Schedule.

G. Construction progress schedule, with network analysis diagrams and reports.

H. Time Impact Analysis for Change Orders, Delays and Contractor Requests.

1.02 DEFINITIONS

A. *Activity (Task)*. A portion of the project that requires time or resources to complete. An activity has a description, start date, finish date, duration, and one or more logic ties. A critical activity is an activity on the critical path.

B. *Activity ID*. A unique, alphanumeric, identification code assigned to an activity that remains constant throughout the project. Baseline Schedule. The original, approved project schedule before the project begins with no progress.

C. *Calendar*. Defined work periods and no work periods that determine when project activities can occur. Multiple calendars may be used.

D. *Constraint*. A restriction imposed in a schedule, which fixes a value that would otherwise be calculated within the schedule. Examples of values that can be fixed by a constraint include start date, end date, and completion date.

E. *Critical Path Method (CPM) Scheduling*. CPM Scheduling is a logic-based planning technique using activity durations and relationships between activities to calculate a schedule determining the minimum total project duration and the interdependencies of all activities.

F. *Critical Path*. The longest logical path through the CPM network driven by calendars, constraints, and activity logic. It consists of activities that determine the shortest time for project completion and the sequence of activities such that a delay to any of the activities on the critical path will prolong contractual project milestones, such as project completion.

G. *Data Date*. The starting point from which to schedule all remaining work. It can also be considered the cut-off date wherein all work before this date has actual starts, actual finishes, or both.

H. *Duration*. The estimated amount of time needed to complete an activity.

I. *Free Float (Free Slack)*. The amount of time an activity can be delayed without delaying the Early Start or Early Finish of its successor activity or activities.

J. *Gantt Chart*. A time-scaled graphical display of the project's schedule. Lag. A time-value assigned to a relationship.

K. *Logic*. Relationships between activities defining the sequence of work (See also predecessor activity and successor activity).

L. *Major Subcontractor*. A subcontractor with a total amount of subcontracted work that exceeds 5% of the total value of the construction contract.

M. *Milestone*. An activity, with zero duration used to represent an event.

N. *Near Critical Activity.* An activity with a total float of five days or fewer, or as defined by the Engineer.

O. *Open-Ended Activity*. An activity that does not have a predecessor activity and a successor activity, or only has a start- to-start as a predecessor or finish-to-finish as a successor.

P. *Planned Completion Date*. The date that the schedule shows work is planned to be completed. Predecessor Activity. An activity that is defined by schedule logic to precede another activity. Relationship. The interdependence between activities.

Q. *Successor Activity.* An activity that is defined by schedule logic to follow another activity.

R. *Time-Scaled Logic Diagram*. Gantt chart that illustrates logic links depicting both schedule logic and the time that activities are performed.

S. *Total Float (Total Slack)*. The amount of time between the earliest date an activity can start and the latest date when an activity must start, or the earliest date an activity can finish and latest date when an activity can finish before the activity causes a delay to the time specified in the Agreement.

1.03 SUBMITTALS

A. Within 10 calendar days after date of Agreement, Contractor may submit a preliminary Progress Schedule defining planned operations for the first 60 days of Work, with a general outline for remainder of Work.

B. If preliminary Progress Schedule requires revision after review, submit revised schedule within 10 days.

C. If Contractor elects to not submit a preliminary Progress Schedule, then a complete Baseline Schedule shall be submitted within 14 days after date of Agreement.

D. Within 45 calendar days after review of preliminary Progress Schedule, submit Baseline Schedule.

E. Submit updated Progress Schedule with each Application for Payment.

F. Submit a 2-week look-ahead planning schedule to the Engineer every week at the same time these are provided to the Contractor's staff.

G. Within 14 calendar days after Substantial Completion, submit As-Built Schedule

H. Submit in PDF format and native file format on USB flash drive or via other media as directed by Engineer.

I. Label each schedule as appropriate such as Preliminary Schedule, Baseline Schedule, Project Schedule Update, Revised Schedule, or As-Built Schedule.
   1. Include project number and project name in the title bar.
   2. If an originally submitted schedule is revised during review, include a revision number (REV1, REV2, etc.) revision date, and submission date in the title bar.

J. Submit under transmittal letter form specified in Section 01 30 00 - Administrative Requirements.

1.04 QUALITY ASSURANCE

A. Scheduler: Contractor's personnel or specialist Consultant specializing in CPM scheduling with one years minimum experience in scheduling construction work of a complexity comparable to this Project, and having use of computer facilities capable of delivering a detailed graphic printout within 48 hours of request.

B. Contractor's Administrative Personnel: ____ years minimum experience in using and monitoring CPM schedules on comparable projects.

1.05 SCHEDULE FORMAT

A. Listings: In chronological order according to the start date for each activity. Identify each activity with the applicable specification section number.

B. Scale and Spacing: To allow for notations and revisions.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRELIMINARY SCHEDULE

A. Prepare Preliminary Schedule in the form of a preliminary network diagram.

B. Include with the Preliminary Schedule a Job Progress Narrative Report that includes the following:
   1. Narrative of the critical and near critical work activities. The narrative is to include:
      a. Real or perceived risks and assumptions.
      b. Production rates.
      c. Activities that are the Contractor's and Owner's responsibilities.
      d. Third party activities.
      e. Long lead procurement items.
   2. Narrative of planned work on night shifts or planned work that will require approval from the Owner or other agencies.
   3. Description of site mobilization (such as dates of expected material shipments, planned dates for equipment arrivals, office setup, etc.).
   4. List of the fabrication and delivery of key and long-lead procurement activities.

C. Preliminary Schedule shall not show any progress.

D. Preliminary Schedule shall be used as the basis for the Baseline Schedule.

E. Engineer must approve Preliminary Schedule before work can commence.

3.02 BASELINE SCHEDULE

A. Prepare Baseline Schedule in the form of a network diagram.

B. Include with the Baseline Schedule a Job Progress Narrative Report that includes the following:
   1. Narrative of the critical and near critical work activities. The narrative is to include:
      a. Real or perceived risks and assumptions.
      b. Production rates.
      c. Activities that are the Contractor's and Owner's responsibilities.
      d. Third party activities.
      e. Long lead procurement items.
   2. Narrative, including attachments if appropriate, of all of the project's calendars. This narrative shall explain work and non-work periods as well as special weather dependent calendars. A list of the calendars used in the schedule, a description of each calendar's work and non-workdays, a list of the activities using each calendar, and an explanation of how the calendar applies to that work.
   3. Narrative of planned work on night shifts or planned work that will require approval from the Owner or other agencies.
   4. List of all added and deleted activities from the Preliminary Schedule along with a brief explanation for the change, if applicable.
   5. Logic and duration changes to any activity from the Preliminary Schedule along with an explanation for changes to any critical and near critical activities.
   6. Description of site mobilization (such as dates of expected material shipments, planned dates for equipment arrivals, office setup, etc.).
   7. List of the fabrication and delivery of key and long-lead procurement activities.

C. Baseline Schedule shall not show any progress.

D. If a Baseline Schedule is submitted in lieu of a Preliminary Schedule, Engineer must approve Baseline Schedule before work can commence.

E. Further partial payments will not be made beyond 60 days after the start of Contract Time unless the Baseline Schedule is approved.

F. When approved, the Baseline Schedule shall become the Project Schedule.

3.03 PROJECT SCHEDULE UPDATES

A. Prepare monthly Project Schedule updates through the cut-off date for each Application for Payment and include a projection for completing all remaining activities.

B. Included with each Project Schedule Update submittal a Job Progress Narrative Report that includes the following:
   1. Description of the work performed since the previous month's schedule update.
   2. Description of changes to any items in the baseline, preliminary, and revised schedules.
   3. Description of problems encountered or anticipated since the previous month's schedule submission.
   4. Description of unusual labor, shift, equipment, or material conditions or restrictions encountered or anticipated.
   5. Status of all pending items that could affect the schedule.
   6. Explanations for milestones forecasted to occur late.
   7. Scheduled completion date status and any change from the previous month's submission.
   8. Explanation for a scheduled completion date forecasted to occur before or after the contract completion date or contract time.
   9. Schedule Delays:
      a. Description of current and anticipated delays including identification of the delayed activity or activities by Activity ID(s) and description(s).
      b. Effect of the delay on other activities, milestones, and completion dates.
      c. Identification of the actions needed to avoid a potential or mitigate an actual delay.
      d. Description of the critical path impact and effect on the scheduled completion date in the previous month's schedule update.
   10. Explanation of any critical and near critical work that is not progressing as planned.
   11. List of all added and deleted activities along with a brief explanation for the change.
   12. Logic and duration changes to a critical or near critical activity along with an explanation for the change.
   13. For working day contracts, a list of planned non-working days with actual work.

C. Schedule update may show a completion date that is different than the Contract completion date. Approval of this schedule shall not relieve the Contractor of its obligation to complete the work within the Contract Time.

D. When approved, the Project Schedule Update will become the Project Schedule.

E. Monthly progress payment will be withheld if Project Schedule Update is not received. Monthly progress payments for the months following the update submission will be withheld until the Engineer approves or approves-as-noted the Project Schedule Update or Revised Schedule.

3.04 WEEKLY PLANNING SCHEDULE

A. Prepare weekly look-ahead planning schedules that include activities for that week and the following 2 weeks.

B. Weekly Planning Schedule may be a Gantt chart, bar chart or calendar grid based on the Project Schedule that shows all planned activities for the look-ahead period.

C. Weekly Planning Schedule shall include the description, duration and sequence of work activities in the look-ahead period.

3.05 REVISED SCHEDULE

A. Prepare a Revised Schedule in the event of any major change to the work. Examples of major changes are:
   1. Significant changes in logic or methods of construction or changes to the critical path;
   2. Addition, deletion, or revision of activities required by Change Order;
   3. Approval of a Contractor submitted Value Engineering Change Proposal;
   4. Delays in milestones or project completion;
   5. Phasing revisions;
   6. When the Engineer determines that the schedule has a fatal flaw; or
   7. When the work cannot be constructed as scheduled.

B. Include with the Revised Schedule a Job Progress Narrative Report that includes the following:
   1. Narrative of the critical and near critical work activities. The narrative is to include:
      a. Real or perceived risks and assumptions.
      b. Production rates.
      c. Activities that are the Contractor's and Owner's responsibilities.
      d. Third party activities.
      e. Long lead procurement items.
   2. Narrative, including attachments if appropriate, of all of the project's calendars. The narrative is to include:
      a. Explanation of work and non-work periods and special weather dependent calendars.
      b. A list of the calendars used in the schedule.
      c. A description of each calendar's work and non-workdays.
      d. A list of the activities using each calendar, and an explanation of how the calendar applies to that work.
   3. Narrative of planned work on night shifts or planned work that will require approval from the Owner or other agencies.
   4. List of all added and deleted activities along with a brief explanation for the change.
   5. Logic and duration changes to any activity along with an explanation for changes to any critical and near critical activities.
   6. Description of site mobilization (such as dates of expected material shipments, planned dates for equipment arrivals, office setup, etc.).
   7. List of the fabrication and delivery of key and long-lead procurement activities.

C. When approved, the Revised Schedule shall become the Project Schedule.

3.06 AS-BUILT SCHEDULE

A. Prepare a final update that shows all work through the Substantial Completion date with actual activity start and finish dates.

B. As-Built Schedule will have no logic and no critical path.

C. As-Built Schedule shall be certified by the Contractor's Project Manager as an accurate representation of how the work was completed.

D. Release of retainage will be withheld until the Engineer approves or approves-as-noted the As-Built Schedule.

3.07 CONTENT

A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.

B. Identify each item by specification section number.

C. Identify work of separate stages and other logically grouped activities.

D. Provide sub-schedules for each stage of Work identified in Section 01 11 00 - Summary of Work.

E. Provide sub-schedules to define critical portions of the entire schedule.

F. Include conferences and meetings in schedule.

G. Include each submittal as an individual activity and add a new activity for each resubmittal.

H. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.

I. Provide separate schedule of submittal dates for shop drawings, product data, and samples, owner-furnished products, products identified under Allowances, and dates reviewed submittals will be required from Engineer. Indicate decision dates for selection of finishes.

J. Indicate delivery dates for owner-furnished products.

K. Include schedule impacts arising from normally anticipated weather conditions in the Project Schedule and document assumptions for these weather-related schedule impacts.

L. Coordinate content with schedule of values specified in Section 01 20 00 - Price and Payment Procedures.

M. Provide legend for symbols and abbreviations used.

3.08 NETWORK ANALYSIS

A. Prepare network analysis diagrams and supporting mathematical analyses using the Critical Path Method for all Project Schedule submittals.

B. Illustrate order and interdependence of activities and sequence of work; how start of a given activity depends on completion of preceding activities, and how completion of the activity may restrain start of subsequent activities.

C. Provide time-scaled logic diagrams plotted on a horizontal timescale per the project calendar that clearly identifies the critical path in a unique color.

D. Mathematical Analysis: Tabulate each activity of detailed network diagrams, using calendar dates, and identify for each activity:
   1. Preceding and following event numbers.
   2. Activity description.
   3. Estimated duration of activity, in maximum 15 day intervals. A series of activities with an aggregate duration of five workdays or less may be grouped into a single activity.
   4. Earliest start date.
   5. Earliest finish date.
   6. Actual start date.
   7. Actual finish date.
   8. Latest start date.
   9. Latest finish date.
   10. Total and free float; float time shall accrue to Owner and to Owner's benefit.
   11. Monetary value of activity, keyed to Schedule of Values.
   12. Percentage of activity completed.
   13. Responsibility.

E. Do not use the following in the Network Analysis, unless approved by the Engineer:
   1. Negative lags.
   2. Lags in excess of 10 work days
   3. Start-to-finish relationships.
   4. Open-ended activities.
   5. Constraints.

F. Analysis Program: Capable of compiling monetary value of completed and partially completed activities, accepting revised completion dates, and recomputation of all dates and float.
   1. Microsoft Project scheduling software shall be used.

G. Float is not for the exclusive use or benefit of either party, but is a project resource available to both parties as needed until it is depleted.

H. Required Reports:
   1. Predecessor Activity and Successor Activity report that defines all schedule logic and indicates all logical relationships and constraints..
   2. Early Start report listing all activities, sorted by actual start/early start date.
   3. Float report listing all activities sorted in ascending order of available float.
   4. Critical Path report listing all activities not yet complete with the percent complete, sorted by float and then by early start.
   5. Listing of all non-workdays

3.09 REVIEW AND EVALUATION OF SCHEDULE

A. Engineer will review the schedules and provide responses within the following days after receipt of the submittal:
   1. Preliminary Schedule: 10 days
   2. Baseline Schedule: 15 days
   3. Progress Schedule updates: 10 days
   4. Revised schedules: 15 days

B. Engineer response will be one of the following:
   1. Approved, no exceptions taken;
   2. Approved-as-Noted; or
   3. Revise and Resubmit within 10 days.

C. Approval of the Project Schedule shall not relieve the Contractor of any contract requirement including the requirement to complete all work within the Contract Time. Contractual requirements shall not change by submission or approval of a schedule, unless specifically amended by a Change Order.

D. Participate in joint review and evaluation of schedule with Engineer at each submittal.

E. Evaluate project status to determine work behind schedule and work ahead of schedule.

F. After review, revise as necessary as result of review, and resubmit within 10 days.

3.10 UPDATING SCHEDULE

A. Maintain schedules to record actual start and finish dates of completed activities.

B. Indicate progress of each activity to date of revision, with projected completion date of each activity.

C. Annotate diagrams to graphically depict current status of Work.

D. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.

E. Indicate changes required to maintain Date of Substantial Completion.

F. Submit reports required to support recommended changes.

G. Provide narrative report to define problem areas, anticipated delays, and impact on the schedule. Report corrective action taken or proposed and its effect.

3.11 DISTRIBUTION OF SCHEDULE

A. Distribute copies of updated schedules to Contractor's project site file, to subcontractors, suppliers, Engineer, Owner, and other concerned parties.

B. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

3.12 TIME IMPACT ANALYSIS FOR CHANGE ORDERS, DELAYS & CONTRACTOR REQUESTS

A. When initiating Change Orders or delays are experienced, complete a Time Impact Analysis to determine the effect on the Contract Completion Date.

B. Mutually agree on any necessary changes to the durations of affected activities and recalculate the Project Schedule.

C. Do not extend Contract Time unless the schedule recalculation shows a completion date beyond the current Contract Completion Date.

D. A delay must impact the critical path of the Project Schedule as a condition to extending the Contract Completion Date.

E. Review delays caused by weather at the monthly Progress Meetings.

F. Consider seasonal weather conditions and include them in the planning and scheduling of all Work influenced by high or low ambient temperatures, wind, and/or precipitation to ensure completion of all Work within the Contract Time(s).

G. Seasonable weather conditions shall be determined by an assessment of average historical climatic conditions.

H. Float is not for the exclusive use or benefit of either the Owner or the Contractor.

I. Extension of the Contract Time will be granted only to the extent the equitable time adjustments to the activity or activities affected by the Change Order or delay exceeds the total (positive or zero) float of a critical activity (or path) and extends the Contract Time as set forth in the Agreement.

END OF SECTION

SECTION 01 35 23
OWNER SAFETY REQUIREMENTS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. Occupational Safety and Health Administration (OSHA) Regulations
   1. 29 CFR 1910 - Occupational Safety and Health Standards
   2. 29 CFR 1926 - Safety and Health Regulations for Construction

1.02 SAFETY AND HEALTH PROVISIONS

A. Personnel.
   1. Project Safety Manager
      a. Before the start of construction, designate a Project Safety Manager and an alternate, who will be responsible for the coordination of safety activities, and preparation, certification, and implementation of the Project Safety Management Plan.
   2. Competent Persons.
      a. Before the start of construction, designate at least one competent person for each of the construction activities being completed.
      b. A competent person is an individual who, by way of training, experience, or combination thereof, is knowledgeable of applicable standards, is capable of identifying existing and predictable workplace hazards relating to a specific construction activity, is designated by the employer, and has authority to take prompt, appropriate actions.
      c. Construction activities and safety considerations that must be addressed by the Plan and by designation of a competent person include, but are not limited to (if applicable to the project):
         1) Concrete placement.
         2) Lead abatement.
         3) Hearing protection.
         4) Respiratory protection.
         5) Rigging.
         6) Assured grounding.
         7) Scaffolding.
         8) Fall protection.
         9) Use of cranes.
         10) Trenching and excavating.
         11) Steel erection.
         12) Underground construction (including caissons and cofferdams).
         13) Demolition.
         14) Blasting and the use of explosives.
         15) Stairways and ladders.
         16) Asbestos.
         17) Confined space.
      d. The appropriate competent persons shall be present on the project site at all times during the specific construction activities that require those competent persons.

B. Project Safety Management Plan.
   1. Before the start of construction, the Contractor's Project Safety Manager shall prepare a written Project Safety Management Plan, which shall be specific to the project. The Plan shall include:
      a. Designation of a Project Safety Manager and an alternate, including names and contact information, and competent persons for each applicable construction activity.
      b. A list of all significant or high-risk construction activities, safety considerations, and a hazard assessment for each.

c. Appropriate measures are to be implemented to address identified hazards. Measures may include engineering, administrative, personal protection measures, training, or a combination thereof.
d. Field Safety Meetings.
    1) Contractor to conduct field safety meetings (also known as Toolbox or Tailgate meetings) at the frequency specified in the Project Safety Management PlanPlan
    2) Minimum frequecy of one meeting per week.
    3) Participation by all persons working at the project site is to be required by the Contractor.
    4) Discuss specific construction activities for that work period, results from safety inspections, required personal protective equipment, and all other necessary safety precautions.
e. Project Safety Meetings. In the event of a safety stand-down, the Contractor shall conduct a project safety meeting to discuss the circumstances leading to the stand-down, and the measures that shall be taken to prevent a recurrence. The Contractor shall notify the Engineer and Owner of the time, date, and location of these meetings, shall require participation by all persons working at the project site, and shall track attendance through sign-up lists.
    1) In the event of a safety stand-down, the Contractor shall conduct a project safety meeting to discuss the circumstances leading to the stand-down, and the measures that are to be taken to prevent a recurrence.
    2) The Contractor shall notify the Engineer and Owner of the time, date, and location of these meetings
    3) Participation by all persons working at the project site is to be required by the Contractor.
    4) Track attendance with sign-up lists.
f. Procedures for assuring compliance by subcontractors, suppliers, and authorized visitors to the project.
g. Measures that will be taken to discourage unauthorized personnel from entering the site.
h. Procedures to be followed in cases where workers are suspected of drug or alcohol impairment.
i. Project Safety Inspections.
    1) Project Safety Manager to conduct regular project safety inspections at the frequency specified in the Project Safety Management Plan.
    2) Minimum frequecy of one inspection per month.
    3) Contractor to notify the Engineer in advance of these inspections.
    4) Documentation of the inspections to include the date of the inspection, the participants, the findings, and the corrective measures taken to address the findings.
    5) Provide a copy of the documentation to the Engineer and Owner within one week after the inspection and maintain a copy on the project site.
j. Procedures to be followed to correct violations of the Project Safety Management Plan by any personnel.
k. The notification, investigation, and implementation procedures that the Contractor shall follow in the case of a safety stand-down. The procedures shall include immediately reporting the reason for safety stand-down and reporting the results of the investigation and implementation procedures.

2. Subcontractor Safety Managment Plan.
    a. Portions of the Project Safety Management Plan may be prepared by the subcontractors that will be performing that subcontracted work.
    b. The Contractor shall remain responsible for the overall Project Safety Management Plan, and for incorporating portions prepared by subcontractors.

c. Portions of the Project Safety Management Plan prepared by subcontractors shall be as stringent as the Contractor's overall Project Safety Management Plan.

3. Submittal of Project Safety Management Plan.
   a. Before the start of construction, submit the Project Safety Management Plan to the Engineer for the project records.
   b. The Engineer will review the Project Safety Management Plan for general compliance with this section. Engineer review of this information shall not relieve the Contractor of liability.
   c. Provide updates to the Project Safety Management Plan as necessary, and as work conditions or personnel change.
   d. Review the Project Safety Management Plan for sufficiency and accuracy at least once per twelve months of contract time. Maintain an up-to-date copy of the Project Safety Management Plan on the project site in the Contractor's possession at all times.

C. Contractor Responsibilities.
   1. Comply with applicable Federal, State, and local laws, rules, regulations, and guidelines governing safety, health and sanitation, including but not limited to the:
      a. Occupational Safety and Health Act
      b. 29 CFR 1910, including National Consensus Standards
      c. 29 CFR 1926
      d. Drug-Free Workplace Act (Public Law 100-690 Title V, subtitle D, 41 USC 701 et seq.).
      e. In the case of conflicting requirements, the more stringent of the requirements shall apply.
   2. Provide all safeguards, safety devices, and protective equipment, and take all other actions necessary to protect the life, safety, and health of persons working at or visiting the project site, and of the public and property in connection with the performance of the work covered by the Contract.
   3. Require that all operations and work practices by the Contractor, subcontractors, suppliers, and Owner personnel and consultants comply with the provisions of the Project Safety Management Plan.
   4. Respond in writing to all safety issues raised by the Engineer or Owner.

D. Safety Stand-Down.
   1. The Engineer or Owner may immediately suspend all or part of any work in the case of an accident (including property damage), or catastrophe (one or more persons hospitalized in a single incident), or other situation presenting an imminent danger to life or health, such as a near miss, violation of the Project Safety Managment Plan, or presence of a hazardous situation.
      a. In the case of a worksite fatality directly related to the Contractor's or any subcontractor's work operations, the safety stand-down shall be mandatory.
      b. In the case of a traffic fatality unrelated to a work-zone incident in the opinion of the Engineer, the safety stand-down will not be mandatory.
   2. During any mandatory safety stand-down due to a fatality, all work on the project shall cease, except that work deemed immediately necessary by the Engineer to make the project safe.
   3. The Contractor will be allowed to resume operations only after providing written documentation, certified by the Project Safety Manager or alternate, regarding the corrective actions taken to prevent recurrence.

E. Regulatory Enforcement Actions.
   1. Provide written notifications of all Regulatory agency actions relating to safety to the Engineer.

F. Personal Protective EquipmentPPE)

1. All personnel on the project site are required to wear the following personal protective equipment (PPE) at all times when on the project, except when in their vehicles:
    a. Head protection
    b. High visibility apparel, reflectorized for night use conforming to American National Standards Institute, Inc. (ANSI)/ International Safety Equipment Association (ISEA) 107 – 2004.
    c. Appropriate, sturdy footwear, all of which shall comply with the latest appropriate national consensus standards.
    d. All other PPE that is stipulated by the Project Safety Management Plan.
    e. All PPE shall comply with the latest appropriate national consensus standards.

G. Equipment Warning Lights.
1. Equip all work vehicles and mobile equipment with one or more functioning warning lights mounted as high as practicable, which shall be capable of displaying in all directions one or more flashing, oscillating, or rotating lights for warning roadway traffic.
2. The lights shall be amber in color.
3. Activate the warning lights when the work vehicle or mobile equipment is operating within the roadway, the right of way, or both.
4. All supplemental lights shall be Society of Automotive Engineers (SAE) Class 1 certified.

H. Failure to Comply.
1. Failure to comply with the requirements of this Section will be grounds for withholding of progress payments, project suspension, or both.

1.03 PERFORMACE OF SAFETY CRITICAL WORK

A. Consider the following work elements safety critical work.
1. Overhead structure erection.
2. Overhead structure construction or repair.
3. Temporary work: falsework, shoring that exceeds 5 feet in height, cofferdams, and temporary bridges.
4. Work requiring the use of cranes or other heavy lifting equipment.
5. Blasting.
6. Excavation and embankment adjacent to a structure, especially if it requires shoring.
7. Work within 50 feet of active railroad track centerline.
8. Caissons and/or directional boring in high density utility corridor.
9. Work over or adjacent to river, stream, or other protected water way.

B. Construction Plan: The Contractor shall submit, for review, an initial, detailed construction plan that addresses safe construction methods for each of the safety critical elements applicable. The Engineer's review will be for general conformance with the plans, specifications, best management practices regarding safety of the operation and industry standards. Submit the detailed construction plan two weeks prior to the safety critical element conference described below.
1. The Contractor's Construction Plan is to be a detailed plan that addresses safe construction methods for each of the applicable safety critical elements.
2. Inital Construction Plan:
    a. A mininum of two weeks before the safety critical element conference, submit an initial Construction Plan to the Engineer for review.
    b. The Engineer's review will be for general conformance with the plans, specifications, best management practices regarding safety of the operation and industry standards.
    c. Engineer review of this information shall not relieve the Contractor of liability.
3. Final Construction Plan:
    a. Prior to beginning construction of safety critical elements, submit a final Construction Plan stamped and signed “Approved for Construction”.
    b. The Engineer's review will be for general conformance with the plans, specifications, best management practices regarding safety of the operation and industry standards.

c. Engineer review of this information shall not relieve the Contractor of liability.

4. The Construction Plan shall include the following:
   a. Safety Critical Element for which the plan is being prepared and submitted.
   b. Contractor or subcontractor responsible for the plan preparation and the work.
   c. Schedule, procedures, equipment, and sequence of operations, that comply with the working hour limitations.
   d. Temporary work required: falsework, bracing, shoring, etc.
   e. Underground, above grade, and overhead utilities identification and protective steps taken.
   f. Communication plan as necessary with stakeholders, media, and the public.
   g. Additional actions that will be taken to ensure that the work will be performed safely.
   h. Names and qualifications of workers who will be in responsible charge of the work:
      1) Years of experience performing similar work
      2) Training taken in performing similar work
      3) Certifications earned in performing similar work
   i. Names and qualifications of workers operating cranes or other lifting equipment
      1) Years of experience performing similar work
      2) Training taken in performing similar work
      3) Certifications earned in performing similar work
   j. The construction plan shall address how the Contractor will handle contingencies such as:
      1) Unplanned events (storms, traffic accidents, work accidents, etc.)
      2) Structural elements that don’t fit or line up
      3) Replacement of workers who don’t perform the work safely
      4) Unexpected absence of critical management team
      5) Equipment failure
      6) Other potential difficulties inherent in the type of work being performed

C. Safety Critical Element Conference.
   1. Schedule conference at least two weeks prior to beginning construction on each safety critical element.
   2. Location: Project Site
   3. Facilitated by: Contractor
   4. Attendence Required by:
      a. Engineer
      b. Engineer's Representative
      c. Contractor
      d. Contractor's Superintendent
      e. Contractor's Engineer
      f. Safety Critical Element Subcontractors
   5. Agenda Items:
      a. Elements of the Construction Plan
      b. Communications
      c. Contingency items
      d. Work site restrictions

D. Temporary Works.
   1. Include, but not limited to falsework, shoring that exceeds 5 feet in height, cofferdams, and temporary bridges.
   2. Design to be performed by the Contractor's Engineer who shall be a registered Professional Engineer in the state of Colorado.
   3. Plans and calculations to be stamped by the Contractor's Engineer.

4. Prior to beginning construction of temporary work elements, submit a final plan stamped and signed by the Contractor “Approved for Construction”. Plans must include the Contractor Engineer's stamp and signature.

E. Performance of Safety Critical Work.
1. Perform safety critical work only when the Engineer, or an authorized representative, is on the project site.
2. The Contractor’s Engineer shall be onsite to inspect and provide written approval of safety critical work for which they provided signed and sealed construction details.
3. Unless otherwise directed or approved, the Contractor’s Engineer need not be onsite during the actual performance of safety critical work but shall be present to conduct inspection for written approval of the safety critical work.

F. Stoppage of Safety Critical Work.
1. When ordered by the Engineer, the Contractor shall immediately stop safety critical work that is being performed in an unsafe manner or which will result in an unsafe situation for the public.
2. Prior to stopping work, the Contractor shall make the situation safe for work stoppage.
3. The Contractor shall submit an acceptable plan to correct the unsafe process before the Engineer will authorize resumption of the work.
4. When ordered by the Engineer, the Contractor shall remove workers from the project that are performing the safety critical work in a manner that creates an unsafe situation.

G. Unplanned Event.
1. If an unplanned event occurs or the safety critical operation deviate from the submitted plan, the Contractor shall immediately cease operations on the safety critical element.
2. Perform all necessary work to ensure worksite safety and provide proper protection of the work and the public.
3. If the Contractor intends to modify the submitted plan, he shall submit a revised plan to the Engineer prior to resuming operations.

H. Liability.
1. The Contractor shall not be relieved from ultimate liability for unsafe or negligent acts or receive a waiver of the Colorado Governmental Immunity Act on behalf of the Owner.
2. The Contractor shall hold the Owner and the Engineer harmless from any civil or criminal penalties imposed as a result of the Contractor’s noncompliance with applicable requirements or failure to perfom the work in a safe manner.

1.04 REMOVAL FROM WORK

A. If, in the opinion of the Engineer or Owner, an employee refuses or repeatedly fails to comply, or a supervisor fails to enforce compliance with the safety or the requirements of these specifications, the Engineer or Owner may require that the individual be removed from the work, and the site if necessary.

1.05 SUBMITTALS

A. Project Safety Management Plan:
1. The Contractor’s certification of the Project Safety Management Plan shall be as follows:

By authorized signature below, (Contractor name),hereinafter referred to as “the Contractor,” hereby certifies that this Project Safety Management Plan (Plan) complies with and meets applicable Federal, State, and local laws, rules, regulations and guidelines governing safety, health and sanitation, including but not limited to the Occupational Safety and Health Act, 29 CFR 1910, 29 CFR 1926, national consensus standards, and the Drug-Free Workplace Act (Public Law 100-690 Title V, subtitle D, 41USC 701 et seq.). All operations and work practices of the Contractor shall comply with this Plan. The Contractor requires that all subcontractors, suppliers, Owner personnel, and consultants comply with this Plan.

_____

(Signature of Contractor's Project Safety Manager or alternate)

_____

Title

_____

Date

B. Construction Plan:
   1. The Contractor shall stamp and sign the construction plan "Approved for Construction"

1.06 SAFETY DATA SHEETS

A. Definitions
   1. List of Hazardous Materials (LHM)
   2. Safety Data Sheet (SDS)
      a. Formerly referred to as Material Safety Data Sheet (MSDS)

B. Application
   1. For the purposes of this contract this includes:
      a. Materials incorporated into work.
      b. Materials used by the Contractor during contract performance at the jobsite.

C. Delivery
   1. Maintain a LHM and make the list available to the Engineer.
   2. Maintain SDS for materials and make available to the Engineer.
   3. Do not deliver hazardous materials to jobsite unless a SDS is available.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 40 00
QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Submittals.

B. Quality assurance.

C. Quality control.

D. Testing and inspection agencies and services.

E. Contractor's construction-related professional design services.

F. Control of installation.

G. Tolerances.

H. Testing and inspection requirements.

I. Manufacturers' field services.

J. Defect Assessment.

1.02 REFERENCE STANDARDS

A. IAS AC89 - Accreditation Criteria for Testing Laboratories; 2021.

1.03 DEFINITIONS

A. Contractor's Quality Control (CQC) Plan: Contractor's management plan for executing the Contract for Construction.

B. Contractor's Professional Design Services: Design of some aspect or portion of the project by party other than the design professional of record. Provide these services as part of the Contract for Construction.

1. Design Service Types Required:
   a. Construction-Related: Services Contractor needs to provide in order to carry out the Contractor’s sole responsibilities for construction means, methods, techniques, sequences, and procedures.
   b. Design-Related: Design services explicitly required to be performed by another design professional due to highly technical and/or specialized nature of a portion of the project. Services primarily involve engineering analysis, calculations, and design, and are not intended to alter the aesthetic aspects of the design.

C. Design Data: Design-related, signed and sealed drawings, calculations, specifications, certifications, shop drawings and other submittals provided by Contractor, and prepared directly by, or under direct supervision of, appropriately licensed design professional.

D. Quality Assurance: Synonymous with "Owner Acceptance". The process whereby all factors used by the Owner (i.e., sampling, testing, and inspection) are evaluated to determine the degree of compliance with contract requirements. Sampling and testing are performed by the Owner, or its designated agent, to evaluate the acceptability of the final product.

E. Quality Control: The system used by a Contractor to monitor, assess, and adjust its production or placement processes to ensure that the final product will meet the specified level of quality. Quality Control includes sampling, testing, inspection, and corrective action (where required) performed by the Contractor to maintain continuous control of a production or placement process.

1.04 CONTRACTOR'S CONSTRUCTION-RELATED PROFESSIONAL DESIGN SERVICES

A. Coordination: Contractor's professional design services are subject to requirements of the General Conditions of the Construction Contract.

B. Provide such engineering design services as may be necessary to plan and safely conduct certain construction operations, pertaining to, but not limited to the following:

1. Temporary sheeting, shoring, or supports.
2. Temporary scaffolding.
3. Temporary bracing.
4. Temporary falsework for support of spanning or arched structures.
5. Temporary foundation underpinning.
6. Temporary stairs or steps required for construction access only.
7. Temporary hoist(s) and rigging.
8. Construction formwork, falsework and accessories.
9. Investigation of soil conditions to support construction equipment.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Designer's Qualification Statement: Submit for Engineer's knowledge as contract administrator, or for Owner's information.
   1. Include information for each individual professional responsible for producing, or supervising production of, design-related professional services provided by Contractor.
      a. Full name.
      b. Professional licensure information.
      c. Statement addressing extent and depth of experience specifically relevant to design of items assigned to Contractor.

C. Design Data: Submit for Engineer's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.
   1. Include calculations that have been used to demonstrate compliance to performance and regulatory criteria provided, and to determine design solutions.
   2. Include required product data and shop drawings.
   3. Include a statement or certification attesting that design data complies with criteria indicated, such as building codes, loads, functional, and similar engineering requirements.
   4. Include signature and seal of design professional responsible for allocated design services on calculations and drawings.

D. Test Reports: After each test/inspection, the testing agency will promptly submit two copies of report to Engineer and to Contractor.
   1. Include:
      a. Date issued.
      b. Project title and number.
      c. Name of inspector.
      d. Date and time of sampling or inspection.
      e. Identification of product and specifications section.
      f. Location in the Project.
      g. Type of test/inspection.
      h. Date of test/inspection.
      i. Results of test/inspection.
      j. Compliance with Contract Documents.
      k. When requested by Engineer, provide interpretation of results.
   2. Test report submittals are for Engineer's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.

E. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor or installation/application subcontractor to Engineer, in quantities specified for Product Data.
   1. Indicate material or product complies with or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

2. Certificates may be recent or previous test results on material or product, but must be acceptable to Engineer.

F. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

G. Manufacturer's Field Reports: Submit reports for Engineer's benefit as contract administrator or for Owner.
   1. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents.

H. Erection Drawings: Submit drawings for Engineer's benefit as contract administrator or for Owner.
   1. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents.
   2. Data indicating inappropriate or unacceptable Work may be subject to action by Engineer or Owner.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications:
   1. Prior to start of work, submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.
   2. Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.
   3. Qualification Statement: Provide documentation showing testing laboratory is accredited under IAS AC89.

B. Designer Qualifications: Where professional engineering design services and design data submittals are specifically required of Contractor by Contract Documents, provide services of a Professional Engineer experienced in design of this type of work and licensed in Colorado.

1.07 QUALITY CONTROL

A. Contractor's Quality Control (CQC) Plan:
   1. Prior to start of work, submit a comprehensive plan describing how contract deliverables will be produced. Tailor CQC plan to specific requirements of the project. Include the following information:
      a. Management Structure: Identify personnel responsible for quality. Include a chart showing lines of authority.
         1) Include qualifications (in resume form), duties, responsibilities of each person assigned to CQC function.
      b. Management Approach: Define, describe, and include in the plan specific methodologies used in executing the work.
         1) Management and control of documents and records relating to quality.
         2) Communications.
         3) Coordination procedures.
         4) Resource management.
         5) Process control.
         6) Inspection and testing procedures and scheduling.
         7) Control of noncomplying work.
         8) Tracking deficiencies from identification, through acceptable corrective action, and verification.
         9) Control of testing and measuring equipment.
         10) Project materials certification.
         11) Managerial continuity and flexibility.

c. Owner will not make a separate payment for providing and maintaining a Quality Control Plan. Include associated costs in Bid price.
d. Acceptance of the plan is required prior to start of construction activities not including mobilization work. Owner's acceptance of the plan will be conditional and predicated on continuing satisfactory adherence to the plan. Owner reserves the right to require Contractor to make changes to the plan and operations, including removal of personnel, as necessary, to obtain specified quality of work results.

B. Quality-Control Personnel Qualifications. Engage a person with requisite training and experience to implement and manage quality control (QC) for the project.

1.08 TESTING AND INSPECTION AGENCIES AND SERVICES

A. Owner will employ and pay for services of an independent testing agency to perform specified testing and inspection.

B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Have work performed by persons qualified to produce required and specified quality.

F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.02 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

3.03 TESTING AND INSPECTION - GENERAL

A. Testing Agency Duties:
1. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
2. Perform specified sampling and testing of products in accordance with specified standards.
3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
4. Promptly notify Engineer and Contractor of observed irregularities or non-compliance of Work or products.
5. Perform additional tests and inspections required by Engineer.
6. Submit reports of all tests/inspections specified.

B. Limits on Testing/Inspection Agency Authority:

1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
2. Agency may not approve or accept any portion of the Work.
3. Agency may not assume any duties of Contractor.
4. Agency has no authority to stop the Work.

C. Contractor Responsibilities:
1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
2. Cooperate with laboratory personnel and provide access to the Work and to manufacturers' facilities.
3. Provide incidental labor and facilities:
   a. To provide access to Work to be tested/inspected, including ladders, scaffolding or other means of OSHA-compliant access.
   b. To obtain and handle samples at the site or at source of Products to be tested/inspected, including hoisting and hauling samples from the point of sampling to another location onsite directed by the Engineer.
   c. To facilitate tests/inspections, including providing temporary lighting, temporary water supply or other items directed by the Engineer.
   d. To provide storage and curing of test samples.
4. Schedule testing and inspection services with sufficient notice to meet Contractor's work schedule and Owner's required testing frequency. Notice to be provided a minimum of 48 hours prior to expected time for operations requiring testing/inspection services. Inspections may include, but not limited to: geotechnical inspections, rebar inspections by Engineer, masonry inspections and structural special inspections.
5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
7. Perform all necessary remedial work resulting from inspections or failing tests to the satisfaction of the Engineer.

D. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by Engineer.

E. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor.

F. Requirements of Regulatory Agencies:
1. If the laws, ordinances, rules, regulations or orders of any public body or authority having jurisdiction require any work to be specifically inspected, tested or approved by someone other than the Contractor, Owner, inspector, or testing agency employed by the Owner, the Contractor shall give all required notices and make all required arrangements therefore and shall deliver to the Owner certificates of inspection, testing or approval issued by the appropriate public bodies or authorities having jurisdiction. The cost of all such inspections, tests, and approvals shall be borne by the Contractor unless otherwise provided in the Contract Documents.

G. Source Quality Control:
1. The Owner 's testing agency may obtain samples of materials at the source of supply and test the materials for compliance with the Contract Documents. The testing agnecy will tag, seal, label or otherwise identify the bulk materials so sampled and no such materials shall be used in the Work until the test reports are submitted to and approved by the Engineer.
2. Applicable tests may be repeated at specified intervals, whenever the source of supply is changed, or whenever the characteristics of the materials change or vary in the opinion of the Engineer.

3. Samples will be retained by the testing agency until a time when the material is no longer needed.

H. Test Witnessing:
1. The Engineer may witness testing performed at the factory, supplier's test facility or at the testing laboratory.
2. The Engineer may inspect fabricated equipment and or witness testing at the factory without cost to the Contractor and without cost from the supplier or manufacturer charged to the Owner.
3. The Contractor shall notify the Engineer in sufficient time so that test witnessing and/or factory inspection can be arranged.
4. Factory inspection will be made after manufacturer has performed satisfactory checks, adjustments, tests and operations.

I. Construction Observation:
1. The Engineer will perform regular observation of the Work at the project site.
2. All work shall be performed and constructed under the observation of the Engineer, unless specified otherwise, elsewhere in the Contract Documents.
3. Such observation may include mill, plant, and shop or field inspection as required.
4. Any work requiring inspection that is performed or constructed in the absence of the Engineer shall be considered defective and is subject to rejection.

3.04 TESTING AND INSPECTION - PROJECT

A. Soils
1. Testing Agency Responsibilities:
a. Sample and test source materials. Tests may include, but not limited to:
1) Soil survey (classification)
2) Gradation
3) Atterberg Limits
4) Moisture-Density Curve (Proctor test)
5) Chemical tests (Waler-Soluble Sulfate, Chloride, Resistivity, pH)
b. Sample and test placed materials. Tests may include, but not limited to:
1) In-place Density
2) Proctor test (e.g. single point)
2. Contractor Responsibilities:
a. Provide access to source materials and project site for sampling.
b. Notify Engineer of changes in material sources.

B. Aggregates
1. Testing Agency Responsibilities:
a. Sample and test source materials. Tests may include, but not limited to:
1) Gradation
2) Atterberg Limits
3) Moisture-Density Curve (Proctor test)
4) LA Abrasion
5) Resistance R-Value
b. Sample and test placed materials. Tests may include, but not limited to:
1) In-place Density
2) Proctor test (e.g. single point)
2. Contractor Responsibilities:
a. Provide access to source materials and project site for sampling.
b. Notify Engineer of changes in material sources.

C. Concrete
1. Testing Agency Responsibilities:
a. Sample and test produced/placed materials. Tests may include, but not limited to:

1) Air Content
2) Unit Weight
3) Temperature
4) Slump
5) Compressive Strength (2 cylinders for 7-day, 3 for 28-day, 3 for 56-day breaks)

2. Contractor Responsibilities:
   a. Submit source material testing results with asphalt mix design.
   b. Provide safe access for Testing Agency personnel when sampling is required at point of placement.

D. Equipment and Process Piping
1. Engineer Responsibilities:
   a. Observe and accept coatings, alignment, support and restraint of all equipment and process piping.
   b. Observe and accept all valves for proper operation. Review to include proper operator type (hand wheel, operator nut, lever, chain as dictated by centerline elevation of the valve) and orientation per manufacturer requirements (seat direction, shaft orientation, operational access to actuator and position indicators).
2. Contractor Responsibilities:
   a. Remove connecting bolts at all equipment to demonstrate proper alignment and stress mitigation.
   b. Correct any noted deficiencies to satisfaction of Engineer prior to operational demonstration.

E. Yard Piping
1. Engineer Responsibilities:
   a. Observe and accept thrust restraints prior to backfilling.
2. Contractor Responsibilities:
   a. n/a

F. Pressure Testing
1. Engineer Responsibilities:
   a. Witness testing.
2. Contractor Responsibilities:
   a. Perform testing in accordance with related project specifications or utility owner requirements.
   b. Repeat tests until results are accepted by Engineer.
3. The following items are to be tested by the Contractor and accepted by the Engineer prior to the Operational Demonstration:
   a. Process piping
   b. Yard piping
   c. Pressurized plumbing - potable and non-potable lines
   d. Gravity water and sewer lines
   e. Manholes and equipment vaults

G. Leak Testing
1. Engineer Responsibilities:
   a. Witness testing.
2. Contractor Responsibilities:
   a. Perform testing in accordance with related project specifications or utility owner requirements.
   b. Repeat tests until results are accepted by Engineer.
3. The following items are to be tested by the Contractor and accepted by the Engineer prior to the Operational Demonstration:
   a. Water holding tanks and structures
   b. Water control gates

c. Control device elevations: weirs, overflows, etc.

H. Bacteriological Testing
1. Engineer Responsibilities:
a. Witness sampling.
2. Contractor Responsibilities:
a. Perform testing in accordance with related project specifications or utility owner requirements.
b. Provide samples to testing laboratory approved by the utility owner.
c. Report testing results to Engineer and utility owner.
d. Repeat tests until results are accepted by Engineer.

I. Vendor Equipment Check
1. Engineer Responsibilities:
a. Witness equipment check
2. Contractor Responsibilities:
a. Supply all required fluids, chemicals and lubricants for operation.
b. In presence of equipment manufacturer, verify the minimum following:
1) Unit readiness for service
2) proper fluid and lubricant types
3) proper fill levels
4) proper anchoring and mechanical connections to structures and piping
5) proper leveling and alignment
6) Electrical service and proper rotational direction.
7) Equipment performance range per project specifications.
8) Volt and amperage draw under normal operational conditions.

J. Instrumentation and Control Check (aka SCADA check)
1. Engineer Responsibilities:
a. Witness testing.
b. Review and approve testing program prior to Validation and Startup Testing. See Section 01 75 16 - Startup Procedures for additional information.
2. Contractor Responsibilities:
a. Submit testing program to Engineer prior to Validation and Startup Testing.
b. Perform testing in accordance with related project specifications.

3.05 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance equipment, and _____ as applicable, and to initiate instructions when necessary.

B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

3.06 DEFECT ASSESSMENT

A. Replace Work or portions of the Work not complying with specified requirements.

B. If, in the opinion of Engineer, it is not practical to remove and replace the work, Engineer will direct an appropriate remedy or adjust payment.

END OF SECTION

SECTION 01 42 13
ABBREVIATIONS AND ACRONYMS

PART 1 GENERAL

1.01 SUMMARY

A. The following abbreviations, which may be used in the Specifications, refer to the organizations and specifications of the organizations listed below. The abbreviation and acronym definitions included on the Drawings or within individual specification sections shall take precedence within those parts of the Contract Documents over those given in this section where in conflict.

1. Trade Associations

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AAN	American Association of Nurserymen
AASHTO	American Association of State Highway and Transportation Officials
ABMA	American Boiler Manufacturers Association
ACI	American Concrete Institute
ACA	American Coatings Association
ACPA	American Concrete Pipe Association
ADC	Air Diffusion Council
AFPA	American Forest and Paper Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHA	American Hardboard Association
AHAM	Association of Home Appliance Manufacturers
AI	Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ALSC	American Lumber Standards Committee
AMCA	Air Movement and Control Association International, Inc.
ANLA	American Nursery and Landscape Association
ANSI	American National Standards Institute
APA	American Plywood Association (See EWA)
APWA	American Public Works Association
ARI	Air Conditioning and Refrigeration Institute
ARMA	Asphalt Roofing Manufacturers Association
ASC	Adhesive and Sealant Council
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, Air Conditioning Engineers
ASLA	American Society of Landscape Architects
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials
ATSSA	American Traffic Safety Services Association
AWI	Architectural Woodwork Institute
AWPA	American Wood Protection Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society, Inc.

AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association, Inc.
BIA	Brick Institute of America
BOCA	Building Officials Code Administrators
CBM	Certified Ballast Manufacturers
CDA	Copper Development Association, Inc.
CID	Commercial Item Description
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturers Institute
CRA	California Redwood Association
CRI	Carpet and Rug Institute
CRSI	Concrete Reinforcing Steel Institute
CSSB	Cedar Shingle and Shake Bureau
DHI	Door and Hardware Institute
EWA	APA-The Engineered Wood Association
FHVA	Fine Hardwood Veneer Association
FM	Factory Mutual System
GA	Gypsum Association
GAMA	Gas Appliance Manufacturers Association
GANA	Glass Association of North America
HI	Hydraulic Institute
HMA	Hardwood Manufacturers Association
HPMA	Hardwood Plywood Manufacturers Association
IA	Irrigation Association
ICBO	International Conference of Building Officials
ICEA	Insulated Cable Engineers Association, Inc.
ICRI	International Concrete Repair Institute
IEEE	The Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society of North America
IGCC	See ITS
ILIA	Indiana Limestone Institute of America, Inc.
ITS	Internek Testing Services
KCMA	Kitchen Cabinet Manufacturers Association
LIA	Lead Industries Association, Inc.
MBMA	Metal Building Manufacturer’s Association
MFMA	Maple Flooring Manufacturers Association
MIA	Marble Institute of America
MIMA	Mineral Insulation Manufacturers Association
MLSFA	Metal Lath/Steel Framing Association A Division of NAAMM
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
NAAMM	The National Association of Architectural Metal Manufacturers
NACE	National Association of Corrosion Engineers
NAIMA	North American Insulation Manufacturers Association
NAPA	National Asphalt Pavement Association
NAPCA	National Association of Pipe Coating Applicators
NCMA	National Concrete Masonry Association
NEC	National Electrical Code (by NFPA)
NECA	National Electrical Contractors Association
NELM	Northeastern Lumber Manufacturers' Association
NEII	National Elevator Industry, Inc.
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association

NHLA	National Hardwood Lumber Association
NHPMA	Northern Hardwood and Pine Manufacturers Association, Inc.,
NIOSH	National Institute for Occupational Safety and Health
NOFMA	National Oak Flooring Manufacturers Association
NPA	National Particleboard Association
NRCA	National Roofing Contractors Association
NSF	NSF International
NTMA	The National Terrazzo and Mosaic Association
NWWDA	National Wood Window and Door Association
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PDI	Plumbing and Drainage Institute
PDCA	Painting and Decorating Contractors of America
PEI	Porcelain Enamel Institute, Inc.
PI	Perlite Institute, Inc.
RFCI	Resilient Floor Covering Institute
RIS	Redwood Inspection Service (Grading Rules)
RMMI	Rocky Mountain Masonry Institute
SCMA	Southern Cypress Manufacturers Association
SDI	Steel Deck Institute
SDI	Steel Door Institute
SFPA	Southern Forest Products Association
SGCC	See ITS
SIGMA	Sealed Insulating Glass Manufacturers Association
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association, Inc.
SPIB	Southern Pine Inspection Bureau (Grading Rules)
SSPC	Steel Structures Painting Council
SWI	Steel Window Institute
TCA	Tile Council of America
TIMA	Thermal Insulation Manufacturers Association (See NAIMA)
TPI	Truss Plate Institute
UBC	Uniform Building Code (by ICBO)
UDFCD	Urban Drainage and Flood Control District (now MHFD)
UL	Underwriters Laboratories, Inc.
WCLB	West Coast Lumber Inspection Bureau (Grading Rules)
WIC	Woodwork Institute of California
WMMPA	Wood Moulding and Millwork Producers Association
WRI	Wire Reinforcement Institute, Inc.
WSFI	Wood and Synthetic Flooring Institute (See MFMA)
WWPA	Western Wood Products Association (Grading Rules)
WWPA	Woven Wire Products Association
WWPI	Western Wood Preservers Institute

2. Government Agencies and Abbreviations

CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CS	Commercial Standard of NBS
EPA	Environmental Protection Agency
FHA	Federal Housing Administration
FHWA	Federal Highway Administration

FS	Federal Specifications
MS	Military Standardization Documents
MSHA	Mine Safety and Health Administration
NBS	National Bureau of Standards
NIST	National Institute of Standards and Technology
OSHA	Occupational Safety and Health Administration
PS	Product Standard of NBS (U.S. Department of Commerce)
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Protection of property

B. Access to work and site

C. Temporary sanitary facilities.

D. Waste removal facilities and services.

E. Noise control.

F. Mud and dirt control.

G. Air pollution control.

H. Water control.

I. Fire prevention.

J. Removal of Utilities, Facilities, and Controls

K. Archeological Findings

1.02 REFERENCE STANDARDS

A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.

1.03 PROTECTION OF PROPERTY - DO NOT USE IF THIS IS REDUNDANT WITH GC'S

A. Preserve private and public property and protect it from damage.

B. The Contractor is responsible for the damage or injury to property resulting from:
   1. The Contractor's neglect, misconduct, or omission in the manner or method of execution or non-execution of the work, or
   2. The Contractor's defective work or the use of unacceptable materials.

C. The Contractor's responsibility shall not be released until the work has been completed in compliance with the Contract. The Contractor shall restore damaged or injured property, at the Contractor's expense, to a condition similar or equal to that existing before the damage or injury occurred, by repairing, rebuilding, or restoring the property.

D. Existing trees, shrubs, bushes or grass, outside the designated work areas but inside project limits that are damaged due to the Contractor's operations shall be replaced in kind at the Contractor's expense.

1.04 ACCESS TO WORK AND SITE - DO NOT USE IF THIS IS REDUNDANT WITH GC'S

A. Provide safe and proper access to the Work at all times for Owner, Engineer, inspectors, consultants, other employees, and governmental agency representatives.

B. Provide access to the Owner at all times for operation and maintenance purposes for all facilities the Contractor must connect to, work in the vicinity of, or work adjacent to.

C. Do not operate valves, equipment or other control devices without written approval of the Owner.

D. Coordinate all construction activities which may affect any of the existing facilities or their operation with the Owner or its representative at least forty-eight (48) hours in advance of the activity.

E. Water and wastewater flows may not be disrupted without an approved bypass in place without written approval of the Owner.

F. Investigate the availability of transportation facilities and make necessary arrangements for delivery of materials and equipment to the site or excavated material from one area of the site to another.

G. Determine the condition and availability of public roads, access, rights-of-way, railroad crossings and associated restrictions, bridge load limits and other limitations affecting transportation and ingress and egress at the site.

H. If access to the site requires crossing of railroad tracks, Contractor shall stress safety and stopping and looking for trains prior to crossing, regardless of control gates and signals.

I. Maintain site and temporary roadway ditches, culverts and similar items as required.

J. Maintain access to existing pump station and electrical equipment, generators, pipelines, manholes and cleanouts.

1.05 TEMPORARY UTILITIES

A. Owner will provide the following:
   1. Electrical power and metering, consisting of connection to existing facilities.
   2. Water supply and metering, consisting of connection to existing facilities.

B. Contractor will provide the following:
   1. Electrical power utilizing temporary generators if existing power facilities are not available.
   2. Temporary power to existing pump stations and treatment plants if construction requires interruption(s) in permanent power of durantion and/or frequency that is unacceptable to the Owner.
   3. Piping, tanks, pumps and other means to distribute potable or irrigation water.
   4. Construction lighting when work is performed at night or under deficient daylight conditions to ensure proper performance, workmanship, inspection and safe working conditions.

C. Provide and pay for all electrical power, lighting, water, heating and cooling, and ventilation required for construction purposes.

1.06 TEMPORARY SANITARY FACILITIES

A. Toilet and Washing Facilities:
   1. Provide temporary chemical toilets and fresh water washing facilities for the use of all workers at the site. Supply paper, soap and towels. Provide at time of project mobilization.
   2. Provide a dedicated facility for the exclusive use of the Owner/Engineer near their field office.

B. Drinking Water:
   1. Maintain a supply of cool pure drinking water at the site, available to all workers, with individual disposable drinking cups or a sanitary bubbler fountain.

C. Maintain facilities in clean and sanitary condition.

D. At end of construction, return facilities to same or better condition as originally found.

1.07 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 periodically.

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.

D. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

E. Locate a suitable area for legal disposal of surplus and waste construction material from the Work

F. Acquire necessary permits and include all permit and disposal costs in the Work.

1.08 NOISE CONTROL

A. Comply with OSHA requirements in 29 CFR 1926 for allowable noise levels during construction.

B. Equip mechanical equipment with effective mufflers or enclose equipment to reduce noise.

C. Obtain necessary permit and limit noise to the levels established in the permit and in applicable local jurisdiction noise control ordinances.

D. Minimize noise disturbance to adjoining property owners and public.

1.09 MUD AND DIRT CONTROL

A. Cover the beds of vehicles and trailers that haul gravel, sand or earth when traveling on public roads.

B. Provide vehicle tracking pads (aka stabilized construction entrances) at the main entrance to the site and at other locations as needed to prevent mud and dirt tracked by construction vehicles from leaving the site.

C. Vehicle tracking pads are to be constructed in accordance with Section 01 57 13 - Temporary Erosion and Sediment Control.

D. Prefabricated or manufactured vehicle tracking pads shall only be used if specified in the Contract or approved by the Engineer. Install prefabricated or manufactured vehicle tracking pads in accordance with Section 01 57 13 - Temporary Erosion and Sediment Control.

E. Maintain vehicle tracking pads as needed or as directed by the Engineer.

F. Perform sweeping when sediment collects on paved surfaces or as directed by the Engineer.
   1. Street washing will not be allowed.
   2. Install storm drain inlet protection prior to sweeping.
   3. Perform sweeping with a pickup broom or equipment capable of collecting sediment. Sweeping with a kick broom will not be allowed.

1.10 AIR POLLUTION CONTROL

A. Exterior Fugitive Dust Control.
   1. Execute Work by methods that minimize raising dust from construction operations.
   2. Provide positive means to prevent airborne dust from dispersing into atmosphere and into Owner-occupied areas.
   3. Sprinkle earthmoving and other places where construction activities create a dust nuisance at frequent intervals and not less than twice daily during earthmoving operations.
   4. For road construction. have a water truck on site at all times for dust control. Wetting the driving surface as required as directed by the Engineer.
   5. For utility construction, dust control may be accomplished by water truck or spray system from an on-site water system.
   6. Provide a water meter for metering any water taken from the municipal water system whether from fire hydrants or private taps.
   7. Watering is considered incidental to the related work and will not be paid for separately.

B. Interior Dust and Fume Control.
   1. For construction activities generating excessive dust or fumes and being performed within existing occupied and/or operating facilities, which may include, but are not limited to interior demolition work, sandblasting, coatings application, and spray-type operations, provide gap-free plastic sheeting or other physical separation barriers and active (negative-pressure) ventilation, and if necessary, filtration, to prevent exposure of existing facilities and personnel to construction dust and/or fumes.
   2. System performance will be reviewed by the Engineer.
   3. Temporary dust/fume control and ventilation system improvements will be made by the Contractor as directed by the Engineer, at no additional cost.
   4. Abnormally high visible dust accumulation and/or detectable fumes, by instrument or by smell, within areas of the facility not actively under construction are not acceptable.

C. Comply with all laws, ordinances, rules, regulations and other restrictions pertaining to air pollution.

D. Do not use any fuel nor perform any operation that emits smoke which is defined as equal to Ringlemann No. 2 or darker.

1.11 WATER CONTROL

A. Perform grading and other operations as required to maintain site drainage.

B. Do not allow surface or groundwater to accumulate in excavations or under structures.

C. Control surface water by means of ditches, dams, temporary pumps and piping and other necessary methods.

D. Do not allow mud, silt or debris from dewatering operations or from runoff to flow on to adjoining property.

1.12 FIRE PREVENTION

A. Prohibit smoking within buildings under construction and demolition. Designate area on Site where smoking is permitted. Provide approved ashtrays in designated smoking areas.

B. Establish fire watch for cutting, welding, and other hazardous operations capable of starting fires. Maintain fire watch before, during, and after hazardous operations until threat of fire does not exist.

C. Portable Fire Extinguishers: NFPA 10; 10-pound capacity, 4A-60B: C UL rating.
   1. Provide one fire extinguisher at each stairway on each floor of buildings under construction and demolition.
   2. Provide minimum of one fire extinguisher in every construction trailer and storage shed.
   3. Provide minimum of one fire extinguisher on roof during roofing operations using heat-producing equipment.

1.13 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.

B. Remove underground installations to a minimum depth of 2 feet. Grade site as indicated.

C. Clean and repair damage caused by installation or use of temporary work.

1.14 ARCHAEOLOGICAL FINDINGS

A. Should the discovery of a potential archaeological or historical resource occur during construction, all work in the area of the find shall stop and a qualified archaeologist will be called in to evaluate the situation and make recommendations as to proceeding with the work.

B. If directed to proceed, the Contractor shall conduct operations in the affected area as directed.

C. Delays to construction may be cause for extension of the Contract Time(s).

D. Additional work required in the affected area will be paid for by the Owner as agreed with the Contractor.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 57 13
TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Prevention of erosion due to construction activities.

B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.

C. Restoration of areas eroded due to insufficient preventive measures.

D. Compensation of Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.02 PERFORMANCE REQUIREMENTS

A. Comply with requirements of State of Colorado Department of Public Health and Environment (CDPHE).

B. Develop and follow a Stormwater Management Plan (SWMP).

C. Assign to the project a Qualified Stormwater Manager, who is an individual knowledgeable in the principles of erosion and sediment control and pollution prevention, and with the skill to assess conditions at construction sites that could impact stormwater quality and to assess the effectiveness of stormwater controls implemented to meet the requirements of the permit.

D. The Stormwater Manager's responsibilites include:
   1. Supervising the installation, construction, and maintenance of all erosion control measures specified in the Contract and SWMP and coordinating the construction of erosion control measures with all other construction operations.
   2. Maintaining and updating the SWMP and identifying critical action items to the Superintendent for corrective measures.
   3. Ensuring compliance with all water quality permits or certifications in effect during the construction work.
   4. Directing the implementation of suitable temporary control measures as necessary to correct unforeseen conditions or emergency situations.
   5. Directing the dismantling of control measures when their purpose has been fulfilled.
   6. Attending project meetings.

E. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.

F. Timing: Install perimeter controls prior to beginning any earth-moving activities. Install control measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.

G. Stormwater Runoff: Control increased stormwater runoff due to disturbance of surface cover due to construction activities for this project.
   1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
   2. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall events that might occur in 25 years.

H. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
   1. Control movement of sediment and soil from temporary stockpiles of soil.
   2. Prevent development of ruts due to equipment and vehicular traffic.
   3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

I. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
   1. Prevent windblown soil from leaving the project site.
   2. Prevent tracking of mud onto public roads outside site.
   3. Prevent mud and sediment from flowing onto sidewalks and pavements.
   4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

J. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
   2. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm.

K. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.

L. Open Water: Prevent standing water that could become stagnant.

M. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

N. Failure to maintain control measures: If the Contractor fails to maintain the erosion and sediment control features in accordance with the Contract, or as directed by the Owner, the Owner may at the expiration of a period of forty-eight (48) hours after having given the Contractor written notice, proceed to maintain the features as deemed necessary. The cost, thereof, will be deducted from any compensation due the Contractor.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Storm Water Management Control Plan:
   1. Submit not less than 30 days prior to anticipated start of clearing, grading, or other work involving disturbance of ground surface cover.
   2. Include:
      a. Site plan identifying soils and vegetation, existing erosion problems, and areas vulnerable to erosion due to topography, soils, vegetation, or drainage.
      b. Site plan showing grading; new improvements; temporary roads, traffic accesses, and other temporary construction; and proposed preventive measures.
      c. Where extensive areas of soil will be disturbed, include storm water flow and volume calculations, soil loss predictions, and proposed preventive measures.
      d. Schedule of temporary preventive measures, in relation to ground disturbing activities.
      e. Other information required by law.
      f. Format required by law is acceptable, provided any additional information specified is also included.
   3. Obtain the approval of the Plan by authorities having jurisdiction.
   4. Obtain the approval of the Plan by Owner.
   5. Update the Plan during construction to reflect current or revised field conditions and changes in control measures.

C. Certificates:

1. Hay and Straw (Weed Free) for Mulch: Certificate of Compliance with transit certificate number, or a copy of the transit certificate as supplied from the producer.
2. Wood Cellulose Fiber Mulch: Certificate of Compliance.
3. Erosion Bale (Weed Free): Certificate of Compliance with transit certificate number, or a copy of the transit certificate as supplied from the producer.
4. Silt Fence: Certificate of Compliance for fabric attesting that fabric and factory seams comply with specified requirements, signed by legally authorized official of manufacturer; indicate actual minimum average roll values; identify fabric by roll identification numbers.
5. Erosion Log: Certificate of Compliance.
6. Prefabricated Concrete Washout Structure: Product information demonstrating product is on the CDOT APL.
7. Prefabricated Vehicle Tracking Pad: Product information demonstrating product is on the CDOT APL.
8. Aggregate Bag: Certificate of Compliance.
9. Storm Drain Inlet Protection: Product information demonstrating product is on the CDOT APL.

D. Samples:
1. Wood Chip Mulch: Submit sample to Engineer at least 30 days before placing on project.

E. Inspection Reports: Submit report of each inspection; identify each preventive measure, indicate condition, and specify maintenance or repair required and accomplished.

PART 2 PRODUCTS

2.01 MATERIALS

A. Mulch: Use one of the following:
1. Certified Weed Free hay or straw: Field or marsh hay or straw of oats, barley, wheat, rye, or triticale certified under the Colorado Department of Agriculture Weed Free Forage Certification Program.
2. Wood Cellulose Fiber Mulch: Virgin wood fibers manufactured from clean whole wood chips processed in a manner to contain no growth or germination inhabiting factors and packaged in units containing current labels, with the manufacturer's name, the net weight, and certification that the material meets the requirements in Table 1. Do not use fiber produced from recycled materials such as sawdust, paper, cardboard, or residue from pulp and paper plants.

Table 1 - Wood Cellulose Fiber Mulch Requirements

Property	Requirement
Percent Moisture Content	10.0% ± 3.0%
Percent Organic Matter* (Wood Cellulose Fiber)	99.3% ± 0.2%
Percent Ash Content*	0.7% ± 0.2%
pH	4.9 ± 0.5
Water Holding Capacity*	1200-1600 grams**
* Oven dried basis **Per 100 grams of fiber	

3. Mulch tackifier: Free-flowing, noncorrosive powder produced either from the natural plant gum of Plantago Insularis (Desert Indianwheat) or pre-gelatinized 100 percent natural corn starch polymer mixed with wood cellulose fiber water and sprayed on hay or straw mulch to bind the mulch and reduce loss of mulch. All fibers to be colored green or yellow with a biodegradable dye. Do not use any materials that may contain mineral fiber, recycled cellulose fiber, clays, or other substances that may inhibit germination or growth of plants.

Table 2 - Mulch Tackifier Properties

Property	Requirement
Plantago Insularis (Desert Indianwheat)	

pH 1% Solution	6.5 - 8.0
Pre-Gelatinized 100 Percent Natural Corn Starch Polymer	
Organic Nitrogen as Protein	5.5 - 7%
Ash Content	0 - 2%
Fiber	4 - 5%
pH 1% Solution	6.5 - 8.0
Size	100% thru 850 microns (20 mesh)
Settleable Solids	< 2%

4. Wood chip mulch: Fresh, moist pole peelings material.
   a. Width: 1/4 to 1/2 inch.
   b. Length: 3 to 4 inches.
5. Erosion control matting or netting.

B. Grass Seed For Temporary Cover: Select a species appropriate to climate, planting season, and intended purpose. If same area will later be planted with permanent vegetation, do not use species known to be excessively competitive or prone to volunteer in subsequent seasons.

C. Bales: Certified Weed Free hay or straw.
1. Cross Section: 14 by 18 inches, minimum.
2. Volume: Approximately 5 cubic feet.
3. Weight: 35 pounds, minimum
4. Bindings: Wire or string, around long dimension.

D. Bale Stakes: One of the following, minimum 3 feet long:
1. Steel U- or T-section, with minimum mass of 1.33 pound per linear foot.
2. Wood, 2 by 2 inches in cross section.

E. Silt Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:
1. Average Opening Size: 30 U.S. Std. Sieve, maximum, when tested in accordance with ASTM D4751.
2. Permittivity: 0.05 sec^-1, minimum, when tested in accordance with ASTM D4491/D4491M.
3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355/D4355M after 500 hours exposure.
4. Grab Tensile Strength: 100 pounds-force, minimum, in cross-machine direction; 124 pounds-force, minimum, in machine direction; when tested in accordance with ASTM D4632/D4632M.
5. Grab Tensile Strength when supported by wire fence (Reinforced): 90 pounds-force, minimum, in cross-machine direction; 90 pounds-force, minimum, in machine direction; when tested in accordance with ASTM D4632/D4632M.
6. Elongation: 15 to 30 percent, when tested in accordance with ASTM D4632/D4632M.
7. Tear Strength: 55 pounds-force, minimum, when tested in accordance with ASTM D4533/D4533M.
8. Color: Manufacturer's standard, with embedment and fastener lines preprinted.

F. Silt Fence Posts: One of the following, minimum 46 inches long:
1. Steel U- or T-section, with minimum mass of 1.33 pound per linear foot.
2. Wood, 1.5 by 1.5 inches in cross section with 1/8 inch tolerance.

G. Silt Fence (Reinforced) Posts:
1. Steel studded T-section, with minimum 0.095-inch minimum wall thickness.
2. Minimum 66 inches long.

H. Wire Fabric Reinforcement for Silt Fence:
1. Minimum 14 gauge.

2. Maximum 6 inch mesh spacing.

I. Erosion Logs: Cylinder casings fill with curled aspen wood excelsior with a consistent width of fibers evenly distributed throughout the log.
   1. Casing: Seamless, photodegradable tube netting.
   2. Curled aspen wood excelsior: Fungus free, resin free, and free of growth or germination inhibiting substances.
   3. Diameter: 12 inches or as specified in the plans.

Table 2 - Erosion Log Dimensions

Diameter (inches)	Min. Length (feet)	Max. Length (feet)	Min. Weight (lb/ft)	Stake Dimensions (inches)
9	10	180	1.6	0.75 thick x 0.75 wide x 18 long
12	10	180	2.5	1.5 thick x 1.25 wide x 24 long
20	10	180	4	1.5 thick x 1.25 wide x 30 long

J. Concrete Washout Structure Impermeable Synthetic Liner

Table 3 - Impermeable Sythetic Liner Requirements

Tested Property	Test Method	Units	Value
Thickness	ASTM D5199	mil	>30 (+/- 1.5)
Tear Strength	ASTM D1004	lbs	>8
Low Temperature Impact	ASTM D1790	°F	Pass at -20

K. Vehicle Tracking Pad
   1. Aggregate: Crushed natural aggregate with at least two fractured faces meeting the gradation requirements in Table 4.

Table 4 - Vehicle Tracking Pad Aggregate Gradation

Sieve Size	Percent by Weight Passing Square Mesh Sieves
3 inch	100
2 inch	0-25
0.75 inch	0-15
Recycled crushed concrete or asphalt can not be used	

   2. Erosion control geotextile: Class 2, minimum.

L. Prefabricated Vehicle Tracking Pad: Multi-use manufactured pads of industrial grade materials.
   1. Weight: 8 lbs/sf, minimum.
   2. Crush Strength: 400 psi, minimum.

M. Aggregate Bag: Fabric bags filled with crushed stone or recycled rubber meeting the properties in Table 5.

Table 5 - Aggregate Bag Properties

Diameter (inches)	Minimum Weight (lb/ft)
6-8	6
10	10
12	15

   1. Crushed stone contained in the aggregate bag meeting the gradation requirements in Table 6.

Table 6 - Aggregate Bag Crushed Stone Gradation

Sieve Size	Percent by Weight Passing Square Mesh Sieves
1 inch	100
3/4 inch	90-100
1/2 inch	20-55
3/8 inch	0-15

#4	0-5

2. Rubber used in aggregate bags to be clean and 95% free of metal and particulates.
3. Geotextile for aggregate bags to be woven meeting the following properties:
   a. Grab Tensile Strength: 90 pounds-force, minimum, when tested in accordance with ASTM D4632/D4632M.
   b. Trapezoid Tear Strength: 25 pounds-force, minimum, when tested in accordance with ASTM D4533/D4533M.
   c. Mullen Burst: 300 psi, minimum, when tested in accordance with ASTM D3786/D3786M.
   d. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355/D4355M after 500 hours exposure.

N. Strom Drain Inlet Protection:
1. Aggregate filled fabric with the following dimensions:

Table 7 - Aggregate Bag Dimensions for Storm Drain Inlet Protection

Storm Drain Inlet Protection Properties	***Protection Type I**	**#Protection Type II**	**^Protection Type III**
Diameter	4 inches	4 inches	N/A
Minimum Section Length	7 feet	5 feet	5 feet
Apron Insert	---	30 inches or sized to grate	30 inches or sized to grate
Notes: *Type I protection used with Inlet Type R. #Type II protection used with Combination Inlet. Option A or B ^Type III protection shall be used with Vane Grate Inlet only. Option A or B Options A and B are shown on CDOT Std Plan M-208-1.			

2. Geotextile for storm drain inlet protection to be woven meeting the following properties:
   a. Grab Tensile Strength: 200x150 pounds-force, minimum, when tested in accordance with ASTM D4632/D4632M.
   b. Trapezoid Tear Strength: 60x60 pounds-force, minimum, when tested in accordance with ASTM D4533/D4533M.
   c. Mullen Burst: 400 psi, minimum, when tested in accordance with ASTM D4533/D4533M.
   d. Percent Open Area: 20% minimum, when tested in accordance with COE-22125-86.
   e. Water Flow Rate: 100 gallon per minute per square foot minimum, when tested in accordance with ASTM D4491/D4491M.
   f. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355/D4355M after 500 hours exposure.
   g. Cut roll weight: 4 pounds per linear foot of device (Type I and II devices).
3. Device to be capable of conforming to the shape of the curb.
4. Aggregate contained in the device to be gravel or crushed stone meeting the gradation requirements in Table 8.

Table 8 - Storm Drain Inlet Protection Aggregate Fill Gradation

Sieve Size	**Percent by Weight Passing Square Mesh Sieves**
1 inch	100
3/4 inch	90-100
1/2 inch	20-55
3/8 inch	0-15
#4	0-5

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.03 SCOPE OF PREVENTIVE MEASURES

A. In all cases, if permanent erosion resistant measures have been installed temporary preventive measures are not required.

B. Vehicle Tracking Pads: Traffic-bearing aggregate surface.
   1. Width: As required; 12 feet, minimum.
   2. Length: 70 feet, minimum.
   3. Thickness: 6 inch, minimum of aggregate placed on geotextile.
   4. Provide at each construction entrance from public right-of-way.
   5. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.

C. Prefabricated Vehicle Tracking Pads: When specified in the contract or approved by the Engineer.
   1. Width: 12 feet, minimum.
   2. Length: 35 feet, minimum.

D. Concrete Washout Structure: Constructed on site, excavated containment area with temporary berm to contain washout from concrete placement, construction equipment cleaning operations, and residue from cutting, coring, grinding, grooving, and hydroconcrete demolition.
   1. Excavated Containment Area:
      a. Width: 9 feet, minimum.
      b. Length: 15 feet, minimum.
      c. Depth: 3 feet, minimum.
      d. 3H:1V ramp for truck access
   2. Temporary Berm:
      a. Width: 4 feet, minimum.
      b. Height: 18 inches, minimum.
      c. Provide around perimeter of excavated containment area, except at truck access opening.
   3. Plastic Fence:
      a. Install around perimeter of temporary berm, except at truck access opening.
   4. Location Sign: High-visibility sign panel labeled "CONCRETE WASHOUT" mounted to adequate sign post.
      a. Sign Panel: 24 inches, minimum width by 18 inches, minimum height; located 5 feet above the ground surface.
   5. Impermeable Synthetic Liner:
      a. Install where the bottom of the excavated containment area is within 5 feet of anticipated high ground water elevation or the soil does not have adequate buffering capacity to meet water quality standards.

E. Prefabricated Concrete Washout Structure: When specified in the contract or approved by the Engineer. Watertight, portable bins to contain liquid concrete washout wastewater, solid residual concrete waste from washout operations, and residue from saw cutting, coring, grinding, grooving, and hydro-concrete demolition.
   1. Type 1: Multi-use watertight container with minimum capacity of 440 gallons, including freeboard.
   2. Type 2: Single-use watertight container with minimum capacity of 50 gallons, including freeboard and system to secure container to the ground.

3. Location Sign: High-visibility sign panel labeled "CONCRETE WASHOUT" mounted to adequate sign post.
    a. Sign Panel: 24 inches, minimum width by 18 inches, minimum height; located 5 feet above the ground surface.

F. Linear Sediment Barriers: Made of silt fences or erosion logs.
1. Provide linear sediment barriers:
    a. Along downhill perimeter edge of disturbed areas, including soil stockpiles.
2. Space sediment barriers with the following maximum slope length upslope from barrier:
    a. Slope of Less Than 2 Percent: 100 feet..
    b. Slope Between 2 and 5 Percent: 75 feet.
    c. Slope Between 5 and 10 Percent: 50 feet.
    d. Slope Between 10 and 20 Percent: 25 feet.
    e. Slope Over 20 Percent: 15 feet.

G. Storm Drain Curb Inlet Sediment Trap: Protect each curb inlet using one of the following measures:
1. Filter fabric wrapped around hollow concrete blocks blocking entire inlet face area; use one piece of fabric wrapped at least 1-1/2 times around concrete blocks and secured to prevent dislodging; orient cores of blocks so runoff passes into inlet.
2. Straw bale row blocking entire inlet face area; anchor into pavement.

H. Storm Drain Drop Inlet Sediment Traps: As detailed on drawings.

I. Temporary Splash Pads: Stone aggregate over filter fabric; size to suit application; provide at downspout outlets and storm water outlets.

J. Soil Stockpiles: Protect using one of the following measures:
1. Cover with polyethylene film, secured by placing soil on outer edges.
2. Cover with mulch at least 4 inches thickness of pine needles, sawdust, bark, wood chips, or shredded leaves, or 6 inches of straw or hay.

K. Mulching: Use only for areas that may be subjected to erosion for less than 6 months.
1. Wood Waste: Use only on slopes 3:1 or flatter; no anchoring required.

L. Temporary Seeding: Use where temporary vegetated cover is required.

M. Surface Roughening: Horizontal grooves along the contour of the slope accomplished by furrowing, scarifying, ripping, or disking the soil surface to create a 2 to 4-inch minimum variation in soil surface.

N. Vertical Tracking: Horizontal grooves and ridges along the contour of the slope created by driving a tracked vehicle up and down the soil surface. Sandy soils or soils that are primarily rock need not be tracked.

3.04 INSTALLATION

A. Vehicle Tracking Pad:
1. Excavate minimum of 6 inches.
2. Place geotextile fabric full width and length, with minimum 12 inch overlap at joints.
3. Place and compact at least 6 inches of aggregate.

B. Prefabricated Vehicle Tracking Pad:
1. Provide anchoring system approved by the manufacturer if pad weighs less than 8 lbs/sf.
2. Provide additional flared sections of approved pads or aggregate to accommodate construction traffic turning radii between the prefabricated tracking pad and a stabilized surface.
3. Place thin layer of stone, geotextile, or other stable surface under pad or area here the vehicles mount or dismount the manufactured trackout control device to stop rutting, as required.

C. Concrete Washout Structure:

1. Locate a minimum of 50 horizontal feet from State waters. Do not allow stormwater to carry wastes from washout and disposal locations.
2. Excavate minimum of 36 inches. Include freeboard capacity in the structure design to reasonably ensure the structure will not overtop during or because of a precipitation event.
3. Place impermeable synthetic liner, if required.
4. Install earthen ramp for truck access.
5. Place temporary berm around excavated area, except at truck access entrance.
6. Install orange plastic fence around perimeter, except at truck access entrance, to aid in identification of the concrete washout area.
7. Install a sign designating concrete washout location.

D. Prefabricated Concrete Washout Structure:
1. Install structure and verify it is ready for use before concrete placement operations.
2. Locate a minimum of 50 horizontal feet from State waters. Do not allow stormwater to carry wastes from washout and disposal locations.
3. Cover washout bins with a tarp tied down to the structure or staked to the ground when a storm event is anticipated.
4. Install a sign designating concrete washout location.
5. Do not move prefabricated structures when they contain liquid, unless approved by the Engineer.

E. Silt Fences:
1. Store and handle fabric in accordance with ASTM D4873/D4873M.
2. Where slope gradient is less than 3:1 or barriers will be in place less than 6 months, use nominal 16 inch high barriers with minimum 36 inch long posts spaced at 6 feet maximum, with fabric embedded at least 4 inches in ground.
3. Where slope gradient is steeper than 3:1 or barriers will be in place over 6 months, use nominal 28 inch high barriers, minimum 48 inch long posts spaced at 6 feet maximum, with fabric embedded at least 6 inches in ground.
4. Where slope gradient is steeper than 3:1 and vertical height of slope between barriers is more than 20 feet, use nominal 32 inch high barriers with woven wire reinforcement and steel posts spaced at 4 feet maximum, with fabric embedded at least 6 inches in ground.
5. Install with top of fabric at nominal height and embedment as specified.
6. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches, with extra post.
7. Fasten fabric to wood posts using one of the following:
   a. Four nails per post with 3/4 inch diameter flat or button head, 1 inch long, and 14 gauge, 0.083 inch shank diameter.
   b. Five staples per post with at least 17 gauge, 0.0453 inch wire, 3/4 inch crown width and 1/2 inch long legs.
8. Fasten fabric to steel posts using wire, nylon cord, or integral pockets.
9. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 12 inches high with post spacing not more than 4 feet.
10. Fasten geotextile to wire fabric reinforcement with ties or nylon cable ties at 12 inches on center at top, middle and bottom wire.
11. Fasten wire fabric reinforcement to steel posts with a minimum of three 12 gauge wire ties per post.
12. Install vinyl or rubber safety caps on tops of steel posts.

F. Erosion Logs
1. Embed erosion logs 2 inches into the soil.
2. Embed stakes so the top of the stake does not extend past the top of the erosion log more than 2 inches.

G. Straw Bale Rows:

1. Install bales in continuous rows with ends butting tightly, with one bale at each end of row turned uphill.
2. Install bales so that bindings are not in contact with the ground.
3. Embed bales at least 4 inches in the ground.
4. Anchor bales with at least two stakes per bale, driven at least 18 inches into the ground; drive first stake in each bale toward the previously placed bale to force bales together.
5. Fill gaps between ends of bales with loose straw wedged tightly.
6. Place soil excavated for trench against bales on the upslope side of the row, compacted.
7. Do not use rebars for stakes.

H. Mulching:
1. Hay or Straw: Apply 2-1/2 tons per acre; crimped in with a crimper or other approved equipment. Mulch and crimp seeded areas within 4 hours after seeding. Areas not mulched and crimped within four hours after seeding or before precipitation or damaging winds on site shall be reseeded with the specified seed mix at the Contractor's expense, before mulching and crimping.
2. Mulch Tackifier: Apply tackifier after Staw or Hay mulch is applied.
3. Wood Waste: Apply 6 to 9 tons per acre.
4. Erosion Control Matting: Comply with manufacturer's instructions.

I. Temporary Seeding:
1. When hydraulic seeder is used, seedbed preparation is not required.
2. When surface soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, and conventional or manual seeding is to be used, prepare seedbed by scarifying sufficiently to allow seed to lodge and germinate.
3. If temporary mulching was used on planting area but not removed, apply nitrogen fertilizer at 1 pound per 1000 sq ft.
4. On soils of very low fertility, apply 10-10-10 fertilizer at rate of 12 to 16 pounds per 1000 sq ft.
5. Incorporate fertilizer into soil before seeding.
6. Apply seed uniformly; if using drill or cultipacker seeders place seed 1/2 to 1 inch deep.
7. Irrigate as required to thoroughly wet soil to depth that will ensure germination, without causing runoff or erosion.
8. Repeat irrigation as required until grass is established.

3.05 MAINTENANCE

A. Inspect control measures weekly, within 24 hours after the end of any precipitation or snowmelt event that may cause surface erosion,.and daily during prolonged rainfall.

B. Repair deficiencies immediately.

C. Concrete Washout Structure:
1. Do not add solvents, flocculants, or acid to wash water.
2. Do not allow concrete waste, liquid and solid, to exceed 2/3 the storage capacity of the washout structure.

D. Prefabricated Concrete Washout Structure:
1. Do not add solvents, flocculants, or acid to wash water.
2. Do not allow concrete waste, liquid and solid, to exceed 2/3 the storage capacity of the washout structure.
3. Check and maintain washout areas as required.
4. Do not allow on-site permanent disposal of concrete washout waste.

E. Silt Fences:
1. Promptly replace fabric that deteriorates unless need for fence has passed.
2. Remove silt deposits that exceed one-third of the height of the fence.
3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.

F. Straw Bale Rows:
   1. Promptly replace bales that fall apart or otherwise deteriorate unless need has passed.
   2. Remove silt deposits that exceed one-third of the height of the bales.
   3. Repair bale rows that are undercut by runoff or otherwise damaged, whether by runoff or other causes.

G. Erosion Logs:
   1. Maintain erosion logs during construction to prevent sediment from passing over or under the logs.

H. Clean out temporary sediment control structures weekly and relocate soil on site.

I. Place sediment in appropriate locations on site; do not remove from site.

J. Maintain seeded areas in good condition until the date the project is declared complete. Any damage to seeded areas or to mulch materials shall be promptly repaired, as directed.

K. If the Contractor fails to maintain the control measures in accordance with the SWMP and Contract, or as directed by the Owner, the Owner may proceed to maintain the features as deemed necessary after giving a written 48 hour notice to the Contractor. The cost of maintaining the control measures will be deducted from any compensation due the Contractor.

3.06 CLEAN UP

A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Engineer.

B. Clean out temporary sediment control structures that are to remain as permanent measures.

C. Haul away all liquid and solid wastes from concrete washouts, including sediments and soils contaminated by concrete waste and liquids.

D. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

END OF SECTION

SECTION 01 57 26
SITE WATERING FOR DUST CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Work under this Section shall include furnishing all materials, labor, equipment and miscellaneous items necessary to provide dust control over the entire project site.

1.02 SUBMITTALS

A. Chemical Products. Descriptive literature defining chemical constituents.

PART 2 PRODUCTS

2.01 MAGNESIUM CHLORIDE

A.

Constituents	Percentage by Weight
Magnesium Chloride	28%-36%
Sulfate	2.5%
Potassium, sodium, calcium	Less than 1%
Nitrate	-0-

2.02 STARCH-BASED OR OTHER 100% NATURAL POLYMER

A. Accepted Product – DustStar by Chemstar or approved equal

PART 3 EXECUTION

3.01 DUST CONTRTOL

A. Dust control to be considered an integral part of the Work. Control shall be provided from the start of construction until the Work is complete. Fugitive dust as a result of construction shall be controlled at all times.

3.02 WATERING

A. For road construction, the Contractor shall have a water truck on site at all times for dust control. Wetting shall be done at the direction of the Engineer as required until the final wearing surface is completed.

B. For utility construction, dust control may be accomplished by water truck or spray system from an on-site water system if approved. Contractor shall be prepared to provide dust control until the final surface is completed.

C. The Contractor shall provide a water meter for metering any water taken from the municipal water system whether from fire hydrants or private taps. Watering shall be considered incidental to the related work and will not be paid for separately.

3.03 CHEMICAL CONTROL

A. Where required by the Engineer, dust control shall be provided by the use of magnesium chloride chemical spray to the road surface.

B. After the surface has been prepared, the road shall be pre-wet to a very damp condition. The product shall be applied using a watering truck with spray applicator, providing an even distribution across the surface. Application rate shall be 1/3 - 1/2 gallon per square yard. The surface shall be re-sprayed until complete coverage is attained. If Contractor is ordered to use magnesium chloride, Contractor shall be paid as per unit price in Bid Schedule, or in the absence of unit price, shall be negotiated with engineer and Owner before any application. No additional payment will be made for dust control.

END OF SECTION

SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General product requirements.

B. Transportation, handling, storage and protection.

C. Product option requirements.

D. Substitution limitations.

E. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 SUBMITTALS

A. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

B. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

C. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

PART 2 PRODUCTS

2.01 NEW PRODUCTS

A. Provide new products unless specifically required or permitted by Contract Documents.

B. Use of products having any of the following characteristics is not permitted:

1. Made using or containing CFC's or HCFC's.
2. Containing lead, cadmium, or asbestos.

2.02 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.03 MAINTENANCE MATERIALS

A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.

B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION LIMITATIONS

A. See Section 01 25 00 - Substitution Procedures.

3.02 TRANSPORTATION AND HANDLING

A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.

B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.

C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.

D. Transport products by methods to avoid product damage; deliver in undamaged condition in manufacturer’s unopened containers or packaging, dry.

E. Transport and handle products in accordance with manufacturer's instructions.

F. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.

G. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

H. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.

I. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.03 STORAGE AND PROTECTION

A. Provide protection of stored materials and products against theft, casualty, or deterioration.

B. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. See Section 01 74 19.

C. Store and protect products in accordance with manufacturers' instructions.

D. Store with seals and labels intact and legible.

E. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product. Maintain within temperature and humidity ranges required by manufacturer’s instructions.

F. For exterior storage of fabricated products, place on sloped supports above ground.

G. Store loose granular materials on solid surfaces in a well-drained area; prevent mixing with foreign matter.

H. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.

I. Comply with manufacturer's warranty conditions, if any.

J. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

K. Prevent contact with material that may cause corrosion, discoloration, or staining.

L. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

M. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

N. Perform and document manufacturer-required maintenance during storage, after installation and until commissioning of facilities. This shall include any lubricants, filters or other maintenance materials needed; any materials used shall not come from spare parts stock.

O. Store spare parts as required.
   1. Tag all spare parts with permanent, labeled packings by equipment designation number and identified with part number, equipment manufacturer, and subassembly component.
   2. Protect spare parts subject to deterioration such as ferrous metal items and electrical components with lubricants or desiccants and encapsulate in hermetically sealed plastic wrapping.
   3. Store spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length in a hinged wooden box. Paint box and

identify with stenciled lettering stating name of equipment, equipment numbers, and words “spare parts”.

4. Prepare and provide a neatly typed inventory of spare parts inserted in watertight plastic sleeve and taped to underside of box cover.

3.04 INSPECTION

A. Provide certificate of factory inspection and testing to Engineer prior to delivery.

B. Provide Engineer and Owner with forty-eight (48) hours advance notice of delivery of materials or products for which either party has requested to be present upon delivery. Jointly inspect items upon arrival. Verify each item's delivery against the Shipping Document or Bill of Lading to be provided by the shipper. Check items delivered against the shop drawings to verify that all items were shipped. Inform the manufacturer of any discrepancies.

C. Inspect all items carefully to verify that no damage occurred during shipping. If acceptable to Contractor, Engineer and Owner, as present, the products shall be unloaded and stored by the Contractor and the Shipper released.

D. If products are damaged but can be repaired in the field after discussion with the manufacturer, the products may be unloaded and stored for repair by the manufacturer at a location determined by the Owner and the Shipper released.

E. If the products are damaged but can only be repaired at the factoIry or must be replaced, the Shipper will be directed to return the product to the manufacturer.

END OF SECTION

SECTION 01 60 13
GENERAL MECHANICAL AND EQUIPMENT PROVISIONS

PART 1 GENERAL

1.01 SUMMARY

A. Requirements of this Section apply to all systems and equipment specified in each and all of the separate Sections of this Project Manual.

B. Contractor shall require all subcontractors and suppliers of mechanical and related appurtenances for the Work to follow the provisions of this Section.

C. The requirements of individual specification Sections supersede those in this Section in the event of a conflict.

1.02 SUBMITTALS

A. Refer to Sections 01 30 00 - Administrative Requirements, 01 77 00 - Closeout Procedures and 01 78 23 - Operation and Maintenance Data for submittal requirements.

1.03 MANUFACTURER'S EXPERIENCE

A. Unless specifically named in the individual Specifications, a manufacturer shall have furnished equipment of the type and size specified which has demonstrated successful operation and is in regular use.

1.04 STANDARD OF QUALITY

A. Items of equipment are specified by the name of a manufacturer for the purpose of establishing a standard of quality and acceptable experience.

B. Manufacturers specified have been determined by the Owner to meet or exceed the minimum acceptable standard for the designated equipment style and model.

C. Substitute equipment will be acceptable if it complies with the requirements for substitutions in the Contract Documents.

D. Refer to the Section 00 72 00 - General Conditions for requirements pertaining to substitutions and equals.

E. All mechanical equipment furnished under this Specification shall be new and of current design.

1.05 QUALITY ASSURANCE

A. Source Quality Control and Tests
   1. Observation of Performance Tests
      a. Where Specifications require presence of Engineer for testing of equipment, Owner is to pay for all costs of Engineer's first visit.
      b. If subsequent visits by Engineer are required because of initial incomplete or failed tests that necessitate retesting, Contractor shall reimburse Owner for all costs.
   2. Balancing
      a. Where specified, submit balancing reports as product data, demonstrating compliance with this requirement.
      b. e = 16 W/N
         1) Where:
            (a) e = imbalance, ounce-inches, maximum
            (b) W = Weight of the balanced assembly, pounds mass
            (c) N = Maximum operational speed, rpm

B. Source Quality Control and Tests
   1. Factory assemble and test equipment and pumps before shipping to job site.
   2. Ship units assembled for erection by Contractor unless shipping limitations or special installation requirements dictate otherwise.
      a. If knocked down, ship equipment in minimum practical number of pieces for field assembly by Contractor.

3. Subject each blower and pump to non-witnessed test at full speed using calibrated motor.
   a. Comprehensive test to develop head, capacity and efficiency for at least 6 points on unit's head/capacity curve and shall confirm performance at guaranteed performance condition (rated condition).
4. Conduct all pump tests in accordance with test standards of ANSI/HI 14.6. Predicted performance for model tests will not be accepted.
5. Test results shall be signed and certified as correct under penalty of perjury by an officer of the manufacturer's corporation.
6. Upon completion of testing, produce curves showing unit performance at full speed and predicted performance at speeds required to meet all other specified operating conditions.
7. Do not ship or deliver blowers or pumps until certified test results have been submitted and reviewed by Engineer.
8. Final acceptance of equipment will depend on satisfactory operation after installation as part of the Work.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Box, crate or otherwise enclose and protect equipment during shipment, handling, storage and installation until final acceptance of the Work.

B. Keep equipment dry and covered from exposure to weather.

C. Store pumps, motors, electrical equipment and equipment having antifriction or sleeve bearings in weather-tight storage facilities.

D. Lift large equipment items only at the points designated by manufacturer.

E. Factory Painted Surfaces
   1. Protect against impact, abrasion, discoloration, and other damage.
   2. Repair damage as directed and to satisfaction of the Engineer.

F. Electrical Equipment
   1. Maintain electrical equipment, controls and insulation dry at all times.
   2. Keep heaters in equipment connected and operating until equipment is placed in operation.

1.07 JOB CONDITIONS

A. Drawings are diagrammatic and show the intended arrangement of principal apparatus, piping and appurtenances.

B. Conform to Drawings as closely as possible and exercise care to secure approved headroom and space conditions, neat arrangement of piping, valves, hangers, and like items and to overcome structural interferences.

C. Verify dimensions and conditions at the place of installation and install materials and equipment in the available spaces.

D. Submit written details and reasons for proposed deviations from Drawings and Specifications and do not deviate from them unless authorized by Field Order, Work Change Directive or Change Order.

E. If approved changes require alteration of structures or related work, make such alterations as approved in advance by Engineer and Owner at no additional cost to Owner.

1.08 ADAPTATIONS OF EQUIPMENT

A. No responsibility for alteration of a planned structure to accommodate substitute equipment will be assumed by the Owner.

B. Equipment which requires alteration of the structures will be considered only if the Contractor assumes all responsibility for making and coordinating all necessary alterations.

C. All revisions to structures, mechanical, electrical, instrumentation or other work made necessary by such substitution shall be approved by the Engineer and Ownerr and the cost of such revisions, including cost of redesign, shall be made at the Contractor's expense.

PART 2 PRODUCTS

2.01 MATERIALS AND WORKMANSHIP

A. Furnish all equipment as new and guaranteed free from defects in materials, design, and workmanship.

B. Determine the condition and service under which the equipment will operate and to warrant that operation under those conditions shall be successful.

C. Proportion all parts of the equipment for all stresses that may occur during fabrication, erection and intermittent or continuous operation.

D. General
   1. All equipment shall be designed, fabricated and assembled in accordance with the best modern engineering and shop practice.
   2. Individual parts shall be manufactured to standard sizes and gauges so that repair parts, furnished at any time, can be installed in the field.
   3. Like parts of duplicate units shall be interchangeable.
   4. Equipment shall not have been in service at any time prior to delivery, except as required by tests.
   5. Materials shall be suitable for service conditions.
   6. Iron castings shall be tough, close-grained gray iron free from blowholes, flaws or excessive shrinkage and shall conform to ASTM A48/A48M.
   7. Except where otherwise specified, structural and miscellaneous fabricated steel used in items of equipment shall conform to the Standards of the AISC (MAN) - American Institute of Steel Construction Manual.
   8. All structural members shall be considered as subject to shock or vibratory loads.
   9. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall have a minimum nominal thickness of ¼ inch.
   10. Provide equipment and materials suitable for the service conditions and meeting standard specifications such as ANSI, ASME , AWWA, ASTM, NEMA, ICC (IBC) and UL. The location of the fabricator and his shop schedule shall be furnished to the Engineer prior to the beginning of fabrication so that the Engineer can schedule a shop inspection.
   11. Contractor to perform all maintenance and startup procedures as required by the equipment manufacturer, prior to substantial completion. This includes but is not limited to turning motors, lubricating equipment, and inspecting for construction debris.
   12. Contractor shall replace all spare parts used during equipment installation and startup prior to Final Completion.

2.02 LUBRICATION

A. Lubricants
   1. Provide lubricants of types recommended by equipment manufacturers, quantities sufficient for consumption prior to completion, testing and final acceptance.

B. Lubricant Systems
   1. Lubrication of equipment shall ensure constant presence of lubricant on all wearing surfaces.
   2. Lubricant fill and drain openings shall be readily accessible.
   3. Easy means for checking the lubricant level shall be provided.
   4. Prior to testing and/or operation, the equipment shall receive the prescribed amount and type of lubricant as required by the equipment manufacturer.
   5. Equipment lubrication systems shall be systems that require attention no more frequently than weekly during continuous operation, shall not require attention during start-up or shut down and shall not waste lubricant.

2.03 EARTHQUAKE DESIGN AND RESTRAINT

A. All machinery, mechanical and electrical equipment, instrumentation panels and electrical panels supplied under this contract shall be designed, constructed and attached to resist stresses produced by seismic forces specified in this Section.

B. Equipment that does not vibrate during normal operation shall be rigidly attached to the foundation or other adequate support to prevent lateral and vertical displacement.

C. Equipment that vibrates during normal operation shall be attached by means of isolators with mechanical stops that limit movement in all directions unless it can be demonstrated by calculations that such stops are not required.

D. Equipment or portions of equipment that move during normal operation shall be restrained with mechanical devices that prevent displacement unless it can be demonstrated by calculations that such restraints are not required.

E. Equipment Restraint Design Factors
   1. All equipment restraints, utilizing ductile materials, shall be designed to resist lateral seismic forces equal to 0.35 of the equipment weight with allowable working stresses increased by one-third, or 0.50 of the equipment weight with allowable stresses equal to the yield point of the material.
   2. For brittle materials, the allowable stresses shall not exceed 50 percent of the ultimate strength of the materials, based on a lateral force equal to 0.50 of the equipment weight.
   3. Cantilever posts supporting equipment shall be designed to resist lateral seismic forces equal to 0.50 of equipment weight with allowable working code stresses increased by one-third.

F. Minimum Earthquake Forces
   1. Except as provided herein the minimum earthquake forces shall be those prescribed by the ICC (IBC) International Building Code.
   2. Refer to Structural Plans Sheet S1 for applicable Code Edition, Importance Category, and Seismic Use Group. If this information is unavailable, consult with Engineer for appropriate design criteria.

G. Submittal Requirements
   1. For all equipment within Seismic Design Category C with a Component Importance Factor of 1.5 and within Seismic Design Category D, E, or F, submit the following items with the equipment shop drawings:
      a. Equipment anchorage details, including the weight of the equipment, anchor system matierials and sufficient detail to permit an evaluation of its structural adequacy.
      b. Mechanical stop details
      c. Engineering calculations, stamped by a Professional Engineer.
   2. All engineering required to comply with these provisions shall be the Contractor's responsibility.
   3. Submittals not meeting these requirements in full will be returned not approved, with deficiencies noted.
   4. Contractor shall be required to correct all deficiencies and resubmit the proposed system of anchorage for approval.
   5. Submittal requirements under this Section shall also be met for all equipment and attachments when, in the opinion of the Engineer, do not appear to meet minimum IBC requirements.

2.04 STRUCTURAL STEEL FABRICATIONS

A. Conform to AISC 303 - Code of Standard Practice for Steel Buildings and Bridges and AISC 360 - Specification for Structural Steel for Buildings, unless otherwise indicated or specified.

B. Design all fabrication for dynamic and vibratory loadings.

C. Use structural steel shapes conforming to ASTM A36/A36M, ASTM A53/A53M ASTM A500/A500M, ASTM A572/A572M, and ASTM A992/A992M or equal and as applicable.

D. Conform welding to AWS D1.1/D1.1M - Structural Welding Code.

E. Galvanize specified items in accordance with ASTM A123/A123M or ASTM A153/A153M, as applicable; use galvanized bolts and fasteners with galvanized assemblies.

2.05 EQUIPMENT BASES AND BEDPLATES

A. Mount equipment assemblies on a single heavy cast iron or welded steel bedplate unless otherwise shown or specified.

B. Provide bases and bedplates with machined support pads, tapered dowels for alignment or mating of adjacent items, adequate openings to facilitate grouting and openings for electrical conduits.

C. Continuously weld seams and contact edges between steel plates and shapes and grind welds smooth.

D. Do not support machinery or piping on bedplates other than that which is factory-installed.

E. Set equipment using leveling nuts.

F. Grout base only after equipment has been properly aligned using laser shaft alignment, sheave alignment, or equal and after equipment has been started and is acceptable to Engineer.

G. Provide plates of minimum thickness of ¼ inch.

H. Pump bedplates shall include a drip lip and provisions for directing gland leakage to a single disposal point.

I. Equipment base for pumps and equipment.
   1. Provide concrete base for all equipment and support legs as shown on Drawings, unless otherwise specified.
   2. Mounting of base plates or support legs directly to concrete floor will not be acceptable.
   3. Dowel all equipment bases directly into concrete floor slab as shown on Drawings.
   4. Cast equipment and pump anchor bolts directly in concrete base using manufacturer provided templates.
      a. Concrete base configuration: Follow same outline or equipment base plate to allow for easy access to equipment components for operation and maintenance.
      b. “Squaring off” base for equipment bases that are not square is not acceptable unless specifically authorized by Engineer in writing.

2.06 ANCHORS AND SLEEVES

A. Each equipment manufacturer shall furnish the required anchor bolts, nuts, washers and sleeves of adequate design for securing bases and bedplates to concrete bases or concrete surface.

B. Provide anchor bolts of length to allow for 1-1/2 inch of grout under base plates and adequate anchorage into structural concrete. Other specifically detailed lengths either shown or specified will supersede this requirement.

C. As applicable, conform to designs for attachments to resist seismic forces.

D. Provide sleeves with a diameter of at least 1-1/2 times anchor bolt diameter and of the same material as the anchor bolts.

E. Anchor bolts shall be:
   1. For Interior Dry Locations
      a. Hot dip galvanized or cadmium plated steel.
   2. Expansion anchors not allowed where less than 4” of concrete cover available from edge of anchor to nearest concrete corner/edge unless specified otherwise on the Drawings.
   3. For Exterior or Wet Locations
      a. Stainless steel Type 316 which conforms to ASTM A182/A182M, ASTM A276/A276M, and ASTM A479/A479M.
      b. Anchors must be drilled and epoxied.

2.07 SAFETY GUARDS

A. Provide exposed moving parts with guards which meet requirements of OSHA.

B. Fabricated of 14 gage steel ½-13-15 expanded metal screen to provide visual inspection

C. Guards shall be free of all sharp edges and corners

D. Use corrosion resistant materials at least equivalent to hot-dipped galvanized.

E. Design to be readily removable to facilitate maintenance of moving parts.

F. Provide reinforced holes at openings.

G. Extend all lubrication and drain fittings/lines through guards.

H. Design guards in outdoor locations to prevent entrance of rain and dripping water.

2.08 DRIVE UNITS

A. Provide drive units designed with a AGMA rating and service factor suitable for 24-hour continuous duty service under operating load, constructed to preclude oil leakage around shafts.

B. Drive unit housings shall be constructed of high-grade cast iron, welded steel or other suitable material.

C. Thermal rating of each unit shall exceed the design load or proper cooling devices shall be provided.

D. All drives shall be designed especially for the service for which they are to operate.

E. Motor Ratings

1. Provide drive motors having nameplate horsepower rating at least equal to the theoretical horsepower required to drive equipment under full load for conditions specified, including all losses in speed reducers and power transmission. Refer to Division 26.

2.09 GEARS

A. Provide oil-lubricated totally enclosed gear reducers and increasers.

B. Service Ratings

1. Each gear shall have a nameplate service horsepower rating equal to the nameplate rating of the driving motor.
2. Each gear shall have mechanical and thermal capacity equal to or greater than an equivalent horsepower determined by multiplying the service horsepower rating by the specified service factor recommended by AGMA for heavy duty service, except each set of worm gears shall have a minimum service factor of 1.20 and all other gears shall have a minimum service factor of 1.50.

C. Thermal Rating

1. Obtain thermal rating for the equivalent horsepower without auxiliary cooling equipment such as heat exchangers.
2. Design units to operate continuously for the conditions specified in a location where the ambient temperatures vary from -10 to 120 degrees F.
3. If a cooling coil is required, provide minimum 1 inch diameter tubing and a 1-inch solenoid supply water valve with the gear.

D. Bearings

1. Provide antifriction bearings throughout, designed to give 20,000 hours B10 life for the specified horsepower in continuous operation, of proportions, mountings and adjustment consistent with acceptable modern practice for applied radial and thrust loads at speeds involved.
2. Provide thrust bearing rates a 1-1/2 times the maximum thrust loadings involved.

E. Gear Nameplates

1. Equip each gear with an AGMA nameplate which shows service horsepower, actual service factor for actual mechanical or thermal rating as applicable, and AGMA gear Class I rating.

2.10 ELECTRICAL MOTORS FOR MECHANICAL EQUIPMENT

A. Horsepower ratings specified and/or shown for the proposed equipment are in accordance with the best information available to the Owner.

B. In the event any equipment item proposed by the Contractor requires motors with larger horsepower rating than indicated on the Electrical Drawings, it shall be the Contractor's responsibility to provide the proper control equipment, required modifications to motor control centers, starting equipment, feeder and branch circuits and accessories as required to make the installation comply with the NFPA 70 National Electrical Code (NEC) and to prevent excessive voltage drop without added cost to the Owner.

C. Conform to applicable requirements of Division 26, Electrical Specifications.

D. Designed and applied in accordance with NEMA, ANSI, IEEE, ABMA, and NEC standards.

E. If driven equipment is subject to frequent starting duty, provide motors suitable for that duty.

F. Nameplate horsepower based on continuous duty at 40 degrees C ambient, unless recognized and defined by the standards and codes for intermittent duty as a standard practice. Temperature rise about 40 degrees C ambient on continuous operation not to exceed the NEMA limit for 1.0 service factor and Class B insulation or Class A insulation if used.

G. Designed for satisfactory operation at any voltage within plus or minus 10 percent of rated voltage.

H. Designed for full voltage starting.

I. Bearing life based on the actual operating load conditions imposed by the drive equipment.

J. De-rated for altitude at which the equipment is to be installed. (See table below)

Project Elevation	Percent De-rated
0 to 3,000 feet above mean sea level	0%
3,000 feet	3%
Every additional 1,000 feet over 3,000	Add 1% for every additional 1,000 feet

K. Nameplate horsepower sized for continuous operation is 40 degrees C ambient at least 15 percent more than the max continuous load imposed by the driven equipment whether service factor is 1.0 or higher.

L. If driven equipment specification calls for encapsulated winding, provide a sealed insulation system designed for a more severe environment that usual varnish treatment can withstand. Motors with encapsulated windings may be single voltage rated.

M. Clamp type grounding terminal inside the motor conduit box.

N. Oversized motor conduit boxes, with ¾ inch NPT minimum, unless noted otherwise.

O. Totally enclosed outdoors.

P. Drip proof or totally enclosed indoors, supplier's option unless noted otherwise.

Q. Motors to be powered by variable frequency controllers shall have "inverter duty" type motor insulation systems shall conform to NEMA MG 00001 Part 31.4. The permanent nameplate shall denote that the motor is rated for inverter duty. Motor shall be de-rated for project elevation and sized without impingement on Service Factor.

R. Minimum motor efficiencies unless otherwise specified.

1. All motors over 5 HP shall be premium efficient

   a. For Standard Efficiency Motors

Hp	Efficiency
1	73
1.5	75
2	77
3	80

b. For Premium Efficiency Motors

Hp	Efficiency
5	87.5
7.5	90.2
10	90.2
15	91
20	91.7
25	92.4
30	92.4
40	93
50	93.6
60	94.1
75	94.5
100	94.5
125	94.5
150	95
200 and above	95.4

S. Motor Testing Requirements
   1. Short commercial test for standard motor horsepower less than 50 hp.
   2. Motor test results for complete test on one of each size motor for motor horsepower 50 hp or greater.
      a. Current balance.
      b. High potential test.
      c. Vibration test.
      d. Winding resistance.
      e. Locked rotor current.
      f. No load running current.
      g. Full load heat run.
      h. Full load percent slip.
      i. Efficiency at 100, 75, and 50 percent load.
      j. Power factor at 100, 75, and 50 percent load.
   3. Submit test results as required by Section 01 30 00 - Administrative Requirements.

2.11 GAUGES

A. Provide pressure gauge taps on suction and discharge sides of pumps, blowers, and compressors.

B. Provide pressure and vacuum gauges where specified.

C. The gauges shall be liquid filled, 4-1/2 inch diameter, and in accordance with the specification. Gauges shall be provided with a ball valve for isolation.

D. Discharge gauge ranges shall be standard commercially available range with the maximum reading not less than 15 psi greater than the pump rated shut-off pressure and shall be equipped with snubbers.

E. Gauges shall read in psi over their entire range.

2.12 EQUIPMENT IDENTIFICATION

A. Nametags: Identify all valves, instruments, and devices with equipment tag designation numbers and prefix and suffix letters as specified and/or shown on Process and Instrumentation Drawings (P&IDs), per requirements of Section 09 90 00 - Painting and Coating.

B. Nameplates: Identify all pumps and equipment with equipment tag designation numbers and prefix and suffix letters as specified and/or shown on Process and Instrumentation Drawings (P&IDs):
   1. Provide engraved or machine stamped non-corrosive metal nameplate fastened to pump or equipment base plate with screws or drive pins of same material.
   2. Nameplate material shall not corrode or discolor in moist or salt water spray atmosphere.
   3. Nameplates to indicate the following:
      a. Manufacturer
      b. Date of Manufacturer.
      c. Model and size.
      d. Serial Number.
      e. Rating in gpm or SCFM (if fan or blower) and feet of head or inches water column.
      f. Impeller or wheel diameter (if fan).
      g. Impeller diameter.
   4. Motor Nameplates
      a. Manufacturer.
      b. Date of Manufacturer.
      c. Model and size.
      d. Serial Number.
      e. Insulation Class
      f. Service Factor
      g. Voltage, Amps and Frequency

2.13 PAINTING

A. Conform to applicable requirements of Section 09 90 00 - Painting and Coating.

2.14 SPECIAL TOOLS, ACCESSORIES, AND LIFTING HANDLES

A. Provide all special tools, instruments and accessories required for proper maintenance.

B. Provide all special lifting and handling devices required.

C. Provide lifting handles, lugs, or eye bolts on all individual components of equipment systems weighing 50 pounds or more.

2.15 PROTECTION AGAINST ELECTROLYSIS

A. Provide suitable insulation between dissimilar metals where used in conjunction with each other between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis.

PART 3 EXECUTION

3.01 COORDINATION

A. General
   1. The Drawings show in a diagrammatic form the arrangements desired for the principal apparatus, piping and similar appurtenances and shall be followed as closely as possible.
   2. Exercise judgment in carrying out the work to provide the best possible headroom and space conditions throughout, to secure neat arrangement of piping valves, fixtures, hangers and similar appurtenances and to overcome local difficulties and interferences of structural conditions wherever encountered.

B. Measurements
   1. The Contractor shall take all measurements for his work at the installation sites, verify all subcontractor drawings and be responsible for the proper installation, within the available space of the apparatus specified and shown on the drawings and shall secure the approval of the Owner and Engineer for any variations before making changes.

C. Unit Responsibility
   1. Refer to pertinent Sections for items of equipment to be assembled of several components under the unit responsibility of a single manufacturer. To coordinate this requirement, the

Contractor shall monitor and verify the unit responsibility processes and submit the following information to the Owner and Engineer in writing on a monthly basis:

a. Shipment dates of the various components to the unit responsibility manufacturers.
b. Scheduled dates of factory tests by unit responsibility manufacturers.
c. Schedule shipment dates to site of unit responsibility items.
d. Schedule arrival date, installation date and start-up date.

3.02 CONTRACTOR INSPECTION

A. Inspect each item of equipment for damage, defects, completeness, and correct operation before installing. Inspect previously installed related work and verify it is ready for installation of equipment.

3.03 PREPARATION

A. Prior to installing equipment, ensure that installation areas are clean and that concrete or masonry operations are completed.

B. Maintain the areas in a broom-clean condition during installation operations.

C. Clean, condition and service equipment in accordance with the approved Operation Manuals and requirements in other Sections of these Specifications before installing.

3.04 INSTALLATION

A. Structural Fabrications
   1. Conform to the AISC Code and Specification references in Article “Structural Steel Fabrications”.

B. Equipment
   1. Conform to approved Instruction Manuals.
   2. Employ skilled craftsmen experienced in installation of the types of equipment specified. Use specialized tools and equipment such as precision machinist levels, dial indicators, gages and micrometers as applicable.
   3. Produce acceptable installations free of vibration or other defects.

C. Anchor Bolts
   1. Deliver bolts with templates or setting drawings and verify that bolts are properly sized and correctly located before structural concrete is placed.

D. Base and Bedplate Grouting
   1. Do not place grout until initial fitting and alignment of connected piping is completed.
   2. Level and align equipment on the concrete foundations, then entirely fill the space under the base or bedplates with grout.
   3. Bevel exposed grout at 45-degree angle. Except round exposed grout at horizontal surfaces for drainage.
   4. Trowel or point exposed grout to a smooth dense surface and damp cure with burlap for three days.
   5. When grout is fully hardened, remove jacking screws and tighten nuts on anchor bolts.
   6. Check the installation for alignment and level and perform corrective work as required to conform to the tolerances given in the applicable Instruction Manual.

3.05 FIELD QUALITY CONTROL

A. Refer to Section 01 40 00 - Quality Requirements.

END OF SECTION

SECTION 01 71 23
CONSTRUCTION SURVEYING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Land surveying services by Contractor completed under the supervision of a Professional Land Surveyor registered in the state of Colorado.

B. Construction surveying by Contractor.

1.02 DESCRIPTION OF SERVICES

A. Specific services listed in this section are in addition to, and do not supersede, general Execution and Closeout Requirements.

B. Sole responsibility for establishing all locations, dimensions and levels of items of work.

C. Sole responsibility for provision of all materials required to establish and maintain benchmarks and control points, including batter boards, grade stakes, structure, and pipeline elevation stakes, and other items.

D. Sole responsibility for coordinating all construction survey efforts.

E. Provision of facilities and assistance necessary for Engineer to check lines and grade points placed by Contractor.
   1. Performance of excavation or embankment work until after all cross-sectioning necessary for determining payment quantities for Unit Price work have been completed and accepted by Engineer.

F. Preparation and maintenance of professional-quality, accurate, well organized, legible notes of all measurements and calculations made while surveying and laying out the work.

G. Prior to backfilling operations, surveying - locating, and recording on a copy of Contract Documents - an accurate representation of buried work and Underground Facilities encountered.

1.03 SURVEY REFERENCE POINTS

A. Control survey at the project site will be provided by the Engineer. Control survey will consist of three (3) control points for horizontal and vertical control as shown on Contract Drawings. Points will be provided one time by the Engineer at no cost to the Contractor.

B. The contact for the control survey is Bob Brandeberry, PLS of SGM (970) 945-1004.

C. Contractor requests for control points shall be made in writing to Engineer a minimum of forty-eight (48) in advance to performing work requiring the control points.
   1. The forty-eight (48)-hour time period will commence from the time Engineer receives such written request from Contractor.
   2. The forty-eight (48)-hour period excludes weekend days, holidays, and days where weather conditions are detrimental to Engineer's ability to accurately perform the requested surveys.

D. Contractor shall verify and document the accuracy of the control points prior to using them for construction surveying control.

E. Work performed by Contractor before control points have been provided may be rejected.

F. Control points shall be carefully preserved. Contractor shall be responsible for the cost of replacing control points by the Engineer.

G. Replacement of control points will be done by the Engineer at the request of the Contractor on a time and materials cost basis.
   1. Costs for replacement of control points will be paid directly to the Engineer by the Contractor.

1.04 REFERENCE STANDARDS

A. FGDC-STD-007.1 - Geospatial Positioning Accuracy Standards - Part 1: Reporting Methodology; 1998.

B. FGDC-STD-007.2 - Geospatial Positioning Accuracy Standards - Part 2: Standards for Geodetic Networks; 1998.

C. FGDC-STD-007.4 - Geospatial Positioning Accuracy Standards - Part 4: Architecture, Engineering, Construction, and Facilities Measurement; 2002.

D. CDOT Survey Manual, Colorado Department of Transportation, 2021.

E. State Plane Coordinate System for Colorado.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Pre-survey Conference: Conduct a pre-survey conference prior to the start of the work of this section; require attendance by Engineer, Contractor's Superintendent, Contractor's Surveyor (PLS) and Survey Party Chief.

B. See Section 01 31 19 - Project Meetings for pre-survey conference information.

1.06 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Submit in addition to items required in Section 01 70 00 - Execution and Closeout Requirements.

C. Informational Submittals: Submit the following:
   1. Surveying work schedule: Submit to the Engineer prior to the pre-survey conference.
   2. Final property survey.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify layout information shown on drawings in relation to property survey and existing benchmarks.

B. Notify Owner’s representative and Engineer of discrepancies immediately in writing before proceeding to lay out work.

C. Locate and protect existing benchmarks, base lines, and demarcations. Preserve permanent reference points during construction.

D. Existing Utilities and Equipment: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify existing conditions.

3.02 LAND SURVEYING

A. General: Follow standards for geospatial positioning accuracy.
   1. FGDC-STD-007.1 as amended by Authority Having Jurisdiction.
   2. FGDC-STD-007.2 as amended by Authority Having Jurisdiction.
   3. FGDC-STD-007.4 as amended by Authority Having Jurisdiction.

B. Coordinate survey data with the State Plane Coordinate System of Colorado.

C. Contractor is responsible for the restoration of all property corners and control monuments damaged or destroyed by construction-related activities. Any disturbed monuments must be replaced at Contractor’s expense by a surveyor licensed in Colorado and approved by the Engineer.
   1. Temporarily suspend work at such points and for such reasonable times as the Owner may require for resetting monuments. The Contractor will not be entitled to any additional compensation or extension of time.
   2. CDOT Right-of-Way monuments shall be reset in accordance with Section 629 or the CDOT Survey Manual.

3.03 CONSTRUCTION SURVEYING

A. Calibration:
   1. All surveying equipment, including electronic distance meters (EDMs), tapes, tribrachs, theodolites, total stations, GPS receivers, and levels shall be calibrated prior to the start of work.
   2. EDMs, total stations, and GPS receivers shall be checked on a National Oceanic and Atmospheric Administration (NOAA) calibrated baseline.

B. General: Perform surveying as applicable to specific items necessary for proper execution of work.
   1. Alignment Staking: Provide alignment stakes at 50 foot intervals on tangent, and at 25 foot intervals on curves.
   2. Slope Staking: Provide slope staking at 50 foot intervals on tangent, and at 25 foot intervals on curves. Re-stake at every ten-foot difference in elevation.
   3. Structure: Stake out structures, including elevations, and check prior to and during construction.
   4. Pipelines: Stake out pipelines including elevations, and check prior to and during construction.
   5. Site Utilities: Stake out utility lines including elevations, and check prior to and during construction.
   6. Road: Stake out roadway elevations at 50 foot intervals on tangent, and at 25 foot intervals on curves.
   7. Cross-sections: Provide original, intermediate, and final staking as required, for site work and other locations as necessary for quantity surveys.
   8. Easement Staking: Provide easement staking at 50 foot intervals on tangent, and at 25 foot intervals on curves. If required by project conditions, provide wooden laths with flagging at 100 foot intervals.
   9. Record Staking: Provide permanent stake at each blind flange and each utility cap is provided for future connections. Use stakes for record staking of material(s) acceptable to Engineer.
   10. Building and Major Process-Related Structures Staking: Initial staking for any buildings or major process-related structures shall be done from two independent setups. An independent check shall be made by the Contractor and shown in the survey records for all buildings and major process-related structures.

C. Record Log: Maintain a log of layout control work. Record any deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used.

D. Use by the Engineer: The Engineer may at any time use line and grade points and markers established by the Contractor. The Contractor's surveys are a part of the work and may be checked by the Engineer at any time.

E. Accuracy:
   1. Establish Contractor's temporary survey references points for Contractor’s use to at least second-order accuracy (e.g., 1:10000). Set construction staking used as a guide for the work to at least third-order accuracy (e.g., 1:5000). Provide the absolute margin for error specified below on the basis established by such orders.
      a. Horizontal Accuracy of Easement Staking: Plus/minus 0.1 foot.
      b. Accuracy of Other Staking: Plus/minus 0.04 foot horizontally and plus/minus 0.02 foot vertically.
      c. Include an error analysis sufficient to demonstrate required accuracy in survey calculations.
   2. Owner reserves the right to check the Contractor's survey, measurements, and calculations. The requirement for accuracy will not be waived, whether this right is exercised or not.

3. The Contractor will not be entitled to any additional compensation or extension of time for corrective measures due to surveying inaccuracies, errors, or omissions or Engineer's inspection or the Contractor's corrections.

3.04 AS-BUILT SURVEYING

A. Required As-Built Survey will be performed by the Contractor.

B. Coordination
   1. Contractor is to coordinate with Owner to confirm which features require as-built surveying.
   2. It is the Contractor’s responsibility to coordinate the as-built survey and required measurements for items that are to be buried such that construction activities are not delayed or negatively impacted.

C. General
   1. The Contractor shall provide as-built survey including the elevation and location (and provide written documentation to the Owner) of construction features **during the progress of the construction** including the following:
      a. Water Lines
         1) Top of pipe elevations and coordinates for waterlines at the following locations:
            (a) Minimum every 250 linear feet, including
            (b) Horizontal and vertical points of inflection, curvature, etc.
            (c) Fire line tee
            (d) Plugs, stub-outs, dead-end lines
            (e) Casing pipe (each end) and all buried fittings
      b. Sanitary Sewer
         1) Top of pipe elevations and coordinates for force mains and siphon sanitary sewer lines (non-gravity facilities) at the following locations:
            (a) Minimum every 250 linear feet and any buried fittings
            (b) Horizontal and vertical points of inflection, curvature, etc.
      c. Stormwater - Not Applicable
   2. The Contractor shall provide as-built survey including the elevation and location (and provide written documentation to the Owner) of construction features **after the construction is completed** including the following:
      a. Water Lines
         1) Cathodic protection test stations
         2) Sampling stations
         3) Meter boxes/vaults (All sizes)
         4) Fire hydrants
         5) Valves (gate, butterfly, etc.)
         6) Air Release valves (Manhole rim and vent pipe)
         7) Blow off valves (Manhole rim and valve lid)
         8) Pressure plane valves
         9) Underground Vaults
            (a) Rim and flowline elevations and coordinates for each Underground Vault
      b. Sanitary Sewer
         1) Cleanouts
            (a) Rim and flowline elevations and coordinates for each cleanout
         2) Manholes and Junction Structures
            (a) Rim and flowline elevations and coordinates for each
      c. Stormwater
         1) Manholes
            (a) Rim and flowline elevations and coordinates for each manhole

3.05 RECORDS

A. Maintain at the Site a complete and accurate log of control and survey work as it progresses.
   1. Organize and record survey data in accordance with recognized professional surveying standards, Laws and Regulations, and prevailing standards of practice in Colorado. Record Contractor's surveyor's original field notes, computations, and other surveying data in Contractor-furnished hard-bound field books. Contractor is solely responsible for completeness and accuracy of survey work, and completeness and accuracy of survey records, including field books. Survey records,(including field books) may be rejected by Owner due to failure to organize and maintain survey records in a manner that allows reasonable and independent verification of calculations, and/or allows identification of elevations, dimensions, and grades of the work.
   2. Illegible notes or data, and erasures on any page of field books, are unacceptable. Do not submit copied notes or data. Corrections by ruling or lining out errors will be unacceptable unless initialed by the surveyor. Violation of these requirements may require re-surveying the data questioned by Engineer.

B. Submit three copies of final property survey to Owner. Include on the survey a certification, signed by the surveyor, that principal metes, bounds, lines, and levels of the Project are accurately positioned as shown on the survey. Include the following information:
   1. Structure locations from property lines, and distances to adjacent buildings.
   2. Dimensions and locations of drives, walks, walls, underground utilities, appurtenances, and major site features.
   3. Location of easements.
   4. Final grading topographic survey.

C. All survey records generated shall be the property of the Owner and shall be available to the Engineer for inspection or reproduction at all times. All survey records shall be transmitted to the Engineer for inclusion into the project records before final project acceptance. All survey records shall be stamped with the seal of, and signed by, the responsible PLS.

END OF SECTION

SECTION 01 74 13
CLEANING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Intermediate and final cleaning of Work not including special cleaning of closed systems specified elsewhere.

1.02 DELIVERY, STORAGE, AND HANDLING

A. Store cleaning products and cleaning wastes in containers specifically designed for those materials.

1.03 SCHEDULING

A. Schedule cleaning operations so that dust and other contaminants disturbed by cleaning process will not fall on newly painted surfaces.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cleaning Agents:
   1. Compatible with surface being cleaned.
   2. New and uncontaminated.
   3. For Manufactured Surfaces: Material recommended by manufacturer.

PART 3 - EXECUTION

3.01 CLEANING - GENERAL

A. Prevent accumulation of wastes that create hazardous conditions.

B. Conduct cleaning and disposal operations to comply with laws and safety orders of governing authorities.

C. Do not dispose of volatile wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains or sewers.

D. Dispose of degradable debris at an approved solid waste disposal site.

E. Dispose of nondegradable debris at an approved solid waste disposal site or in an alternate manner approved by Engineer and regulatory agencies.

F. Handle materials in a controlled manner with as few handlings as possible.

G. Do not drop or throw materials from heights greater than 4 FT or less than 4 FT if conditions warrant greater care.

H. On completion of work, leave area in a clean, natural looking condition.
   1. Remove all signs of temporary construction and activities incidental to construction of required permanent Work.

I. Do not burn on-site.

3.02 INTERIOR CLEANING

A. Cleaning During Construction:
   1. Keep work areas clean so as not to hinder health, safety or convenience of personnel in existing facility operations.
   2. At maximum weekly intervals, dispose of waste materials, debris, and rubbish.
   3. Vacuum clean interior areas when ready to receive finish painting.
      a. Continue vacuum cleaning on an as-needed basis, until substantial completion.
   4. Control dust in work areas of existing facilities.
      a. Provide protection to existing electrical and mechanical equipment as required to eliminate detrimental effects due to construction.
      b. Weekly check air handling filters in existing units having construction activities.

1) Replace as necessary.

c. At maximum monthly intervals, check interior of existing electric panels and vacuum if dust accumulation has occurred.

d. At maximum weekly intervals, sweep all floors, including basins, tunnels, platforms, walkways, and pick up and dispose of all debris.

1) Use dust suppressant sweeping compound in areas open to areas of existing facility operations.

B. Final Cleaning:

1. Complete immediately prior to Substantial Completion inspection.
2. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from sight-exposed surfaces.
3. Wipe all lighting fixture reflectors, lenses, lamps and trims clean.
4. Wash and shine glazing and mirrors.
5. Polish glossy surfaces to a clear shine.
6. Ventilating systems:

a. Clean permanent filters and replace disposable filters if units were operated during construction.

b. Clean ducts, blowers and coils if units were operated without filters during construction.

7. Replace all burned out lamps.
8. Broom clean process area floors.
9. Mop office and control room floors.

3.03 EXTERIOR (SITE) CLEANING

A. Cleaning During Construction:

1. Construction debris:

a. Confine in strategically located container(s):

1) Cover to prevent blowing by wind.

2) Haul from site minimum once a week.

b. Remove from work area to container daily.

2. Vegetation: Keep weeds and other vegetation trimmed to 3 inch maximum height.
3. Soils, sand, and gravel deposited on paved areas and walks:

a. Remove as required to prevent muddy or dusty conditions.

b. Do not flush into storm sewer system.

B. Final Cleaning:

1. Remove trash and debris containers from site.

a. Re-seed areas disturbed by location of trash and debris containers.

2. Broom clean paved surfaces.
3. Rake clean other surfaces of grounds.

3.04 FIELD QUALITY CONTROL

A. Immediately prior to Substantial Completion inspection, conduct an inspection with Engineer to verify condition of all work areas.

END OF SECTION

SECTION 01 75 16
STARTUP PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Performance Validation Testing and Startup Period requirements.

B. Operational demonstration requirements for equipment, systems or facility.

1.02 DEFINITIONS

A. Project System: Specific system, consisting of an independent arrangement of equipment, structures, components, piping, wiring, materials or incidentals that work together to achieve an identifiable outcome.

B. Related System: Equipment or subsystem whose function is necessary for the start-up, testing and operation of the Project System as a whole.

C. Validation Testing: A period of time during which Project Systems and Related Systems are operated to demonstrate the general performance intended by the Specifications.

D. Start-up Period: A period of time, of specified duration, following Validation Testing, during which process flow or product is introduced to the facility or Project System. This period is used to demonstrate successful operation and performance of the project without exceeding specified downtime limitations, to prove functional integrity of mechanical systems, electrical equipment and control interfaces to the satisfaction of the Engineer.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL

A. Validation Testing and Start-up Period activities must be a coordinated, collaborative effort between the Contractor, Owner and Engineer due to the many personnel and existing systems that may be affected.

B. When requested, furnish access, equipment, facilities and labor assistance as necessary for the Engineer and Owner to evaluate system operation during testing and start-up, including ladders, hoisting, temporary lighting, temporary water supply, and like services.

C. Provide sufficient number of properly trained personnel to supervise and conduct testing.

D. Pay all costs associated with facility, systems or equipment start-up, including all fluids, lubricants, chemicals, consumables, equipment and maintenance.

E. Items provided for testing and startup are in addition to those to be provided under the Technical Specifications.

F. Conduct coordination meetings 7 days before all Validation Testing and Start-up Period activities. Meetings shall include Owner, Engineer and any manufacturers or trades associated with the system test.

G. Provide all pumping and by-pass connections required during the Validation Testing and Start-up Period activities.

H. Provide the first required maintenance checkup for all equipment.
   1. Coordinate with Owner for timing of checkup to ensure operations and maintenance staff is involved to the extent possible.

I. Mandatory prerequisites:
   1. Manufacturer training has been completed on all components of the Project System and any Related Systems to be tested.
   2. Each piece of equipment within the Process System and any Related Systems has been field-verified by a manufacturer's representative to be properly installed and functional.

3. The control system for the Project System and Related Systems has been checked to the extent possible (e.g. contact closures, interlock functions, signal generation and transmission, alarming, trending, instruments calibration, etc.) prior to the introduction of process media.
4. Approved vendor operation & maintenance manuals are on-site.
5. Contractor has submitted and received dispositions from Engineer of “no exceptions taken” (NET) or “make corrections noted” (MCN) on Validation and Startup plans prior to field testing/startup activities.

3.02 TESTING PROCEDURES

A. Ranges for Testing
   1. Flow metering systems shall be tested at not less than three (3) values corresponding approximately to minimum, average, and maximum capacity, respectively.
   2. Liquid level indicating systems shall be tested at not less than five (5) levels corresponding to low, average, normal, maximum and high alarm levels, respectively.
      a. Low-low and High-high level alarms and system reaction shall also be tested where equipment or instruments are required to react to such conditions.
   3. Remotely controlled valves shall demonstrate suitable operation both from local controls and remote controls.
      a. At a minimum, these procedures shall include full-open and full-closed positioning.
      b. Each test shall be repeated not less than three (3) times for non-throttling and non-modulating valves.
      c. In addition to these minimum requirements, and subject to approval, all throttling valves and modulating valves shall be operated at not less than three (3) intermediate positions and shall demonstrate the ability of each valve to hold the set position under operating conditions.
   4. Variable speed equipment shall demonstrate accurate response to speed controlling devices and controls within the required operating range.
      a. Actual output shaft speeds of manually adjustable speed equipment shall be validated by measurement of shaft speeds versus speeds shown by equipment instruments.

B. Equipment response to appropriate manual or automatic controls, or combinations of both automatic and manual controls, shall be demonstrated to be correct and accurate.

C. Where applicable, all components shall be tested for both manual and automatic operation.

D. Where a component performs more than one function, every function shall be validated.

E. Pumping equipment shall respond accurately and reliably to liquid level and flow rate signals from devices in appurtenant basins, sumps or wet wells.
   1. Automatic alternation and backup pump functions shall also be validated.

F. Chemical feed systems shall respond accurately to flow, and if applicable, water quality instrument signals and feed proportionally over the ranges of process flows to be validated.

G. Auxiliary equipment items such as annunciators, alarms and like items shall respond accurately and reliably to every condition to which they are programmed, in the manner specified.

H. Recording of Data.
   1. Maintain neat and comprehensive records of each operational Start-up and system Validation test.
   2. Describe each portion of the demonstration or validation procedure with all components itemized. Prepare records on forms in a step-by-step fashion paralleling the approved procedure plans. Forms shall list for each condition:
   3. Prepare records on forms in a step-by-step fashion paralleling the approved procedure plans. Forms shall list for each condition:
      a. Step taken
      b. Result anticipated

c. Result obtained
d. If incorrect, corrective action taken
e. Retest result
f. Steps “d” and “e” shall be repeated until all elements of the system being tested operates as required.

4. Instruments, gauges and other sensors and display devices forming a part of the various systems shall be employed for data acquisition to the extent applicable. The Contractor shall furnish all other instruments, gages, recorders and test devices as required, types conforming to the approved procedure plans.
5. All applicable data, such as, but not limited to, water and other liquid levels, flows, pressures, head differentials, run durations, instrument readings, chemical feed rates, voltage settings, drive speeds, motor running currents, torques, voltages, flows, pressures, water quality parameter values, and related information, as applicable, and in accordance with the approved procedure plans, shall be recorded at the start and finish of each operational Start-up Period test, and at maximum, 8-hour intervals during system Validation Tests, unless shorter intervals are specified elsewhere.
6. When a repeat of the same demonstration or Validation Test is required to verify the results, the repeat procedure shall be indicated on the recorded data by numerical indication, date and time.

3.03 VALIDATION TESTING

A. Cooordinate with Owner and Engineer to ensure means of operation under simulated representative operational conditions without interference with existing operations.

B. Testing shall be done using clean water, unless otherwise approved in advance in writing by the Engineer.

C. Validation Testing may only occur after the Project System’s and Related Systems’ components have been field-verified by a manufacturer's representative to be pro.

D. Validation Testing must be witnessed and accepted in writing by Engineerr.

E. Validation testing will be accepted after the entire Project System and Related Systems operate as intended and uninterrupted for 72 hours.

F. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled times, at equipment location.

G. Demonstrate the functional integrity of the mechanical, electrical, and control interfaces of the respective equipment and components comprising the facility or Project System.

H. Owner reserves the right to simulate operational variables, equipment failures, routine maintenance scenarios, etc., to verify the functional integrity of automatic and manual backup systems and alternate operating modes.

3.04 START-UP PERIOD

A. Owner will provide operational personnel to provide process decisions affecting plant performance. Owner’s assistance will be available only for process decisions.

B. Maintain all equipment and components of each system during the entire Start-up Period, 24 hours per day, following manufacturers’ instructions, recording and controlling the plant’s performance, recording all maintenance, repairs and instrument settings and submitting records to the Owner at the end of the Startup Period.

C. The Owner’s staff will be available to assist during the Start-up Period, but the responsibility for the proper operation and maintenance during the Startup Period rests solely with the Contractor.

D. Remedy all deficiencies noted in Validation Testing prior to the Start-up Period.

E. Conduct a Pre-Startup Meeting not less than fifteen (15) days prior to the beginning of the plant Startup Period.

1. The Owner, Engineer and other responsible parties (equipment manufacturers and Owner operations staff members) shall also attend.
2. Submit a start-up plan five (5) days prior to this meeting. Start-up Plan to address:
   a. Schedule.
   b. Remaining items to complete
   c. Remaining items to complete
   d. Step-by-step procedure for startup of the facility/system including schedule, system tie-ins, sequence of events, basin filling and pipeline charging requirements (as applicable), review and checking of systems before and during startup, and requirements and responsibilities of each party.

F. Provide final field instruction on select systems and respond to any system problems or failures which may occur.

G. The Start-up Period will commence once process flows have reached all systems. The Start-up Period will continue until the entire system operates as intended and uninterrupted for seven (7) days.

H. If, during the Start-up Period, the aggregate amount of time used for repair, alteration, or unscheduled adjustments to any equipment or systems that renders the affected equipment or system inoperative exceeds ten (10) percent of the Start-up Period, the demonstration of functional integrity will be deemed to have failed.
   1. In the event of failure, a new Start-up Period will recommence after correction of the cause of failure.
   2. The new Start-up Period shall have the same requirements and duration as the Start-up Period previously conducted.

I. Conduct the demonstration of functional integrity under full operational conditions.

J. After completion of the Startup Period and acceptance of the plant facilities by the Owner, the Contractor shall verify in writing that:
   1. All systems are performing and operating satisfactorily and in accordance with the specifications.
   2. Any specified manufacturer's field modifications or services are complete.
   3. All auxiliary and support systems are operating properly.
   4. No safety defects exist.
   5. All manual and automatic controls are operational.
   6. All equipment has been lubricated; calibrated; filters replaced or cleaned; serviced and is ready for continuous operation.

3.05 TESTING, ADJUSTING, AND BALANCING

A. Perform testing, adjusting and balancing under provisions of Division 23.

B. Reports will be submitted by an independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with specified requirements of the Contract Documents.

END OF SECTION

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Closeout submittals.

B. System startup.

C. Final cleaning.

D. Substantial completion and final closeout procedures.

E. Warranties and bonds.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Project Record Documents:
   1. Maintain on site record documents in accordance with Section 01 32 00 - Construction Progress Documentation.
   2. Submit documents to Engineer with final Application for Payment.

C. Warranties and Bonds:
   1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
   2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
   3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SYSTEM STARTUP

A. Coordinate with requirements of Sections 01 60 13 - General Mechanical and Equipment Provisions, 01 75 16 - Startup Procedures, and 01 91 13 - General Commissioning Requirements.

B. Coordinate schedule for start-up of various equipment and systems.

C. Notify Engineer and Owner seven days prior to start-up of each item.

D. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.

E. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

F. Verify that wiring and support components for equipment are complete and tested.

G. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.

H. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

I. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.02 FINAL CLEANING

A. Perform final cleaning prior to Substantial Completion in accordance with the requirements of Section 01 74 13 - Cleaning.

3.03 SUBSTANTIAL COMPLETION PROCEDURES

A. See Sections 00 72 00 - General Conditions and 00 73 00 - Supplementary Conditions for additional information.

B. Make submittals that are required by governing or other authorities.
   1. Provide copies to Engineer and Owner.

C. Notify Engineer and Owner when work is considered ready for Engineer's Substantial Completion inspection.

D. Complete the following incidental items prior to the Substantial Completion inspection:
   1. Required testing and training.
   2. Connect all utilities and verify functionality.
   3. Dismantle and remove temporary construction facilities.
   4. Successful completion of startup tests.

E. Submit written certification that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Engineer's Substantial Completion inspection.

F. Conduct the Substantial Completion inspection with the Engineer and Owner.

G. Create Final Correction Punch List containing Engineer's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Engineer and Owner.

H. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.

I. Notify Engineer when work is considered finally complete and ready for Engineer's Substantial Completion final inspection.

J. Complete items of work determined by Engineer listed in executed Certificate of Substantial Completion.

3.04 RE-INSPECTION FEES

A. See Section 00 73 00 - Supplementary Conditions for requirements related to financial obligations of re-inspections.

B. Submit any question with regard to any items on the punch list before final inspection.

3.05 MISCELLANEOUS KEYS, SWITCHES AND WRENCHES

A. Provide the following items to the Owner at the completion of the project:
   1. All loose keys for hose bibs
   2. Adjustment keys and wrenches for door closers and panic hardware
   3. Keys for electric switches, electrical panels, etc.

3.06 SPARE PARTS

A. Provide all spare parts and products as required by the Technical Specifications.

B. Submit an itemized list of all items furnished, describing each item and citing all appropriate Specification Sections and paragraphs.

C. Package each item for long term storage and mark or tag for easy identification.

D. Deliver items to the project site to an area designated by the Owner.

E. Provide an inventory of delivered items and obtain a receipt from the Owner after inspection.

F. Deliver the inventory with an affidavit stating these are the specified spare parts or products delivered by the manufacturer or supplier of the installed equipment or material.

3.07 FINAL COMPLETION

A. Deliver the following items to the Engineer:
   1. Inspection certificates.

a. Upon completion of the Work, secure in triplicate from any state or local governing bodies having jurisdiction (e.g. State Electrical Board) that the work is in accordance with applicable codes.
b. Subcontractors are responsible for obtaining inspection certificates for their work and providing to the Contractor for transmittal to the Engineer.

2. Equipment and material manufacturers' guarantees/warranties, as required by the Specifications and described in this Section.
3. A signed letter stating the Contractor's general warranty and guarantee of materials and workmanship as required by the General Conditions and Supplementary Conditions.
4. Operation and maintenance manuals and spare parts, as specified.
5. Receipts for extra materials delivered to the Owner.
6. Affidavit of Release of Liens. See Section 00 65 19.16 for additional information.
7. Consent of Surety to Final Payment. See Section 00 65 19.19 for additional information.
8. Project Record Documents.
9. Acknowledgement of date of Substantial Completion.
10. Final Application for Payment.

B. Make final change-over of locks and deliver keys.

C. Release of final payment will be contingent upon receipt of these items.

3.08 CERTIFICATE OF FINAL COMPLETION

A. The Engineer will issue a Certificate of Final Completion in writing to Contractor after successful facility/process startup with proper operation and control (if applicable), correction of all punch list items, receipt and acceptance of the verification letter, and completion of all relevant items identified in this Section.

3.09 WARRANTIES AND BONDS

A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.

B. Verify that documents are in proper form, contain full information, and are notarized.

C. Co-execute submittals when required.

D. Retain warranties and bonds until time specified for submittal.

E. Manual: Bind in commercial quality 8-1/2 by 11 inch three D side ring binders with durable plastic covers.

F. Cover: Identify each binder with typed or printed title **WARRANTIES AND BONDS**, with title of Project; name, address and telephone number of Contractor and equipment supplier; and name of responsible company principal.

G. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.

H. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

I. Correct defective work within the Correction Period per the General Conditions and Supplementary Conditions.

J. Attend a final warranty inspection per Section 01 31 19 - Project Meetings.**]**

K. In the event that multiple or phased system startups are required, Warranty Periods will begin upon written acceptance by Owner with Certificate of Substantial Completion?] for each system after successful startup of the complete system.

L. Equipment warranties shall be the greater of the manufacturer's standard warranty and the Contractor's general warranty and guarantee requirement specified in the Supplementary Conditions.

END OF SECTION

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SUMMARY

A. Operation and Maintenance (O&M) instructions, information and other data to be provided by the Contractor.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Provide O&M instructions in accordance with this Section and as required in the Technical Specifications.

C. Provide O&M instructions for each maintainable piece of equipment, equipment assembly or subassembly, and material provided or modified under this Contract.

D. Submit O&M instructions in electronic format to Engineer for review a minimum of twenty (20) days before on-site training begins. Instructions must be accepted by the Engineer before on-site training begins.

E. Provide final approved versions of O&M instructions in electronic format and two (2) hardcopy sets to the Owner at project closeout.

1.03 REQUIRED INFORMATION

A. Provide the following O&M information and data:
   1. Name, address, and telephone number of the manufacturer.
   2. Name and contact information of nearest representative of the manufacturer.
   3. Name and contact information of nearest supplier of the manufacturer's equipment and parts

B. Use drawings, photos, graphics and pictorials to illustrate the printed text as necessary to present the information.

C. Provide the following information with the O&M instructions:
   1. GENERAL INFORMATION
      a. Introduction and overall material, equipment and system description, purpose, functions, and simplified theory of operation, if applicable.
      b. Provide catalog number, size, composition, color and texture designations for materials, as applicable.
      c. Identify equipment, devices, and valves by tag IDs included on the Project’s P&ID Drawings.
   2. INSTALLATION INSTRUCTIONS
      a. Procedures, sequences, precautions, and tolerances for level and horizontal/vertical alignment during installation as well as proper setting and testing of protective devices.
   3. TEST REPORTS AND PERFORMANCE DATA
      a. Provide manufacturer’s test reports and performance curves/data.
      b. Include test reports for dynamic balancing.
      c. Provide additional performance data required by the Specifications for approval.
   4. OPERATING INSTRUCTIONS
      a. Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:
         1) STARTUP, SHUTDOWN, AND POST SHUTDOWN PROCEDURES
         2) Provide a control sequence for each of these operations.
         3) NORMAL OPERATIONS
            (a) Provide control diagrams with data to explain operation and control of systems and specific equipment.

(b) Include a discussion of special seasonal operations, if applicable.

4) EMERGENCY OPERATIONS

(a) Provide emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment.

(b) Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency operations of all utility systems including valve locations and portions of systems controlled.

(c) Provide guidance on emergency operations of all utility systems including valve locations and portions of systems controlled.

5. OPERATOR PRESTART

a. Provide requirements to set up and prepare each system for use.

b. Provide requirements to set up and prepare each system for use.

6. SAFETY PRECAUTIONS

a. List personnel hazards for equipment and list safety precautions for all operating conditions.

b. Provide Safety Data Sheets for hazardous media/materials, as applicable.

7. OPERATOR SERVICE REQUIREMENTS

a. Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.

b. Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.

8. ENVIRONMENTAL CONDITIONS

a. Provide a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.

9. PREVENTATIVE MAINTENANCE

a. The following information shall be provided for preventive and scheduled maintenance to minimize corrective maintenance and repair:

1) LUBRICATION DATA:

(a) Provide lubrication data and other than instructions for lubrication.

(b) A table showing recommended lubricants for specific temperature ranges and applications;

(c) Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities;

(d) A lubrication schedule showing service interval frequency.

(e) SAE types.

2) PREVENTATIVE MAINTENANCE PLAN AND SCHEDULE

(a) Provide manufacturer's schedule for routine preventive maintenance, inspections, testing, balancing, calibration, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair.

(b) Provide manufacturer's projection of preventive maintenance man-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft.

3) CLEANING INSTRUCTIONS

(a) Provide manufacturer’s recommended cleaning agents and methods, cleaning precautions and recommended cleaning schedule.

10. CORRECTIVE MAINTENANCE

a. Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.

11. TROUBLESHOOTING GUIDES AND DIAGNOSTIC TECHNIQUES

a. Provide step-by-step procedures to promptly isolate the cause of typical malfunctions.

b. Describe clearly why the checkout is performed and what conditions are to be sought.
c. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or requires replacement.

12. WIRING DIAGRAMS AND CONTROL DIAGRAMS
    a. Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide single line diagrams for motor control centers. Provide a complete and accurate depiction of the actual “as installed” job-specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identically to actual installation numbering.
    b. Provide single line diagrams for motor control centers.
    c. Provide a complete and accurate depiction of the actual “as installed” job-specific wiring and control work.
    d. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identically to actual installation numbering.
13. MAINTENANCE AND REPAIR PROCEDURES
    a. Provide instructions and list tools, instruments, accessories, and special lifting/handling devices required for periodic maintenance, adjustment, calibration or restoration of product or equipment to proper condition or operating standards.
14. REMOVAL AND REPLACEMENT INSTRUCTIONS
    a. Provide step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments.
    b. Provide tolerances, dimensions, settings, and adjustments required. Instructions shall include a combination of test and illustrations.
15. SPARE PARTS, TESTING EQUIPMENT AND SUPPLY LISTS
    a. Provide lists of spare parts, testing equipment and other supplies required for maintenance, repair and/or special testing to ensure continued service or operation without unreasonable delays.
    b. Special consideration is required for facilities at remote locations.
    c. List spare parts, testing equipment and supplies that have a long acquisition lead times.
16. CORRECTIVE MAINTENANCE MANHOURS
    a. Provide manufacturer's projection of corrective maintenance man-hours including craft requirements by type of craft.
    b. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.
17. PARTS IDENTIFICATION
    a. Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement.
    b. Include special hardware requirements, such as requirement to use high-strength bolts and nuts.
    c. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification.
    d. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items.
    e. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part.
    f. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.
18. WARRANTY INFORMATION

a. List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force.

19. PERSONNEL TRAINING REQUIREMENTS
    a. Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.
20. TESTING EQUIPMENT AND SPECIAL TOOL INFORMATION
    a. Provide information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 TRANSMITTAL PROCEDURE

A. Transmit O&M manuals, information, and data in accordance with Section 01 30 00 accompanied by:
   1. Transmittal Form 01 78 23-A
   2. Equipment Record Form 01 78 23-B

B. Use the Transmittal Form as a checklist to ensure the manual is complete.

C. Only complete sets of O&M instructions will be reviewed for acceptance.

D. Label each manufacturer's brochure and manual with the equipment name and equipment number as it appears in the Project Manual.

E. Organize hardcopy information in binders in numerical order by the equipment numbers assigned in the Project Manual. Provide each binder with a table of contents and tab sheets.

F. Provide electronic information in a single, compiled pdf document with bookmarks.

G. Where O&M information covers a family or series of similar materials or equipment items, identify the applicable portions by heavy weighted arrows, boxes or circles and strike out the inapplicable data.

H. Manuals containing non-conforming data are not acceptable and will returned for revisions and re-submission.

3.02 FIELD CHANGES

A. Following the acceptable installation and operation of an equipment item, the item's instructions and procedures shall be modified and supplemented by the Contractor to reflect any field changes or information requiring field data.

SEE FORMS FOLLOWING END OF SECTION

END OF SECTION

TRANSMITTAL FORM 01 78 23-A
OPERATION AND MAINTENANCE INFORMATION

Date: _____

To: _____

_____

_____

_____

Attention: _____

Submittal No.: _____

Contract No.: _____

Spec. Section: _____

Submittal Description: _____

From: _____

_____

Checklist	Contractor		Engineer	
	Satisfactory	N/A	Accept	Deficient
1. Table of contents				
2. Equipment record forms				
3. Manufacturer information				
4. Vendor information				
5. Installation instructions				
6. Test reports and performance data				
7. Startup, shutdown, and post shut down procedures				
8. Normal operations				
9. Emergency operations				
10. Operator prestart				
11. Safety precautions				
12. Operator service requirements				
13. Environmental conditions				
14. Lubrication data				
15. Preventive maintenance plan and schedule				
16. Cleaning instructions				
17. Trouble-shooting guides and diagnostic techniques				
18. Wiring diagrams and control diagrams				
19. Maintenance and repair procedures				
20. Removal and replacement instructions				

21. Spare parts, testing equipment and supply list				
22. Corrective maintenance man-hours				
23. Parts identification				
24. Warranty information				
25. Personnel training requirements				
26. Testing equipment and special tool information				
26. Testing equipment and special tool information				

Remarks: _____

_____

_____
Contractor's Signature

EQUIPMENT RECORD FORM 01 78 23-B
OPERATION AND MAINTENANCE INFORMATION

EQUIP DESCRIP		EQUIP LOC	
EQUIP NO.	SHOP DWG NO.	DATE INST	COST
MFGR		MFGR CONTACT	
MFGR ADDRESS			PHONE
VENDOR		VENDOR CONTACT	
VENDOR ADDRESS			PHONE

MAINTENANCE REQUIREMENTS

D W M Q S A HOURS

LUBRICANTS RECOMMENDED:

ALTERNATIVE:

MISC. NOTES:

RECOMMENDED SPARE PARTS

PART NO.	QTY.	PART NAME	COST

ELECTRICAL NAMEPLATE DATA

EQUIP			
MAKE			
SERIAL NO.		ID NO.	
MODEL NO.		FRAME NO.	
HP	V	AMP	HZ
PH	RPM	SF	DUTY
CODE	INSL CL	DES	TYPE
NEMA DES	C AMB	TEMP RISE	RATING
MISC			

MECHANICAL NAMEPLATE DATA

EQUIP			
MAKE			
SERIAL NO.		ID NO.	
MODEL NO.		FRAME NO.	
HP	RPM	CAP	SIZE
TDH	IMP SZ	BELT NO.	CFM
PSI	ASSY NO.	CASE NO.	
MISC			

SECTION 01 79 00
DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 SUMMARY

A. Demonstration of products and systems where indicated in specific specification sections.

B. Training of Owner personnel in operation and maintenance of systems and equipment.

C. Exceptions to these requirements are in individual Technical Specification Sections.

D. The requirements of this Section remain in force unless specifically deleted in the Technical Specification Sections.

E. Training under this Section is in addition to, not a replacement for, manufacturer's training required by individual Technical Specification Sections.

1.02 TRAINING REQUIREMENTS

A. Develop training courses, in coordination with the manufacturers. for each system identified on the P&IDs and in the laboratory. At a minimum, training shall cover the following segments:
   1. Mechanical systems operations and maintenance.
   2. Electrical and instrumentation systems operation and maintenance.

B. Develop and submit the curriculum to the Engineer for approval based on the following:
   1. The curriculum shall be established for high school graduate level and shall include tests with at least 15 questions on each outline topic.
   2. A task and skills analysis shall be performed, identifying the requirements for proper operation, maintenance and repair of the system and all of its components.
   3. A training analysis shall be performed identifying: tasks requiring training; logical order of presentation; objectives of each training segment and methods for measuring achievement of objectives for each segment.

C. Prepare an instructor's manual, including notes to the instructor, for each training session. The manual shall address:
   1. Session objectives.
   2. Session outline.
   3. Session application.
   4. Instructor qualification and knowledge requirements.
   5. List of tools and supplies required for instruction.
   6. Safety and standby equipment.
   7. Student and course evaluation forms.
   8. Audio/visual resources and/or reproductions.
   9. Session tests and grading guide.
   10. References to the source of answers shall be provided in the course material.
   11. Additional notes such as references, review questions, demonstration techniques, class exercises, coordination with other sessions and achievement measurements.

D. Instruction shall be in accordance with the following:
   1. Timing of sessions shall suit Owner's employees' normal working hours.
   2. A 10-minute break shall be provided after each hour of instruction.

E. Minimum curricular requirements shall include:
   1. Use of the manufacturers' Operation and Maintenance Manuals, including the location of information.
   2. System layout.
   3. Wiring, instrumentation and controls.
   4. Control sequence and logic.
   5. Normal and emergency operating procedures.
   6. Basic and advanced operation and maintenance.

7. Equipment/instrument adjustment and calibration.
8. Site walk through the facility to locate and identify equipment.
9. Preventative maintenance.
10. Major maintenance.
11. Safety.
12. Troubleshooting.
13. How to use special tools/lab equipment.
14. Operation and maintenance supplies/spare parts.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures and submit the following for approval:
   1. Curriculum development document, prior to training materials submission.
   2. Instructor's manual, prior to training.
   3. Complete schedule of training activities including schedule of submittals, schedule of classes, and coordination with startup activities.
   4. Master training and start-up plan submitted 30 days (minimum) prior to first proposed training session that includes the following:
      a. Target date and time for Owner witnessing initial start-up of each system.
      b. Target date and time for operation and maintenance training for each system, both field and classroom.
      c. Target date for initiation of start-up period.
      d. Submit for review and approval by Owner.
      e. Include holidays observed by Owner.
      f. Attend a schedule planning and coordination meeting 45 calendar days prior to first anticipated training session:
      g. Provide a status report and schedule-to-complete for requirements prerequisite to manufacturer's training.
      h. Identify initial target dates for individual manufacturer's training sessions.
      i. Resubmit schedule until approved.
   5. Individual training plans shall include course outline, time allocation for each training segment and instructor qualifications as well as:
      a. Presentation materials (two copies).
      b. Manuals and class handouts (one copy for review and one copy for each student at least five working days prior to class).
      c. Owner reserves the right to insist on a minimum 7 days' notice of rescheduled training session not conducted on master schedule target date for any reason.

1.04 QUALITY ASSURANCE

A. Instructor Qualfications:
   1. Minimum 3 years exerience of actual operation and maintenance on equipment.
   2. Academic or factory training.
   3. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

1.05 TRAINING LOCATION

A. Contractor to provide training location and area, meeting the following requirements:
   1. Heated/air conditioned (depending upon the season).
   2. Seating for 15 people.
   3. Tables sufficient for writing and to layout class materials.
   4. All equipment required for audio/visual presentations.
   5. The training location shall be within 5 miles of the project site.

1.06 SEQUENCING AND SCHEDULING

A. Conduct classroom training prior to system startup and conduct hands on training prior to system demonstration testing. Contractor shall notify the Engineer at least three days in advance of scheduled training of any delays. Failure to provide notice shall make the Contractor responsible for costs incurred by the Owner for Owner's personnel. The Owner may delay scheduled training by up to five calendar days for personnel time conflicts but shall notify Contractor of delay at least three days in advance of scheduled training.

B. Notify the Engineer at least three days in advance of scheduled training of any delays. Failure to provide notice shall make the Contractor responsible for costs incurred by the Owner for Owner's personnel.

C. The Owner may delay scheduled training by up to five calendar days for personnel time conflicts but shall notify Contractor of delay at least three days in advance of scheduled training.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PREPARATION

A. Provide all materials and supplies (including consumables) necessary for training and demonstrations, special tools/equipment and all safety equipment required by instructors.

B. All required submittals must be approved prior to their use by the Contractor in delivering training courses. Contractor shall assemble instruction materials and set up demonstration materials/equipment prior to classes.

3.02 DEMONSTRATION - GENERAL

A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.

B. Demonstrations conducted during Validation/Functional Testing need not be repeated unless Owner personnel training is specified.

C. Demonstrations may be combined with Owner personnel training if applicable.

D. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
   1. Perform demonstrations prior to Substantial Completion.

3.03 TRAINING - GENERAL

A. Training session for each piece of equipment shall be separately video recorded on a dedicated CD/DVD delivered to Owner. Disc shall be clearly labeled with equipment name and manufacturer.

B. Schedule
   1. Minimum of two (2) separate occasions.
   2. Minimum of two (2) days training per occasion.
   3. Minimum of ten (10) persons per class.
   4. Date and time to be coordinated with Owner.
   5. Verify training requirements with Owner and Engineer.

C. Written Examination
   1. Students' understanding of the course material shall be evaluated and written tests shall be conducted at the end of each training segment. Tests shall be graded and evaluated to ensure fulfillment of course objectives. The original graded tests shall be submitted to the Owner.

D. Student Evaluation
   1. A written evaluation of each student shall be prepared by the Contractor presented to the Owner in a summary report. Originals of the student course evaluations shall be submitted to the Owner in the summary report.

E. Trainer Evaluation

1. Training methods, teaching techniques and trainer qualifications will be evaluated by the Owner. Unacceptable training will be repeated at Contractor's cost.

END OF SECTION

SECTION 03 30 00
CAST IN PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Work to be completed under this section shall include all labor, equipment, plant and materials necessary to furnish and install all poured-in-place concrete, together with all miscellaneous and appurtenant items, as shown on the Construction Drawings and as specified herein.

1.02 RELATED SECTIONS

A. Section 31 23 16 – Excavation and Fill

B. Section 31 23 23 – Fill

C. Section 31 23 33 – Trenching and Backfilling

1.03 REFERENCES

A. Except as modified or supplemented herein, all Work shall conform to the following standards, latest edition. Refer to standards for detailed requirements.

1. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials
2. ACI 301 – Specifications for Concrete Construction
3. ACI 305.1 – Specification for Hot Weather Concreting
4. ACI 306.1 – Standard Specification for Cold Weather Concreting
5. ACI 308.1 – Specification for Curing Concrete
6. ACI 318 – Building Code Requirement for Reinforced Concrete.
7. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures
8. Publication SP-2, ACI Manual for Concrete Inspection
9. Army Corps of Engineers Specification CRD-C-572 for Polyvinylchloride Waterstops
10. ASTM A185 – Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
11. ASTM A615 – Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
12. ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
13. ASTM C33 – Standard Specification for Concrete Aggregates
14. ASTM C94 – Standard Specification for Ready-Mixed Concrete
15. ASTM C143 – Standard Test Method for Slump of Portland Cement Concrete
16. ASTM C150 – Standard Specifications for Portland Cement
17. ASTM C157 – Standard Test Method for Length Change of Hardened Cement Mortar and Concrete
18. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete
19. ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
20. ASTM C666 – Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
21. ASTM C1077 – Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
22. ASTM C1157 – Standard Performance Specification for Hydraulic Cement
23. ASTM C1260 – Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
24. CRSI – Placing Reinforcing Bars Reference Guide
25. NSF-61 – Drinking Water System Components

1.04 SUBMITTALS

A. Concrete Batch Plant Certification. The production facility supplying hydraulic cement concrete shall have a current certification of Ready-Mix Concrete Production Facilities from the National Ready Mixed Concrete Association or be currently listed on CDOT's preapproved contractor list with a recent history of producing CDOT concrete mixes that appear within section 601 of the CDOT specifications manual, specifically mix D, in which case the same materials shall be used for the concrete on this project. Contractor will be required to provide all necessary documentation.

B. Lab Design Mix. Prior to the start of Work, Contractor to submit a statement of the proportions for the concrete mixture signed by a registered engineer in the state in which the Project shall be performed. Statement to include:
   1. Location & identification of aggregate source.
   2. Batch quantities for one (1) cubic yard of concrete, including:
      a. Weight of fine aggregate in a saturated surface dry condition.
      b. Weight of coarse aggregate in a saturated surface dry condition.
      c. Weight or number of 94-pound bags of cement.
      d. Weight or gallons of water.
   3. Amount and description (including manufacturer, specific product name, and number) of all admixtures.
   4. Test results on trial batch concrete made from the proposed mix design, including:
      a. Cement factor in bags per cubic yard based on yield tests.
      b. Water-cement ratio.
      c. Percent of entrained air.
      d. Consistency in inches of slump.
      e. At least three 28-day compressive strength tests.
      f. Brand, type, and place of manufacture of cement.
   5. Aggregate test results for grading, deleterious substances and physical properties using test procedures developed by ACI. Aggregate shall be free of substances that are deleteriously reactive with the alkalis in the cement in an amount sufficient to cause excessive expansion of the concrete. Acceptable aggregate shall be based on satisfactory evidence furnished by the Contractor that the aggregate is free from such materials. This evidence shall include service records of concrete of comparable properties under similar conditions of exposure and certified records of tests by a testing laboratory that meets the requirements of ASTM C 1077. Tests shall be made in accordance with ASTM C 1260.
   6. Prior to approval of mixture design, the Contractor shall submit written certification that the aggregate does not have a history of D-Cracking and that the aggregate is approved by a state Department of Transportation specifically addressing susceptibility to D-Cracking. If the aggregate is not approved by a state agency, the aggregates may be approved provided the aggregate is tested in accordance with ASTM C 666 and receives a durability factor of 95 percent or greater.
   7. Prior to approval of mixture design, the Contractor shall submit written certification that the aggregate does not have a history of alkali-aggregate reactivity and that the aggregate is approved by a state Department of Transportation. If the aggregate is not approved by a state agency, the aggregates may be approved provided the aggregate is tested in accordance with ASTM C 1260 and receives an expansion index of less than 0.10% and has been shown to meet the quality requirements of ASTM C33 with the last two years.

C. Materials Scaling. Scales shall be accurate within the allowable tolerances as prescribed by State law. The scales shall be sealed by the Measurement and Standards Section of the Colorado Department of Agriculture at least once each year, each time the scales are relocated, and as often as the Engineer may deem necessary.

D. Reinforcing Steel. Product data sheet and statement of manufacturer's compliance with applicable standards. Shop drawings prepared in accordance with ACI 301 and AC SP-66. Shop drawings shall include detail plans, sections, reinforcing bar sizes, grades, placements,

spacing, splice lengths, tail and hook configurations, chair and bolster heights, mechanical splice devices, and development length where applicable.

E. Test Reports: Submit report for each test or series of tests specified.

F. Detailed Work Plans:
   1. Cold weather curing and the protection of concrete placed and cured in weather below 40°F, develop cold weather work plans in general conformance with ACI 306R: Guide to Cold Weather Concreting.
   2. Hot weather placements including curing and the protection for concrete place in ambient temperatures above 80°F. Develop hot weather work plans in general conformance with ACI 305R: Guide to Hot Weather Concreting.
   3. Pumping concrete, identifying the pump location, and placing sequence.

G. Repair methods: Submit methods of repair including methods for:
   1. Water holding structure.
   2. Surface finish.
   3. Honeycomb, rock pockets, and bug holes.
   4. Application schedule and instructions for patching materials and blending to match adjacent concrete.

H. Placement Drawings: Identifying the location of each type of joint and placement sequence. Where not indicated on the construction plans the contractor shall provide a plan indicating the proposed location of all construction joints in slabs and walls for all fluid containing tanks. Refer to “Construction, Control, and Expansion Joints” for a detailed description of joint placement and construction within structures.

1.05 RECORD OF THE WORK

A. Contractor to keep a record of time, date and location of each concrete pour and submit these records to the Engineer.

1.06 NOTICE OF INTENTION TO POUR

A. Contractor shall notify the Engineer at least 48 hours before an intended cast-in-place concrete pour. No structural cast-in-place concrete shall be poured until all reinforcing, forms and foundation soils have been inspected by the Engineer.

1.07 PROTECTION OF THE WORK

A. Contractor to be responsible for protection of all Work prior to acceptance. In place concrete shall not be subjected to loadings or stress prematurely.

1.08 STORAGE OF MATERIALS

A. Cement and aggregate shall be stored in such a manner as to prevent deterioration or intrusion of foreign matter. Any material which has deteriorated, or which has been damaged shall not be used for concrete.

B. All reinforcing steel shall be stored in a dry location and protected from excessive accumulation of rust or scale.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement. All cement shall be Portland Cement Type II conforming to "Standard Specifications for Portland Cement" (ASTM C 150) or Type IL conforming to “Standard Specifications for Blended Hydraulic Cements” (ASTM C 595). The same brand cement for all exposed cast-in-place concrete shall be used. Flyash conforming to ASTM C618 may be substituted for a portion of the cement; type and amount to be approved at time of mix design submittal.

B. Stone Aggregate. Fine and coarse aggregate shall conform to "Specifications for Concrete Aggregates" (ASTM C33). Fine aggregates shall be clean, hard, natural and free from all foreign matter. Coarse aggregate shall be sound, crushed rock or gravel, free from adherent coating, organic water or injurious amounts of flat or friable pieces.

C. Water. Water used in mixing shall be potable, cleaned and free from deleterious amounts of oil, acids, alkalis and organic material.

D. Admixtures. Conforming to the Standard Specification for Air-Entraining Admixtures for Concrete (ASTM C260). Other admixtures for retarding or accelerating concrete may be used in strict accordance with manufacturer's recommendations and ASTM Specifications upon approval of the Engineer.

E. Form Material. For unexposed concrete surfaces, forms may be undressed lumber free from excessive knots. For exposed surfaces, use wood or metal forms as required to give finish as specified.

F. Reinforcing Steel. Reinforcing steel shall be deformed bars conforming to "Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement" (ASTM A615) and shall be Grade 60.

G. PVC Waterstop
   1. Waterstops shall be extruded from a PVC compound and shall be flat ribbed or ribbed with center-bulb. Waterstop shall comply with Army Corps of Engineers Specification CRD-C-572.
   2. PVC waterstops for construction joints:
      a. Ribbed with a center bulb, 6 inches wide with a minimum thickness of 3/8-inches. The center bulb shall have an O.D. not less than 7/8-inches.
      b. Products:
         1) Sika Greenstreak; Model 732.
         2) Or Engineer approved equal.
   3. Provide waterstops resistant to chemical action with Portland cement, alkalis, acids, and not affected by mildew or fungi. It shall show no effect when immersed for 10 days in a 10 percent solution of sulfuric or hydrochloric acid, saturated lime solution or salt water. Water stops shall be such that any cross section will be dense, homogeneous, and free from porosity and other imperfections. They shall be symmetrical in shape.

H. Hydrophilic Rubber Waterstop
   1. Provide a bentonite free rubber waterstop. Waterstop shall expand by a minimum of 80 percent of dry volume in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast. Provide minimum concrete cover as recommended by the waterstop manufacturer.
   2. Products:
      a. SikaSwell S-2
      b. Greenstreak; Hydrotite.
      c. Or Engineer approved equal.

I. Non-Swelling Gasket Waterstop
   1. Provide waterstop in concrete walls less than 10" in width that allows installation outside of reinforcing steel with minimal concrete cover.
   2. Products:
      a. Sika Lockstop
      b. Or Engineer approved equal.

2.02 CONCRETE MIX DESIGN

A. General.
   1. See the Structural General Notes for mix design requirements for each class of concrete required.
   2. Prepare design mixtures for each type and strength of concrete, selecting and proportioning ingredients in accordance with the requirements of ACI 301, unless otherwise specified.
   3. Unless otherwise permitted, use water-reducing admixture or water-reducing admixture and high-range, water-reducing admixture in pumped concrete, in concrete with a water-

cementitious materials ratio below 0.50, and in concrete that is part of a liquid-containment structure.

4. Unless otherwise specified, desired fresh properties of concrete shall be determined by Contractor and coordinated with concrete producer. Fresh properties of concrete shall remain stable to satisfaction of Contractor, for duration of placement and consolidation, and shall remain in conformance with requirements of Contract Documents.

B. Concrete Shrinkage Limits

1. Concrete mix for all liquid retaining structures shall have a shrinkage limit of 0.04% cast in the laboratory. The Contractor shall only use a mix design for construction that has first met the trial batch shrinkage requirements.
2. Testing shall be in accordance with ASTM C 157 except that the specimens shall be cured in a water bath until 7 days of age, then stored in a 50% humidity environment for an additional 28 days. Percent length change shall be calculated using the 7-day soak measurement as the initial length.
3. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than twenty-five percent (25%).
4. If the required shrinkage limitation is not met during construction, the Contractor shall take all necessary action, at no additional cost to the Owner, for securing the specified shrinkage requirements. These actions may include changing the source of aggregates, cement and/or admixtures; reducing water content ratio; washing or aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

PART 3 EXECUTION

3.01 CONCRETE MIX

A. Proportions. Concrete is to be proportioned according to laboratory designed mixes using the type of aggregate, maximum water/cement (W/C) ratio, maximum aggregate size, minimum of twenty-eight (28) day ultimate compressive strength, and entrained air as shown on Contract Documents.

B. Air Entrainment. An air-entraining agent shall be added to all stone concrete to entrain 5%-7% by volume. Air-entraining agents shall be in strict accordance with the recommendations of the manufacturer and the testing laboratory for the design mix to assure strength requirements are being fully met or exceeded.

C. Mixing of Materials. The concrete shall be mixed until there is a uniform distribution of the materials and shall be discharged completely before the mixer is recharged. For job-mixed concrete, the mixer shall be rotated at the speed recommended by the manufacturer.

1. For stone concrete, mixing shall continue for at least one minute after all materials are in the mixer. Ready mixed concrete shall be mixed and delivered in accordance with "Standard Specification for Ready Mixed Concrete" (ASTM C94).
2. Sufficient time shall be allowed for proper mixing of the concrete to provide uniformity throughout the batch. Mix not less than ten minutes after addition of the mixing water. Long delays in concrete placement shall be avoided and any concrete that has not been placed within 90 minutes after water has been added to the mix shall be rejected. The 90-minute time limit may be extended to 120 minutes if no water is added after 90 minutes and the concrete temperature prior to placement is less than 90 F. Over wet mixes shall be rejected and shall not be corrected by the addition of either aggregate or cement to the mixer.

D. Consistency. Slumps shall be minimum, consistent with placing requirements. Slump test shall be made in accordance with "Standard Test Method for Slump of Portland Cement Concrete" (ASTM C143). Unless written approval is obtained from the Engineer, the maximum slump shall be four (4) inches.

3.02 CONCRETE FORMS

A. Forms shall conform to the shape, lines, grades, and dimensions of the concrete as detailed on the Construction Drawings. All forms for exposed finished surfaces shall be built with the material needed to produce the form, texture and design specified in Concrete Finishes of this section.

B. Design of Forms. Forms shall be sufficiently tight to prevent leakage of mortar and shall be properly braced or tied together to maintain the desired position. Design Formwork in general conformance with ACI 347R: Guide to Formwork for Concrete.

C. The forms shall be oiled for ease of removal of forms after setting of concrete.

D. Form Ties and Incidentals. All form ties shall be bolts and rods (adjustable for tightening) arranged so that no metal is within 3/4 inches of surface after removal of forms. No ties through exposed concrete will be allowed. Ties for water/wastewater structures (tanks, basins, channels etc.) shall be furnished with water resistant washers and cones, as manufactured by SYMONS, or approved equal. Ordinary wire ties will be allowed on building foundations with the specific approval of the Engineer. Set forms for all required anchors, bolt inserts, slots, sleeves, supports, etc., furnished under portions of this Specification and installed under this section.

E. Removal of Forms. Forms shall not be disturbed until concrete has hardened sufficiently to permit their removal with safety. The removal of the forms shall be carried out in such a manner as to ensure the safety of the structure. Unless otherwise permitted by the Engineer, forms for walls and columns shall not be removed until 24 hours after pouring or the concrete has reached a compressive strength of 1000 psi, whichever is shorter. Forms and falsework for beams, girders, structural slabs and other members that resist dead load bending shall not be removed until the concrete has attained a minimum compressive strength of 80% of F'c.

3.03 CONSTRUCTION, CONTROL, AND EXPANSION JOINTS

A. Expansion, construction, and control joints shall be constructed in accordance with the construction drawings, and the specifications found in this section.

B. Expansion joints - Unless otherwise indicated on the construction drawings, install one-half inch (½") thick asphalt impregnated fiberboard expansion joint filler (ASTM D1751) wherever concrete slabs on grade abut buildings or footings or as shown on the plan details. All expansion joint filler shall extend full depth of the slab.

C. Control joints – control joints shall be placed in all non-fluid containing slabs-on-grade and shall not be spaced more than 20 feet on center or forming an area greater than 400 sq.ft. Control joints shall be sawn, or trowel cut into concrete slab a maximum of 12 hours after the concrete has been placed.

D. Construction joints – construction joints shall be constructed in accordance with the construction drawings. Provide uniformly spaced vertical joints in walls, avoiding penetrations and corners. No horizontal joints are permitted in the walls of water-holding structures. Space joints to limit the size of placements to allow for volume change from shrinkage and to minimize the potential of restraint and shrinkage cracking. Control joints in walls and slabs shall be placed at a maximum spacing provided in the following table unless shown or approved otherwise:

1. Fluid filled Tank - Walls: 40 ft on-center maximum spacing.
2. Fluid filled Tank - Slabs: 40 ft on-center maximum spacing.
3. Non-fluid containing structures - Walls: 50 ft on-center maximum spacing.
4. Non-fluid containing structures - Slabs: 50 ft on-center maximum spacing.

3.04 CONCRETE PLACEMENT

A. Preparation for Placing. Before placing concrete, all equipment for mixing and transporting concrete shall be cleaned and all debris and ice shall be removed from places to be occupied by concrete. Forms shall be properly treated, and all reinforcement cleaned of ice and other coatings. Water shall be removed from place of deposit before concrete is placed.

B. Conveying. Concrete shall be conveyed from the mixer to the place of final deposit by methods, which will prevent the separation or loss of the materials. Equipment for chuting, pumping, or pneumatically conveying concrete shall be of such size and design as to ensure a practically continuous flow of concrete at the delivery and without separation of the materials.

C. Other Trades. Install by way of example, anchor bolts, reinforcing steel, pipe and conduit openings and sleeves, bearing plates, and knockouts as provided by other trades and as required by other trades. Provide minimum 7 days' notice to Engineer, Owner, or other trades prior to requiring materials or detailing information. Installation to meet location, dimension, and alignment requirements of other trades.

D. Depositing. Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to re-handling or flowing. The concreting shall be carried on at such a rate that the concrete is at all times is plastic and flows readily into the space between the bars. No concrete that has been partially hardened or been contaminated by foreign matter shall be deposited on the Work, nor shall re-tempered concrete be used. When concreting is once started, it shall be carried on as a continuous operation until the placing of the panel or section is completed. Place concrete in approximately horizontal layers avoiding displacement of reinforcement above fresh concrete and formation of seams and planes of weakness in sections. When construction joints are necessary, they shall be located as specified in this section under Construction Joints. For bonding fresh concrete, roughen and clean exposed surface and brush with neat cement grout. Place new concrete before grout takes initial set.

E. Compaction. Place concrete in layers not over 24 inches deep; compact each layer by mechanical internal vibrating equipment supplemented by hand spading, rodding, tamping, or forking to eliminate honeycombing at the form face and voids around embedded items. Vibrators shall not be used to transport concrete inside forms. Limit vibration duration to the time necessary to produce satisfactory consolidation without causing objectionable segregation. Do not insert vibrator into lower courses that have begun to set.

F. Hot Weather: Batch, deliver, place, cure and protect concrete during hot weather in accordance with ACI 305.1 and the submitted detailed work plan for hot weather. Maintain concrete temperature below 90°F at time of placement. If the rate of surface evaporation approaches 0.20 lbs/sf/hr in accordance with ACI 305.1, make provisions for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other precautions against plastic shrinkage.

G. Cold Weather: Batch, deliver, place, cure, and protect concrete during cold weather in accordance with ACI 306.1 and the submitted detailed work plan for cold weather. Maintain concrete temperature above 55°F at time of placement. Provide cold weather protection when air temperatures are below 40°F. Provide supplemental heating enclosures, hydronic heating, blankets, or other measures to maintain proper temperatures including at corners, edges, and in thin sections. Cold weather protection shall remain in place until concrete has attained a minimum compressive strength of 3500 psi as determined by field cylinders, or 7 days, whichever is shorter. Removal of protection shall allow the concrete to cool gradually.

H. Protection and Curing. Concrete protection and curing shall be in conformance with ACI 308. Immediately after placing or finishing, concrete surfaces not covered by forms shall be protected from loss of surface moisture. All concrete shall be kept in a moist condition for at least seven (7) days after placement. Curing compounds may be used upon approval of the Engineer.

I. Minimum Time Between Adjacent Placements: Do not place adjacent concrete until previously placed concrete has attained 100% of the approved submitted 28-day compressive strength as determined by field cylinders, or 7 days, whichever is shorter.

3.05 NON-STRUCTURAL SLABS ON GRADE

A. All slabs on grade shall be poured directly on prepared gravel sub grade where shown on the Construction Drawings. Construction joints shall be placed such that no section of slab is greater than 20 feet on a side. Finishes, Expansion and Control Joints and Protection shall be as specified under other sections of this section.

B. Minimum four-inch (4") of screened crushed rock shall be installed under the entire slab unless otherwise directed by the Engineer. The grading requirements as per Section 31 23 00 for the aggregate course shall apply.

3.06 CONCRETE FINISHES

A. Patching. Patching shall be done on all concrete surfaces immediately after stripping forms; all surfaces exposed to air, water/wastewater, or are to be waterproofed shall have fins and other projections carefully removed, offsets leveled, and voids saturated with water and patched to a true and even surface with a wood float. Patch all holes left by the removal of the form ties or bolts. Patching material shall be a stiff mixture of sand and cement, the color of which matches the concrete being patched. Any major area of faulty or honeycombed concrete shall be completely removed and patched at the direction of the Engineer. For water/wastewater structures (tanks, basins, etc.), surface voids larger than ¼-inch diameter shall be patched. Any visible locations with iron corrosion byproducts present at the wetted surfaces of concrete water-retaining structures shall be remediated. Corrosion byproducts shall be removed, any form ties, rebar ties, or other ferrous materials at or near the concrete surface shall be ground down to at least ¾" below the surface, and the concrete surface patched.

B. Floor slabs. All concrete slabs shall be screened to levels or grades indicated and float finished monolithically completely free from humps or pits. Slabs shall not show surface deviation more than one-quarter inch (1/4") when tested with a 10-foot straightedge. Before the finish has set, the surface cement film shall be removed with a fine brush to have a fine-grained, smooth but sanded texture.

C. Chamfer. All exposed exterior corners shall receive 3/4-inch chamfer.

3.07 REINFORCING

A. Placing Reinforcement. Reinforcing steel, at the time concrete is placed, shall be free from scale, rust or other coatings that will destroy or reduce bond. Reinforcement shall be accurately placed as shown on the Construction Drawings and shall be adequately secured in position by concrete or metal chairs and spacers.

B. Reinforcing shall be furnished in the full lengths indicated on the Construction Drawings unless otherwise authorized by the Engineer. Splicing of bars, except where shown on the Construction Drawings or specified, shall not be permitted without written approval by the Engineer. Reinforcement placed in any member shall be inspected before any concrete is placed and the Engineer shall be notified 24 hours in advance before any concrete placement.

C. The placing, fastening, splicing, and supporting of reinforcing steel shall be in accordance with the Construction Drawings and the latest edition of the CRSI "Placing Reinforcing Bars Reference Guide" and in accordance with ACI 318. Bars shall be placed around all corners to splice steel in adjacent walls, footings, and slabs (such detailing may not be shown on Construction Drawings).

D. Concrete Protection & Reinforcement. Where not otherwise indicated on the Construction Drawings, the minimum thickness of concrete over the reinforcement shall be as follows:
   1. Concrete deposited against earth: 3 inches.
   2. All other concrete placed in forms:
      a. For bars larger than #5: 2 inches
      b. For bars #5 or smaller: 1½ inches
   3. Sanitary Structures: 2 inches

E. Bearing Plates, anchor bolts, etc. Place all bearing plates, anchor bolts, reinforcing rods and other structural items furnished by other trades. Contractor to provide 7-day notice to all such trades prior to affected pour. Installation to be within tolerances required by other trades.

3.08 FIELD QUALITY CONTROLS

A. Concrete Tests. 6-inch x 12-inch (or 4-inch x 8-inch) cylinders shall be taken at the point of placing in the forms, shall be job cured and tested in accordance with ASTM Standards by the Engineer. For each strength of concrete used, one set of four (4) cylinders for each day's pour,

but not less than one (1) set of cylinders for each 50 cubic yards poured shall be taken. Two (2) cylinders at twenty-eight (28) days shall be tested to determine strength. One cylinder at seven (7) days, and one cylinder at fifty-six (56) days may be tested as indicators at the direction of the Engineer. In addition, when in the opinion of the Engineer there is a possibility of the surrounding air temperature falling below 40º F; additional specimens to be cured under job conditions may be required.

B. Enforcement of Strength Requirements. Should the strengths shown by the test specimens fall below the specified values, the Engineer shall have the right to require changes in proportions to apply on the remainder of the Work.

C. If concrete fails to meet the strength requirements of this specification, the Engineer may order the Contractor to have a testing laboratory, acceptable to the Engineer, take and test core samples of questionable concrete. The Engineer may order all low-strength concrete removed and replaced if core strengths are below specified strengths. All costs connected with concrete coring and removal and replacement of low-strength concrete shall be borne by the Contractor.
   1. Contractor shall repair all core holes at his expense.

D. Slump Tests. Engineer to conduct slump tests on each day's pour and on individual trucks whenever concrete consistency varies. Test failure shall be grounds for rejection of individual or batch loads.

E. Air Content. Engineer to conduct air tests on samples from the first three batches in the placement of each day's pour. When air content is below the specified limit, it may be adjusted with an approved air entraining admixture and re-tested. Successive batches shall be tested until three consecutive batches have air contents within the range specified, at which time every fifth batch will be tested. This test frequency will be maintained until a batch is not within the range specified, at which time testing of each batch will be resumed until three consecutive batches have air contents within the range specified. Additional test may be performed as determined by the Engineer.

3.09 LEAKAGE TESTING OF WATER HOLDING STRUCTURES

A. The tightness testing of cast in place reinforced concrete liquid retaining structures shall conform to ACI 350.1-01 and as specified herein. Where the requirements of this specification and ACI 350 are in conflict, those of this specification shall prevail.

B. Perform tightness tests prior to application of exterior waterproofing or sealants and prior to placing backfill around the structure to permit observation and detection of leakage points.

C. Preparation
   1. Remove all dirt, mud and debris from the structure prior to initiating tightness tests. The floor and sumps shall be flushed with water to provide a clean surface, ready for testing.
   2. Inlet and outlet pipes not required to be operational for the tests shall be temporarily sealed or bulkheaded prior to testing.
   3. Confirm that all gates, valves and watertight access doors are completely closed. Repair and reset seals if necessary. All gates, valves, and watertight access doors shall be tested for leakage in accordance with the requirements of the respective Sections as part of the preparation for final tightness testing under this Section. Estimates of gate, valve, or door leakage will not be allowed as adjustments to the measured structure leakage.

D. Conditions of Testing
   1. Do not begin filling of reinforced concrete structure until all concrete elements of the structure have attained the specified design strength, but not less than 14 days after all concrete elements have been placed.
   2. All joint sealants and surface coatings on the interior, water retaining side of the structure shall be placed and fully cured in accordance with the manufacturer’s instructions prior to filling.
   3. Filling of reinforced concrete structure shall not exceed a rate of 4-ft in 1 hour.

E. Fill reinforced concrete structure to the maximum operating water surface level or 4 in. below any fixed overflow level and maintain the water at that level for at least 72 hours prior to beginning tightness tests to minimize water absorption by the concrete during testing.
   1. Test only a single structure at a time. Concurrent testing of contiguous or adjacent structures will not be allowed. For the purpose of tightness testing a single structure is any tank, wet well, basin, cell, compartment, filter, channel or similar construction which may be isolated by gates, valves, or stop logs or the like such that it may be full of liquid when adjacent construction is empty.
   2. Test measurements shall not be scheduled for a period when the forecast is for a substantial change in the weather pattern. Water temperature shall be recorded 18 inches below the surface and the difference shall not exceed 35 degrees between the beginning and end of the test. Include volume corrections for temperature differences in Test B. Tests shall not be scheduled when the weather forecast indicates the water surface would be frozen before the test is completed.
   3. Visual tests shall not be scheduled for a period when the forecast is for a substantial change in weather pattern. Ambient temperature and the dry side concrete temperature must be above 35 degrees for at least 3 consecutive days prior and between the beginning and end of the test.

F. Testing Procedure
   1. Duration of the test shall not be less than the time required to produce a drop in the water surface of 3/8-in based on the calculated maximum allowable leakage rate or 3 days, whichever is greater.
   2. Measure water surface elevations at 24-hour intervals. Measure water surface elevations at the same locations. Record water temperature 18-in below the water surface when taking the first and last sets of measurements. The methods used to determine the amount of precipitation or evaporation shall be approved by the Engineer.
   3. The percentage of water volume loss shall be computed based on the measured change in water surface elevation, the area of the horizontal water surface, the initial water volume and any correction for precipitation or evaporation where applicable.
   4. Test A is a visual inspection of the dry side of the walls during both the morning and afternoon hours of a day. All exposed wall surfaces, inside and out, shall be inspected. If no damp spots (areas where moisture can be picked up on a dry hand) are observed within the 72-hour period, the tank(s) will have passed Test A.
   5. Test B shall be a water level measurement to the nearest 1/16 of an inch taken at least every 24 hours for a minimum of 72 hours. Change in volume shall be calculated and adjusted, if necessary, for evaporation, precipitation, and temperature. If volume loss exceeds the acceptance criteria, the structure has failed the test.

G. Acceptance
   1. The following conditions shall be considered as NOT meeting the criteria for acceptance regardless of the actual loss of water volume from the structure.
      a. Groundwater seeping or flowing into the structure through floors, walls, or wall-floor joints.
   2. Structures which exhibit seeping or flowing water from joints, cracks, voids, honeycombs, or from beneath the foundation.
      a. Moisture can be deposited on a dry hand held against the exterior surface of the structure.
   3. The tightness of concrete tanks and structures shall be considered acceptable when the conditions of Paragraph 3.09 F 1 are not present and when loss of water volume is less than the criteria listed below:
      a. For fully lined or secondary containment structures there shall be no measurable loss. No measurable loss is defined as less than 1/8 of an inch in surface level in 72 hours.

b. For unlined reinforced concrete tanks or structures with monolithically placed floor slabs without joints, loss of volume not exceeding 1/80th of 1 percent in any 24-hour period.

c. For other unlined reinforced concrete tanks or structures, loss of volume not exceeding 1/20th of 1 percent in any 24-hour period.

3.10 CONCRETE REPAIRS AND RETESTING

A. Concrete Repair. In the event there are leaks as determined by the testing program as specified on the drawings, Contractor shall make repairs as necessary to satisfy the requirements of the program. Repairs shall be made in accordance with the submitted repair methods. Acceptable manufacturers are DeNeef, Sika, or Engineer-approved equal. Type and installation methods as recommended by the manufacturer for the specific application. Product and method of installation as selected by the Contractor shall be submitted to the Engineer for approval. Products in potable water treatment and storage applications will require NSF-61 certification.

B. Structures failing the tightness test and not exhibiting visible leakage may be retested after an additional stabilization period of 7 days. Structures failing this second test shall be repaired at no additional cost to the Owner prior to further testing.

C. Repaired structures shall be retested. Repairs and retesting shall be conducted at no additional cost to the Owner and shall be continued and repeated until the structure meets all requirements specified herein.

END OF SECTION

SECTION 03 60 00
GROUTING

PART 1 GENERAL

1.01 SUMMARY

A. Work to be completed under this section shall include all labor, equipment, plant and materials necessary to furnish and install all grouting of equipment and pipe support base plates, grouting of sloped surfaces in basins, wetwells, sumps and channels, grouting of anchors and dowels into existing concrete, and any other grouting, as shown on the Construction Drawings and as specified herein.

1.02 REFERENCES

A. ASTM C109—Test Method for Compressive Strength of Hydraulic Cement Mortar.

B. ASTM C157—Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete.

C. ASTM C191—Time of Setting of Hydraulic Cement by Vicat Needle.

1.03 SUBMITTALS

A. Submit under provisions of Sections 01 30 00.

B. Product Data: Provide manufacturer's catalog sheet for material indicating test data and physical properties.

1.04 QUALITY ASSURANCE

A. Conform to applicable industry standard, Corps of Engineers, Specification CRD C 621—Specification for non-shrink grout.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Non-Shrink, Non-Metallic Grout:
   1. Master Builders—Masterflow 928.
   2. Burke—Non-Ferrous Non-Shrink.
   3. L & M Inc.—Crystex.
   4. R. Meadows—Sealtight 588.
   5. Sonneborn—Sonogrout G.P.
   6. Tamms—Tammsgrout 621.
   7. Sika—SikaGrout 212.
   8. Or equal

B. Epoxy/Grout Adhesive:
   1. Hilti Hit HY-200.
   2. Or equal

C. Latex Bonding Agent:
   1. Speeco—B20 Liquid Latex.
   2. Euclid—Flexbond.
   3. MR Meadows—Intralok Bonding Agent.

2.02 MATERIALS

A. Non-Shrink, Non-Metallic Grout: Factory premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, capable of developing minimum compressive strength of 4,000 psi in one day and 8,000 psi in 7 days.

B. Epoxy Grout: Three Component Epoxy Resin System:
   1. Two liquid epoxy components.
   2. One inert aggregate filtered component.
   3. Each component furnished in separate package for mixing at job site.

C. Water: Clean and free from deleterious substances.

D. Latex Bonding Agent: Acrylic liquid compound readily mixable as an admixture to grout.

2.03 CONCRETE TOPPING

A. Proportions: 100 lbs. cement, 300-400 lbs. sand and pea gravel mix, less than 5 gal per sack of cement.

B. Mix 5 minutes minimum in a mechanical mixer.

C. Maximum slump: 2 inches.

PART 3 EXECUTION

3.01 PREPARATION

A. Non-Shrink, Non-Metallic Grout:
   1. Clean concrete surface to receive grout.
   2. Saturate concrete with water for 24 hrs. prior to grouting and remove excess water just prior to placing grout.
   3. Cold weather conditions:
      a. Warm concrete, substrate and base plate to 40 degrees F, or above; store grout in warm area.
      b. Follow manufacturer's recommendations for cold weather application.
   4. Hot weather conditions:
      a. Use cold mixing water and cool base plate if possible; store grout in cool area.
      b. Follow manufacturer's recommendations for hot weather application.
   5. Apply to clean, sound surface.
   6. Apply latex bonding agent to hardened concrete, mix-in-grout, or as directed by Engineer.

B. Epoxy Grout: Apply only to clean, dry, sound surface.

3.02 APPLICATION

A. Non-Shrink, Non-Metallic Grout:
   1. Mix in a mechanical mixer.
   2. Use no more water than necessary to produce flowable grout.
   3. Provide expansion joints on long pours.
   4. Provide air vents where necessary to eliminate air pockets.
   5. Place in accordance with manufacturer's instructions.
   6. Completely fill all spaces and cavities below the top of base plates.
   7. Provide forms where base plates and bedplates do not confine grout.
   8. Where exposed to view finish grout edges smooth.
   9. Except where a slope is indicated on the drawings, finish edges flush at the base plate, bedplate, member or piece of equipment.
   10. Protect against rapid moisture loss by immediately covering with wet rags and polyethylene sheets or curing compound.
   11. Wet cure grout for 7 days, minimum.
   12. Maintain the temperature at a minimum of 40 degrees F until grout reaches 3,000 psi.
   13. After placement of grout, eliminate excessive external vibration.

B. Epoxy Grout
   1. Mix and place in accordance with manufacturer's instructions.
   2. Completely fill all cavities and spaces around dowels and anchors without voids.
   3. Grout base plates and bedplates as specified for non-shrink, non-metallic grout.
   4. Obtain manufacturer's field technical assistance as required to insure proper placement.

3.03 SCHEDULE

A. Non-Shrink, Non-Metallic Grout: General Use:
   1. Grouting of column, equipment and pipe support base plates.
   2. Grouting of sloped surfaces in basins, wetwells, sumps and channels.

3. Grouting of sloped and flat surfaces in clarifiers.
4. Other grouting as indicated on the Drawings.

B. Epoxy Grout
1. Grouting of dowels and anchor bolts into existing concrete.

END OF SECTION

SECTION 04 20 00
UNIT MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete block.

B. Mortar and grout.

C. Reinforcement and anchorage.

D. Lintels.

E. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 07 92 00 - Joint Sealants: Sealing control and expansion joints.

1.03 REFERENCE STANDARDS

A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

B. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.

C. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2019.

D. ASTM A951/A951M - Standard Specification for Steel Wire for Masonry Joint Reinforcement; 2022.

E. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2022.

F. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units; 2023.

G. ASTM C91/C91M - Standard Specification for Masonry Cement; 2023.

H. ASTM C140/C140M - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units; 2023a.

I. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar; 2018.

J. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.

K. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2019a, with Editorial Revision.

L. ASTM C404 - Standard Specification for Aggregates for Masonry Grout; 2024.

M. ASTM C476 - Standard Specification for Grout for Masonry; 2023.

N. ASTM C780 - Standard Test Methods for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry; 2023.

O. ASTM C1714/C1714M - Standard Specification for Preblended Dry Mortar Mix for Unit Masonry; 2019a.

P. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures; 2022, with Errata (2024).

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.

C. Shop Drawings: Reinforcement detail plans, sections, bar sizes, grades, placements, spacing, and splice lengths.

D. Samples: Submit 2 samples of any decorative block units to illustrate color, texture, and extremes of color range.

E. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

F. Manufacturer's Qualification Statement.

G. Installer's Qualification Statement.

1.05 QUALITY ASSURANCE

A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.

B. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with minimum three years of documented experience.

C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.06 MOCK-UPS

A. Construct a masonry wall as a mock-up panel sized 4 feet long by 4 feet high; include mortar and decorative block units in mock-up.

B. Mock-up may remain as part of work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

B. Concrete masonry units shall be protected against wetting prior to use. During freezing weather, all masonry units shall be protected with tarpaulin or other suitable material. Concrete masonry units shall be stored under covers that will permit circulation of air and prevent excessive moisture absorption. Materials showing evidence of water or other damage are subject to rejection.

C. Reinforcement shall be protected from the elements; immediately before placing, reinforcement shall be free from loose rust, ice or other foreign coatings that will destroy or reduce the bond.

D. Deliver packaged material in original manufacturer's containers. Cement, lime and air-settling mortars shall be stored in watertight sheds with elevated floors.

E. Handle and store pre-faced concrete block units in protective cartons or trays. Do not remove from protective packaging until ready for installation.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

A. Concrete Block: Comply with referenced standards and as follows:
   1. Size: Standard units with nominal face dimensions of 16 by 8 inches and nominal depths as indicated on drawings for specific locations.
   2. Special Shapes: Provide nonstandard blocks configured for corners, lintels, headers, control joint edges, and other detailed conditions.
   3. Load-Bearing Units: ASTM C90, normal weight.
      a. Hollow block, as indicated.
      b. Exposed Faces: Manufacturer's standard color and texture where indicated.

2.02 MORTAR AND GROUT MATERIALS

A. Masonry Cement: ASTM C91/C91M, Type S.

B. Portland Cement: ASTM C150/C150M, Type I; color as required to produce approved color sample.

C. Mortar Aggregate: ASTM C144.

D. Grout Aggregate: ASTM C404.

E. Water: Clean and potable.

F. Accelerating Admixture: Nonchloride type for use in cold weather.

G. Packaged Dry Material for Mortar for Unit Masonry: Premixed Portland cement, hydrated lime, and sand; complying with ASTM C1714/C1714M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
   1. Type: Type S.
   2. Color: Mineral pigments added as required to produce approved color sample.

H. Packaged Dry Material for Grout for Masonry: Premixed cementitious materials and dried aggregates; capable of producing grout of the specified strength in accordance with ASTM C476 with the addition of water only.
   1. Type: Coarse.

2.03 REINFORCEMENT AND ANCHORAGE

A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi), deformed billet bars; uncoated.

B. Single Wythe Joint Reinforcement: ASTM A951/A951M.
   1. Type: Ladder.
   2. Material: ASTM A1064/A1064M steel wire, hot dip galvanized after fabrication to ASTM A153/A153M Class B.
   3. Size: 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not less than 5/8 inch of mortar coverage on each exposure.

C. Multiple Wythe Joint Reinforcement: ASTM A951/A951M.
   1. Type: Ladder.
   2. Material: ASTM A1064/A1064M steel wire, mill galvanized to ASTM A641/A641M Class 3.
   3. Size: 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not less than 5/8 inch of mortar coverage on each exposure.

2.04 ACCESSORIES

A. Preformed Control Joints: Polyvinyl chloride material. Provide with corner and tee accessories, fused joints.

B. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.05 MORTAR AND GROUT MIXING

A. Mortar for Unit Masonry: ASTM C270, using the Proportion Specification.
   1. Masonry below grade and in contact with earth: Type N.
   2. Exterior, loadbearing masonry: Type S.
   3. Interior, loadbearing masonry: Type S.

B. Colored Mortar: Proportion selected pigments and other ingredients to match Engineer's sample, without exceeding manufacturer's recommended pigment-to-cement ratio.

C. Grout: ASTM C476; consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches.

D. Admixtures: Add to mixture at manufacturer's recommended rate and in accordance with manufacturer's instructions; mix uniformly.

E. Mixing: Use mechanical batch mixer and comply with referenced standards.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive masonry.

B. Verify that related items provided under other sections are properly sized and located.

C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 PREPARATION

A. Direct and coordinate placement of metal anchors supplied for installation under other sections.

B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.03 COLD AND HOT WEATHER REQUIREMENTS

A. Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.

3.04 COURSING

A. Establish lines, levels, and coursing indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

C. Concrete Masonry Units:
   1. Bond: Running.
   2. Coursing: One unit and one mortar joint to equal 8 inches.
   3. Mortar Joints: Concave.

3.05 PLACING AND BONDING

A. Lay hollow masonry units with face shell bedding on head and bed joints.

B. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.

C. Remove excess mortar and mortar smears as work progresses.

D. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.

E. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

F. Isolate masonry partitions from vertical structural framing members with a control joint.

3.06 REINFORCEMENT AND ANCHORAGE - GENERAL

A. Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches on center.

B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.

C. Place continuous joint reinforcement in first and second joint below top of walls.

D. Embed longitudinal wires of joint reinforcement in mortar joint with at least 5/8 inch mortar cover on each side.

E. Lap joint reinforcement ends minimum 6 inches.

3.07 LINTELS

A. Install reinforced unit masonry lintels over openings where steel or precast concrete lintels are not scheduled.
   1. Reinforce per schedule on drawings.
   2. Do not splice reinforcing bars.
   3. Allow masonry lintels to attain specified strength before removing temporary supports.

3.08 GROUTED COMPONENTS

A. Reinforce bond beams as shown on drawings.

B. Lap splices minimum 48 bar diameters.

C. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.

D. Place and consolidate grout fill without displacing reinforcing.

E. At bearing locations, fill masonry cores with grout for a minimum 12 inches either side of opening.

3.09 CONTROL AND EXPANSION JOINTS

A. Do not continue horizontal joint reinforcement through control or expansion joints.

B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.

C. Size control joints as indicated on drawings; if not indicated, 3/4 inch wide and deep.

3.10 BUILT-IN WORK

A. As work progresses, install built-in metal door frames, glazed frames, anchor bolts, and plates and other items to be built into the work and furnished under other sections.

B. Install built-in items plumb, level, and true to line.

C. Do not build into masonry construction organic materials that are subject to deterioration.

3.11 TOLERANCES

A. Install masonry within the site tolerances found in TMS 402/602.

B. Maximum Variation from Alignment of Columns: 1/4 inch.

C. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.

D. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.

E. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.

F. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.

G. Maximum Variation of Mortar Joint Thickness: Head joint, minus 1/4 inch, plus 3/8 inch.

H. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.12 CUTTING AND FITTING

A. Cut and fit for chases, pipes, conduit, and sleeves. Coordinate with other sections of work to provide correct size, shape, and location.

B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.13 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.

B. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140/C140M for compliance with requirements of this specification.

C. Mortar Tests: Test each type of mortar in accordance with ASTM C780, testing with same frequency as masonry samples.

3.14 CLEANING

A. Remove excess mortar and mortar droppings.

B. Replace defective mortar. Match adjacent work.

C. Clean soiled surfaces with cleaning solution.

3.15 PROTECTION

A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Structural steel framing members.

B. Structural steel support members.

C. Base plates, .

D. Grouting under base plates.

1.02 PRICE AND PAYMENT PROCEDURES

A. See Section 01 20 00 - Measurement and Payment, for additional unit price requirements.

1.03 REFERENCE STANDARDS

A. AISC (MAN) - Steel Construction Manual; 2023, with Errata (2025).

B. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges; 2022, with Errata (2025).

C. AISC 360 - Specification for Structural Steel Buildings; 2022, with Errata (2025).

D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

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

F. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished; 2024.

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

H. ASTM A563/A563M - Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric); 2021a.

I. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel; 2021, with Editorial Revision.

J. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.

K. ASTM A992/A992M - Standard Specification for Structural Steel Shapes; 2022.

L. ASTM F436/F436M - Standard Specification for Hardened Steel Washers Inch and Metric Dimensions; 2024.

M. ASTM F959/F959M - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series; 2017a.

N. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength; 2020.

O. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi, 144 ksi, and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength; 2025.

P. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.

Q. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021, with Errata (2023).

R. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025.

S. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.

T. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).

U. SSPC-SP 2 - Hand Tool Cleaning; 2024.

V. SSPC-SP 3 - Power Tool Cleaning; 2024.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop Drawings:
   1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
   2. Connections.
   3. Indicate cambers and loads.
   4. Indicate ASTM material grading.
   5. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.

C. Design Calculations: For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Manufacturer's Mill Certificate: Certify that products meet or exceed specified requirements.

E. Certificates of Compliance: Certify that high-strength bolts comply with ASTM F3125/F3125M.

F. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.

G. Fabricator's Qualification Statement.

1.05 QUALITY ASSURANCE

A. Fabricate structural steel members in accordance with AISC (MAN) "Steel Construction Manual."

B. Fabricator: Company specializing in performing the work of this section with minimum 3 years of documented experience. Participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant.
   1. For conventionally framed buildings of one to five stories: Certified by AISC’s Qualification Program for SBD.
   2. For framed buildings greater than five stories or other complex structures: Certified by AISC’s Quality Certification Program for CBD or CBR.

C. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and no more than 12 months before start of scheduled welding work.

D. Erector: Company specializing in performing the work of this section with minimum 5 years of documented experience or an AISC Certified Erector, Category CSE.

E. Design connections not detailed on drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in Colorado.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store steel off the ground on platforms, skids, or other supports; separate with wooden separators.

B. Protect steel from corrosion.

C. Prevent damage to the prime coat; use wooden protectors to prevent damage from chain or cable cinches.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel Angles, Plates, S Shapes, M Shapes, and HP Shapes: ASTM A572/A572M, Grade 50 (345) high-strength steel.

B. Steel W Shapes, Tees, Channels, and Miscellaneous Channels (MC): ASTM A992/A992M.

C. Rectangular Hollow Structural Sections (HSS): ASTM A500/A500M, Grade C.

D. Round Hollow Structural Sections (HSS): ASTM A500/A500M, Grade C.

E. Pipe: ASTM A53/A53M, Grade B, Finish as indicated.

F. Shear Connectors: ASTM A108, Grade 1015, Type B; Forged steel, headed, unfinished.

G. Headed Concrete Anchors or Studs: ASTM A108, Grade 1015, Type A or B.

H. High-Strength Structural Bolts, Nuts, and Washers: ASTM F3125/F3125M, with matching compatible ASTM A563/A563M nuts and ASTM F436/F436M washers.

I. Tension Control Bolts: Twist-off type; ASTM F3125/F3125M.

J. Unheaded Anchor Rods: ASTM F1554, Grade 36, zinc coated, with matching ASTM A563/A563M nuts and ASTM F436/F436M Type 1 washers.

K. Headed Anchor Rods: ASTM F1554 Grade 36, zinc-coated, with matching matching compatible ASTM A563/A563M nuts and ASTM F436/F436M Type 1 washers.
   1. Provide two hexagonal nuts and two hardened steel washers for each anchor rod.
   2. Provide 3/8 inch thick square plate washers in lieu of steel washer on base plates with oversided holes.

L. Load Indicator Washers: Provide washers complying with ASTM F959/F959M at connections requiring high-strength bolts with coating type to match the bolt finish.

M. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

N. Grout: ASTM C1107/C1107M; Non-shrink; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
   1. Minimum Compressive Strength at 48 Hours: 2,000 pounds per square inch.
   2. Minimum Compressive Strength at 28 Days: 7,000 pounds per square inch.

O. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

P. Touch-Up Primer for Galvanized Surfaces: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION

A. Shop fabricate to greatest extent possible.

B. Ease exposed edges to a radius of approximately 1/32 inch.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Continuously seal joined members by continuous welds. Grind exposed welds smooth.

E. Provide a drilled drain hole at the lowest point where collection of water inside the structural tubing could occur.

F. Cap the open ends of tubes and seal the weld. Wherever practicable, weld connections all around. Seal seams that cannot be welded with joint sealer.

G. Fabricate connections for bolt, nut, and washer connectors.

H. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware and similar items.

2.03 FINISH

A. Prepare structural component surfaces in accordance with SSPC-SP 2 or SSPC-SP 3.

B. Remove oil, grease and similar contaminates in accordance with SSPC-SP 1.

C. Shop prime structural steel members. Do not prime surfaces that will be fireproofed, field welded, in contact with concrete, high strength bolted, having incompatible coatings applied, or galvanized.

D. Brush or spray on primer in accordance with manufacturer's instructions and at a rate to provide uniform dry film thickness of 2.0 mils for each coat.

E. Apply one shop coat to fabricated metal items, except apply two coats of paint to surfaces inaccessible after assembly or erection finishes.

F. Use painting methods which will result in full coverage of joints, corner, edges and exposed surfaces.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are appropriate for erection of structural steel and that the work may properly proceed.

3.02 ERECTION

A. Erect structural steel in compliance with AISC 303 and AISC 360.

B. Accurately assemble to the lines and elevations shown on the Drawings within specified erection tolerances.

C. Align and adjust members forming parts of the complete frame or structure after assembly but before fastening.

D. Allow for erection loads and provide sufficient temporary bracing to maintain structure in safe condition, plumb, and in true alignment until completion of erection and installation of permanent bracing.

E. Tighten erection bolts and leave in place or remove bolts and fill holes with plug welds.

F. Provide templates for setting anchor bolts. Position anchor bolts by using templates with two nuts to secure in place prior to the placement of concrete.

G. Align bearing plates with leveling plates.

H. Fasten splices of compression members after abutting surfaces are brought completely into contact.

I. Clean bearing surfaces and surfaces that will be in permanent contact before assembling members.

J. Locate splices only where shown on drawings.

K. Field weld components indicated on shop drawings.

L. Do not field cut or alter structural members without approval of Engineer.

M. High-Strength Bolted Connections:
   1. Tighten in accordance with AISC 303 and AISC 360.
   2. Hardened washers:
      a. Provide hardened washers at the locations required by AISC for structural joints; include slip-critical connections using slotted or oversized holes or bolts in accordance with ASTM F3125/F3125M.
      b. Use beveled style and extra thickness where required.
      c. Do not substitute direct tension indicators for hardened flat washers at slotted and oversized holes.
   3. For bearing type connections not fully tensioned, tighten to a snug-tight condition; use a hardened washer over slotted or oversized holes in outer members.
   4. Use tension-control bolts only in snug-tight bearing connections.

N. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.

O. Grout solidly between column plates and bearing surfaces, complying with manufacturer's instructions for nonshrink grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees.

P. Touch up bolt heads, nuts, field welds, and abrasions in the shop coating with the same primer used in the shop.

Q. Touch up welds and abrasions in galvanized members in accordance with ASTM A780/A780M.

3.03 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.

B. Maximum Variation From Level: 1/4 inch in 10 feet, non-cumulative.

C. Maximum Offset From True Alignment: 1/4 inch.

D. Displacement of centerline of exterior columns and columns adjacent to elevator shafts: Maximum 1/16 inch inch per story.

END OF SECTION

SECTION 05 31 00
STEEL DECKING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof deck.

B. Composite floor deck.

C. Metal form deck.

D. Supplementary framing for openings up to and including 18 inches.

E. Bearing plates and angles.

F. Stud shear connectors.

1.02 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

B. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished; 2024.

C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.

D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

E. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2024.

F. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025.

G. AWS D1.3/D1.3M - Structural Welding Code - Sheet Steel; 2018, with Errata (2022).

H. SDI (DM) - Publication No.30, Design Manual for Composite Decks, Form Decks, and Roof Decks; 2007.

I. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.

B. Product Data: Provide deck profile characteristics, dimensions, structural properties, and finishes.

C. Shop Drawings: Indicate deck plan, support locations, projections, openings, reinforcement, pertinent details, and accessories.

D. Certificates: Certify that products furnished meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this Section with minimum _____ years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Cut plastic wrap to encourage ventilation.

B. Store deck on dry wood sleepers; slope for positive drainage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Steel Deck:
   1. New Millennium Building Systems; ____: www.newmill.com/#sle.
   2. Nucor-Vulcraft Group; ____: www.vulcraft.com/#sle.
   3. Engineer Approved Equal.

2.02 STEEL DECK

A. Roof Deck: Non-composite type, fluted steel sheet:
   1. Ungalvanized Steel Sheet: ASTM A1008/A1008M, Designation SS, Grade 33, Type 1.
   2. Primer: Shop coat of manufacturer's standard primer paint over cleaned and phosphatized substrate.
   3. Structural Properties:
      a. Span Design: per drawings.
   4. Minimum Base Metal Thickness: per drawings.
   5. Nominal Height: per drawings.
   6. Profile: Fluted.
   7. Side Joints: Lapped, mechanically fastened.
   8. End Joints: Lapped, welded.

B. Composite Floor Deck: Fluted steel sheet embossed to interlock with concrete:
   1. Galvanized Steel Sheet: ASTM A653/A653M, Structural Steel (SS) Grade 33/230, with G90/Z275 galvanized coating.
   2. Primer: Shop coat of manufacturer's standard primer paint over cleaned and phosphatized substrate.
   3. Span Design: per drawings.
   4. Minimum Base Metal Thickness: per drawings.
   5. Nominal Height: per drawings.
   6. Profile: Fluted.
   7. Side Joints: Lapped, mechanically fastened.
   8. End Joints: Lapped, welded.

C. Metal Form Deck: Corrugated sheet steel:
   1. Galvanized Steel Sheet: ASTM A653/A653M, Structural Steel (SS) Grade 33/230, with G90/Z275 galvanized coating.
   2. Ungalvanized Steel Sheet: ASTM A1008/A1008M, Designation SS, Grade 33, Type 1.
   3. Primer: Shop coat of manufacturer's standard primer paint over cleaned and phosphatized substrate.
   4. Side Joints: Lapped, mechanically fastened.
   5. End Joints: Lapped, mechanically fastened.

2.03 ACCESSORY MATERIALS

A. Bearing Plates and Angles: ASTM A36/A36M steel.

B. Stud Shear Connectors: Made from ASTM A108 Grade 1015 bars.

C. Welding Materials: AWS D1.1/D1.1M.

D. Fasteners: Galvanized hardened steel, self tapping.

E. Mechanical Fasteners: Steel; hex washer head, self-drilling, self-tapping.

F. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

G. Flute Closures: Closed cell foam rubber, 1 inch thick; profiled to fit tight to the deck.

2.04 FABRICATED DECK ACCESSORIES

A. Sheet Metal Deck Accessories: Metal wet concrete stops and cover plates, 20 gauge, 0.0359 inch thick sheet steel; of profile and size as indicated; finished same as deck.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions prior to beginning work.

B. Examine support framing and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work of this section.

3.02 INSTALLATION

A. Erect metal deck in accordance with SDI Design Manual and manufacturer's instructions. Align and level.

B. Locate deck bundles to prevent overloading of support members.

C. Do not use deck units as a working platform or storage area until units are permanently attached in position.

D. Do not impose construction loads that exceed load carrying capacity of deck.

E. On concrete and masonry surfaces provide minimum 4 inch bearing.

F. On steel supports provide minimum 1-1/2 inch bearing.

G. Fasten deck to steel support members at ends and intermediate supports at 12 inches on center maximum, parallel with the deck flute and at each transverse flute using methods indicated on drawings.
   1. Welding: Use fusion welds through weld washers.

H. At mechanically fastened male/female side laps fasten at 24 inches on center maximum.

I. Drive mechanical sidelap connectors completely through adjacent lapped sheets; positively engage adjacent sheets with minimum three-thread penetration.

J. Weld deck in accordance with AWS D1.3/D1.3M.

K. Where deck (other than cellular deck electrical raceway) changes direction, install 6 inch minimum wide sheet steel cover plates, of same thickness as deck. Fusion weld 12 inches on center maximum.

L. At floor edges, install concrete stops upturned to top surface of slab, to contain wet concrete. Provide stops of sufficient strength to remain stationary without distortion.

M. At openings between deck and walls, columns, and openings, provide sheet steel closures and angle flashings to close openings.

N. Close openings above walls and partitions perpendicular to deck flutes with single row of foam cell closures.

O. Do not cut unscheduled openings through the deck without the approval of the Engineer. Reinforce openings as directed.

P. Weld stud shear connectors through steel deck to structural members below.

Q. Immediately after welding deck and other metal components in position, coat welds, burned areas, and damaged surface coating, with touch-up primer.

3.03 REPAIRS

A. Before placement of roof insulation and roof covering:
   1. Inspect the deck for tears, dents, or other damage that may prevent the deck from action as a structural roof base.
   2. Repair tears, dents, or other damage.
   3. Obtain the approval of the Engineer.

END OF SECTION

SECTION 05 52 13
PIPE AND TUBE RAILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall mounted handrails.

B. Stair railings and guardrails.

C. Free-standing railings at steps.

1.02 REFERENCE STANDARDS

A. AAMA 611 - Specification for Anodized Architectural Aluminum; 2024.

B. ASTM B241/B241M - Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube; 2022.

C. ASTM B429/B429M - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube; 2020.

D. ASTM B483/B483M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Tube and Drawn Pipe for General Purpose Applications; 2021.

E. ASTM E935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings; 2021.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

C. Calculations: Submit calculations to the Engineer for approval.

D. Designer's Qualification Statement.

E. Fabricator's Qualification Statement.

1.04 QUALITY ASSURANCE

A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in Colorado, or personnel under direct supervision of such an engineer.

B. Fabricator Qualifications:
   1. A company specializing in manufacturing products specified in this section, with not less than five years of documented experience.

PART 2 PRODUCTS

2.01 RAILINGS - GENERAL REQUIREMENTS

A. Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of applicable local code.

B. Distributed Loads: Design railing assembly, wall rails, and attachments to resist distributed force of 50 pounds per linear foot applied to the top of the assembly and in any direction, without damage or permanent set.

C. Concentrated Loads: Design railing assembly, wall rails, and attachments to resist a concentrated force of 200 pounds applied at any point on the top of the assembly and in any direction, without damage or permanent set.

D. Allow for expansion and contraction of members and building movement without damage to connections or members.

E. Dimensions: See drawings for configurations and heights.
   1. Top Rails and Wall Rails: 1-1/2 inches diameter, round.
   2. Intermediate Rails: 1-1/2 inches diameter, round.

3. Posts: 1-1/2 inches diameter, round. Spacing of 6'-0" maximum.
4. Toe plates: 4 inches height minimum.

F. Openings in the railing shall be guarded by a self-closing gate. Safety chains shall not be used unless specifically shown on the Drawings.

G. Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.

H. Provide slip-on non-weld mechanical fittings to join lengths, seal open ends, and conceal exposed mounting bolts and nuts, including but not limited to elbows, T-shapes, splice connectors, flanges, escutcheons, and wall brackets.

2.02 ALUMINUM MATERIALS

A. Aluminum Pipe: Schedule 40; ASTM B429/B429M, ASTM B241/B241M, or ASTM B483/B483M.

B. Non-Weld Mechanical Fittings: Slip-on cast aluminum, for Schedule 40 pipe, with flush setscrews for tightening by standard hex wrench, no bolts or screw fasteners.

C. Straight Splice Connectors: Collar with locking set screws; cast aluminum.

D. Exposed Fasteners: Flush countersunk screws or bolts; consistent with design of railing.

2.03 FABRICATION

A. Accurately form components to suit specific project conditions and for proper connection to building structure.

B. Fit and shop assemble components in largest practical sizes for delivery to site.

C. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.

2.04 ALUMINUM FINISHES

A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.

B. Touch-Up Materials: As recommended by coating manufacturer for field application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

A. Supply items required to be cast into concrete or embedded in masonry with setting templates, for installation as work of other sections.

B. Apply one coat of bituminous paint to concealed aluminum surfaces that will be in contact with cementitious or dissimilar materials.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.

C. Anchor railings securely to structure.

D. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

E. Posts shall not interrupt the continuation of the top rail at any point along the railing, including corners and end terminations. The top surface of the top railing shall be smooth and shall not be interrupted by projecting fittings.

F. Toe plates shall be set above the walking surface.

3.04 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per floor level, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch.

C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION

SECTION 09 90 00
PAINTING AND COATING

PART 1 GENERAL

1.01 SUMMARY

A. Work under this Section shall include all labor, parts, materials and equipment necessary to furnish and install all painting and finish systems as specified herein and shown on the Drawings. This section shall apply to all buildings and all exposed interior and exterior materials and piping.

1.02 REFERENCES

A. ASTM D16 – Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products.

B. AWWA C204 – Chlorinated Rubber-Alkyd Paint Systems for the Exterior of Above Ground Steel Water Piping.

C. AWWA D102 – Painting Steel Water Storage Tanks.

D. NACE – National Association of Corrosion Engineers-Industrial Maintenance Painting.

E. NPCA – National Paint and Coatings Association-Guide to U.S. Government Painting Specifications

F. NSF 61 – Drinking Water System Components-Health Effects.

G. PDCA – Painting and Decorating Contractors of America-Painting-Architectural Specifications Manual.

H. SSPC - Steel Structures Painting Council Specifications.

I. ICRI - International Concrete Repair Institute.

1.03 SUBMITTALS

A. Product Data
   1. Complete listing of all materials to be used including generic type, surface preparation requirements and recommended application techniques. Include material safety data sheets.

B. Color Samples
   1. Furnish color chips for color selection by Owner. Selections by Owner may exceed manufacturer's standard range of colors.

C. Field Samples
   1. Furnish representative samples of color and finish texture of each paint type.

D. Manufacturer's Instructions
   1. Indicate special surface preparation procedures, substrate conditions requiring special attention.

E. Painting Schedule
   1. Identify all surfaces to be painted.
   2. Identify surface preparation to be used.
   3. Identify type of primer coating, film thickness, shop or field applied.
   4. Identify type of final coating, film thickness, shop or field applied.

1.04 DELIVERY, STORAGE AND HANDLING

A. All materials delivered to the job site shall be in original sealed and labeled containers of the paint manufacturer. Labels and directions shall be legible. Store materials in dry location, designated by Engineer, kept within temperature limits set by manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers

1. Tnemec Company.
2. Sherwin Williams.
3. Engineer Approved Equal.

B. Coating thicknesses stated are the minimum acceptable Dry Film Thickness (DFT) for the reference product.

2.02 METAL SURFACES

A. All structural and miscellaneous steel surfaces, exterior, non-immersion, except galvanized and stainless steel. This includes, but is not limited to the following; doors and frames, steel handrails, pumps, motors, and other process equipment, etc.
1. System: Epoxy
2. Surface Preparation: Per representative manufacturer.
3. Coatings:

Prime Coat	Factory Primed	
Intermediate	Tnemec Series V69	2.0 – 3.0 mils
Finish Coat	Tnemec Series 73	2.0 – 5.0 mils
	Total	4.0 – 8.0 mils

4. Color: Match Building 4.

B. All structural and miscellaneous steel surfaces, interior, non-immersion, except galvanized and stainless steel. This includes, but is not limited to the following; doors and frames, beams and roof decking, steel handrails, pumps, motors, and other process equipment, etc.
1. System: Epoxy
2. Surface Preparation: Per representative manufacturer
3. Coatings:

Prime Coat	Tnemec Series V69	3.0 – 5.0 mils
Finish Coat	Tnemec Series V69	3.0 – 5.0 mils
	Total	6.0 – 10.0 mils

4. Color:Match Building 4.

C. All steel surfaces, interior or exterior, immersion, except galvanized and stainless steel.
1. System: Epoxy
2. Surface Preparation: Per representative manufacturer.
3. Coatings:

Prime Coat	Tnemec Series V69	3.0 – 5.0 mils
Finish Coat	Tnemec Series V69	4.0 – 6.0 mils
	Total	7.0 – 11.0 mils

OR

4. Color: Match Building 4.

2.03 PIPING

A. All ductile iron piping, interior or immersion.
1. System: Epoxy.
2. Surface Preparation: Per representative manufacturer.
3. Coatings:

Prime Coat	Tnemec Series V69	3.0 – 5.0 mils
Finish Coat	Tnemec Series V69	4.0 – 6.0 mils
	Total	7.0 – 11.0 mils

4. Color: Per process color identification requirements

B. All exterior ductile iron piping, non-immersion.
1. System: Epoxy/Polyurethane.
2. Surface Preparation: Per representative manufacturer.

3. Coatings:

Prime Coat	Tnemec Series V69	3.0 – 5.0 mils
Finish Coat	Tnemec Series V69	4.0 – 6.0 mils
	Total	7.0 – 11.0 mils

4. Color: Per process color identification requirements.

C. All ductile iron piping below ground.
1. System: Epoxy.
2. Surface Preparation: Per representative manufacturer.
3. Coatings:

Prime Coat	Tnemec Series 66	3.0 – 5.0 mils
Finish Coat	Tnemec Series 46H-413	16.0 – 20.0 mils
	Total	19.0 – 25.0 mils

4. Color: Black.

D. All interior plastic, PVC, and copper piping
1. System: Epoxy.
2. Surface Preparation: Per representative manufacturer.
3. Coatings:

Prime Coat	Tnemec Series V69	2.0 – 3.0 mils
Finish Coat	Tnemec Series V69	2.0 – 3.0 mils
	Total	4.0 – 6.0 mils

4. Color: Per process color identification requirements.
5. For exterior service: Top coat with Tnemec Series 73 at 2.0-3.0 mils OR SW Acrolon 218 at 3.0-6.0 mils.

2.04 CONCRETE AND MASONRY SURFACES

A. The interior masonry walls shall be coated as follows:
1. System: Epoxy
2. Surface Preparation: Per representative manufacturer.
3. Coatings:

Prime Coat	Tnemec Series V69	4.0 - 6.0 mils
Finish Coat	Tnemec Series V69	4.0 - 6.0 mils

4. Color: White

B. All exterior concrete block surfaces:
1. System: Penetrating Sealer.
2. Surface Preparation: Per representative manufacturer.
3. Coatings:

Prime Coat	Tnemec Series 633	100 – 125 sf/gal
	Total	100 – 125 sf/gal

4. Color: Transparent

C. All smooth finished interior concrete floors and walkways that will not be otherwise covered or treated shall be coated.
1. System: Concrete Sealer
2. Surface Preparation: Per representative manufacturer.
3. Coatings:

Finish Coat	Tnemec Series 629	300 - 350 sf/gal
OR		
Finish Coat	SW H&C Concrete Stain	100 – 125 sf/gal

4. Color: Transparent

2.05 PIPE MARKING SYSTEM

A. Required on any rigid potable / non-potable waterlines.
   1. Type - Paint conforming to the various sections above or pressure-sensitive tape equal to VX Company or Seton Nameplate Corporation.
   2. Information required - Director of flow and name of fluid.
   3. Marking requirements.
   4. Color requirements.

2.06 IDENTIFICATION OF PIPING AND PROCESS SYSTEMS

A. Scope of Work. Work under this Section covers installation of piping marking systems for permanent piping and appurtenances. Piping systems include conduits for the transport of gases, liquids, semi-liquids, and their component parts, including valves, sluice gates and slide gates and any control devise, which is an operational component of the system.

B. Reference Standards. Standards listed hereunder and referenced elsewhere in these Specifications shall become a part of this specification and are incorporated herein by reference. The latest edition, amendment or supplement thereto in effect 30 days before date of invitation shall apply.
   1. Scheme for Identification of Piping Systems.
   2. Safety Color Code for Marking Physical Hazards.

C. Submittals
   1. Product Data: Submit catalog data or brochures on manufactured items specified and proposed for use.
   2. Certificates of Compliance: Furnish certification that standards specified herein are met.
   3. Samples: Furnish physical examples to illustrate materials, equipment or workmanship.

D. Materials
   1. General. Content of piping systems shall be identified according to base color of pipe supplemented by completely encircling solid color bands at least 9 inches in length (longer when necessary to accommodate full identification labels and two-inch end borders), applied to pipe or pipe covering. Stencils or labels may be used.
   2. Lettering. Paint, stencil, or use identification labels. Letter size as follows:

Outside Diameter of Pipe of Covering (Inch)	Minimum Height of Letters (Inch)
5/8 or smaller	Metal Tags 1/4
3/4 through 4	3/4
5 or larger	2

   3. Identification Labels. Identification labels shall be Brady "Quik-Labels" (mastic back) as manufactured by the W. H. Brady Company or equal.
   4. Metal Tags
      a. Aluminum or stainless steel, stamped in identifying letters.
      b. Provide on pipe 5/8 inch or smaller (including cover) outside diameter.
      c. Color code as specified.
   5. Color Classification (General)
      a. Green or Blue: Identifying color or non-hazardous media causing no danger to person or property.
      b. Yellow: Identifying color for materials hazardous to life or property by virtue of being explosive, flammable, or productive or poisonous gases or in themselves poisonous, corrosive or hazardous due to their physical state.
      c. Orange: Identifying color where electrical currents in excess of 120 volts occur.
   6. Pipe Identification.
      a. Color Band and Legend Dimensions:

Outside Diameter of Pipe Or Pipe Covering	Width of Color Band	Size of Legend

¾” to 1¼”	8”	½”
1½” to 2”	8”	¾”
2½” to 6”	12”	1¼”
8” to 10”	24”	2½”
Over 10”	32”	3½”

7. Legend Information: Include the name of the fluid, and an arrow indicating direction of flow. Where pipes are too small for an application of bands or legends, install stainless steel identification tags at the specified locations.

2.07 COLOR AND IDENTIFICATION

A. Wastewater Treatment Facility

Media	Base Color	Band Color	Letter Color	Legend
Potable Water	Blue	Vista Green	White	H2O
Non-Potable Water	Purple	White	Black	Non-Potable
Chlorine Gas	Lemon Yellow	None	Black	Cl2 Gas
Chlorine Solution	Lemon Yellow	White	Black	Cl2 SOL
Sanitary Sewer	Light Gray	Lemon	Yellow White	SAN
Secondary Effluent	Light Gray	Lemon	Yellow White	SE
Raw Wastewater	Light Gray	Lemon	Yellow White	WW
Settled Sewage	Light Gray	Lemon	Yellow White	
Mixed Liquor	Light Brown	Lemon Yellow	White	ML
Return Activated Sludge	Light Brown	Lemon Yellow	White	RAS
Sludge	Light Brown	Lemon Yellow	White	
Waste Activated Sludge	Light Brown	Lemon Yellow	White	WAS
Biosolids	Light Brown	Lemon Yellow	White	BIO
Sloppy Cake Discharge	Light Brown	Lemon Yellow	White	SLC
Scum	Dark Brown	Lemon Yellow	White	SC
Grit Slurry	Dark Gray	Lemon Yellow	White	GR
Drain	Dark Gray	Lemon Yellow	White	D
Centrate	Dark Gray	Lemon Yellow	White	CEN
Centrate / Supernatant	Dark Gray	Lemon Yellow	White	CEN/SNT
Decant / Supernatant	Dark Gray	Lemon Yellow	White	SNT
Sample	Light Gray	Green	Black	
Polymer Solution	Yellow	White	Black	POLY
Refrigerant	Yellow	Blue	Black	Refrigerant
Sodium Hypochlorite	Yellow	Red	Black	NaOCl
Fire Protection	Red	None	Black	Fire
Natural Gas	Red	None	Black	NG
Compressed Air	Light Green	None	Black	Air

Low Pressure Air(aeration supply)	Light Green	None	Black	LP Air
Instrument Air	Kelly Green	None	White	
Electrical (over 120V)	Bright Orange	None	Black	Voltage (list amount)
Control		Black	Black	Control
Vent	Light Gray		Black	
Other Lines	Light Gray		Black	

Lemon yellow, orange and green colors shall conform to ANSI Z53.1.

PART 3 EXECUTION

3.01 GENERAL

A. It is the intent of this specification to give the general coating requirements for different substrates and service conditions. Where multiple products could be used in the same general vicinity, such as a clarifier where some steel is immersed and some is exposed, the more stringent requirement shall prevail and the associated coating shall be used for the entire assembly. In the clarifier example, all immersed and exposed parts shall be coated with the product for the more stringent service application.

B. Application. Apply base color to entire run of piping. Prior to application of bands and legend, verify suitability of proposed locations with Engineer as described hereafter. Protect painted legends from damage and concealment by foreign matter throughout the construction period. Verify total visibility of legends prior to final acceptance.

C. Pipe Identification. Identify straight lines of pipe at intervals of approximately 20 feet. Piping shall also be identified at a point approximately two feet from all turns, valves and upstream side of distributional fittings or branches. Branch take-offs from horizontal runs to outlet cocks or valves less than 10 feet in length need not be identified if in the same room. The lettered label, besides identifying the materials, shall indicate unusual qualities of the pipe contents, such as hot (85ºF or higher) or high pressure (above 30 psig). On service piping, either liquid or gas, apply black arrows of same height and with same background color as adjacent identification labels to indicate direction of flow. Legends shall be located so a person standing at ground level may read them.

D. Shop Coatings. Verify compatibility of any shop coatings with finish field coatings and these Specifications. Provide barrier coats as required.

E. Surface Preparation. Inspect all surfaces to be painted and perform such surface preparation as is normally required by good painting practice, as required by product manufacturer, and as specified herein. Should any surface be found unsatisfactory to produce a proper finish, the Engineer shall be notified in writing and no material shall be applied until the unsuitable surfaces have been made satisfactory. Surface preparation shall be approved prior to any paint application. Where media blasting is required, contractor shall control dust and protect adjoining areas.

F. Material Preparation. Materials shall be mixed, thinned and applied in strict accordance with the manufacturer's printed instructions. No exceptions will be allowed without written explanation from manufacturer and prior approval by Engineer.

G. Application. Coatings shall be applied during good painting weather. Coating shall only be applied to properly prepared surface and within manufacturer’s coating windows. Air and surface temperatures shall be within limits prescribed by the coating manufacturer. The work areas shall be kept reasonably free of airborne dust at the time of application and while the coating is drying.

H. Allow each coat to dry thoroughly before applying the next coat. Dry time shall be as recommended by manufacturer with no exceptions.

I. All work shall be cut neatly and finish coats shall be uniform in color and texture without streaks, laps, heavy build-ups, runs, sags or missed areas. Intermediate coats shall be shaded sufficiently to allow visual inspection of adequacy of coverage. Each coat shall be approved prior to application of subsequent coats.

J. Contract shall protect all work to eliminate product overspray and drift. Contractor responsible for all cleanup and restoration to pre-work conditions or better.

K. Excess Materials. All paint materials, opened, but unused, shall remain the property of the Owner for use in maintenance and touch-up. Contractor shall ensure that remaining product is clearly marked with product type, color and intended application.

3.02 FIELD QUALITY CONTROL

A. Contractor shall complete and sign daily field reports documenting field conditions, work areas and materials applied. Contractor shall complete Form 9900-A (or other approved form) on a daily basis and submit record copies on a weekly basis to Engineer.

B. Surface Preparation. Receive approval before paint application.

C. Finish. Receive approval on all coats prior to additional coating applications.

D. Contractor to document and submit wet mil thickness for all applications using standard “notch” configuration or circular dial gauges.

E. Testing. The following tests are considered the minimum field quality assurances tests. The prescribed test shall be performed by a third-party inspector that will be paid fort by the Owner.

1. Concrete – any concrete scheduled for specialty coating,
   a. Prior to application, test substrate for relative humidity using ASTM F2170.
   b. Consult Engineer if values are outside manufacturer’s allowed range
2. DFT of all applied coatings.
   a. Equipment
      1) Type 1: Magnetic pull-off type gauge
      2) Type 2: Fixed probe magnetic flux gauge with microprocessor
      3) Use eddy current type gauge or probe attachment for non-ferrous metal substrates
      4) Gauge accuracy: ±10 percent
   b. Comply with inspection and film thickness testing requirements of SSPC-Volume 1, Chapter 6 and SSPC-PA 2.
      1) Make five (5) separate spot measurements (average of three readings for each spot measurement) spaced evenly over each 100 square feet (9.3 square meters) of area to be measured
      2) The average of five spot measurements for each such 100 square foot area shall not be less than the specified thickness
      3) No single spot measurement in any 100 square foot area shall be less than 80 percent of the specified thickness
      4) Any one of three readings which are averaged to produce each spot measurement may under-run by a greater amount
      5) The five spot measurements shall be made for each 100 square feet of area as follows:
      6) For structures not exceeding 300 square feet in area, each 100 square foot area shall be measured
      7) For structures not exceeding 1,000 square feet in area, three 100 square foot areas shall be randomly selected and measured
      8) For structures exceeding 1,000 square feet in area, the first 1,000 square feet shall be measured as stated above and for each additional 1,000 square feet of area or increment thereof, one 100 square foot area shall be randomly selected and measured
      9) If the dry film thickness for any 100 square foot area is not in compliance with the requirements above, then each 100 square foot area shall be measured

c. Other size areas or number of spot measurements may be adjusted as appropriate for the size and shape of the structure to be measured as determined by Engineer

END OF SECTION

FORM 9900-A. DAILY FIELD COATING REPORT

DATE

COMPANY

SUPERVISOR

WEATHER (ATMOSPHERIC) DAILY HIGH

DAILY LOW

TEMP @ START

TEMP @ FINISH

% REL. HUMIDITY

DEW POINT

WORK AREA 1

LOCATION DESCRIPTION

APPLICATION PERSONNEL

EQUIPMENT

SUBSTRATE

PRODUCT DESCRIPTION (MFG AND TYPE)

INTENDED USE FOR PRODUCT

SURFACE PREPARATION REQUIREMENT

TIME FOR TOPCOAT TIME FOR RECOAT – MAX.

PRODUCT PREPARATION AND MIX REQUIREMENTS

PRODUCT STORAGE REQUIREMENT

WORK AREA DAILY HIGH

DAILY LOW

TEMP @ START

TEMP @ FINISH

% REL. HUMIDITY

DEW POINT

WORK AREA PROTECTIVE MEASURES (TO PROTECT WORK)

NOTES:

SIGNATURE

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe markers.

1.02 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Schedule of project specific applications:
   1. Duct service types and associated labeling acronym to be used.
   2. Pipe service types and associated labeling acronym to be used.
   3. Equipment receiving identification.

D. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

A. Heat Pump Units: Nameplates.

B. Fan Coil Units: Nameplates.

C. Fans: Nameplates.

D. Control Panels: Nameplates.

E. Major Control Components: Nameplates.

F. Piping: Pipe markers.

G. Refrigerant Lines and Linesets: Pipe markers.

H. Small-sized Equipment: Tags.

I. Thermostats: Tags or Nameplates.

2.02 NAMEPLATES

A. Manufacturers:
   1. Brimar Industries, Inc; _____: www.pipemarker.com/#sle.

B. Type: Acrylic, adhesive backed.

C. Lettering Method: Engraved.

D. Letter Color: White.

E. Letter Height: Minimum 1/4 inch.

F. Background Color: Black.

2.03 TAGS

A. Manufacturers:
   1. Brimar Industries, Inc; _____: www.pipemarker.com/#sle.

B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges, and corrision resistant ball chain.

2.04 PIPE MARKERS

A. Manufacturers:
   1. Brimar Industries, Inc: www.pipemarker.com/#sle.

B. Color: Comply with ASME A13.1.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion.

B. Install tags with corrosion resistant chain.

C. Install plastic pipe markers in accordance with manufacturer's instructions.

D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

E. Install piping with pipe markers:
   1. Identify service and flow direction.
   2. Install in clear view and align with axis of piping.
   3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
   4. Use tags on piping [1 inch] diameter and smaller.

END OF SECTION

SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping insulation.

B. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

1.03 REFERENCE STANDARDS

A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019, with Editorial Revision (2023).

B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2019).

C. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2019).

D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

E. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2017 (Reapproved 2023).

F. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2023.

G. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2022a.

H. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).

I. ASTM D93 - Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester; 2020.

J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.

K. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2023.

L. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than 5 years of documented experience.

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, RIGID

A. Manufacturers:
   1. Johns Manville Corporation; Micro-Lok HP: www.jm.com/#sle.

B. Insulation: ASTM C547; rigid molded, noncombustible.
   1. Facing: Factory applied vapor retarder ASJ.
   2. K Value: ASTM C1045 and ASTM C335, 0.23 at 75 degrees F.
   3. Maximum Service Temperature: 850 degrees F.
   4. Maximum Moisture Absorption: 5 percent by weight.

C. Vapor Barrier Jacket: Factory applied, white kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

D. Vapor Barrier Lap Adhesive: Compatible with insulation.

E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.03 HYDROUS CALCIUM SILICATE

A. Manufacturers:
   1. Johns Manville Corporation; Thermo-1200: www.jm.com/#sle.

B. Insulation: ASTM C335; rigid molded, asbestos free, water resistant.
   1. K Value: 0.44 at 300 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
   2. Maximum Service Temperature: 1200 degrees F.
   3. Density: 15 pcf.
   4. Compressive Strength: ASTM C165, >100psi 5% compression.
   5. Surface Burning Characteristics: ASTM E84 Flame Spread 0, Smoke Developed 0.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

D. Insulating Cement: ASTM C449.

E. High Temperature Adhesive: Fire-retardant, sodium silicate based adhesive with fibers treated in compliance with ASTM D93.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturers:
   1. Armacell LLC; ArmaFlex: www.armacell.us/#sle.
   2. Armacell LLC; ArmaFlex Shield: www.armacell.us/#sle.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
   1. K Value: 0.28 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
   2. Minimum Service Temperature: Minus 40 degrees F.
   3. Maximum Service Temperature: 180 degrees F.
   4. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

D. Weather Barrier Coating: Pre-jacketed with durable moisture and UV resistant coating, suitable for outdoor applications, meeting ASTM C1775.

2.05 JACKETING AND ACCESSORIES

A. PVC Plastic.
   1. Manufacturers:
      a. Johns Manville Corporation; Zeston: www.jm.com/#sle.
   2. Jacket: One piece molded type fitting covers and sheet material, off-white color, UV inhibitors.
      a. Minimum Service Temperature: 0 degrees F.
      b. Maximum Service Temperature: 150 degrees F.
      c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
      d. Thickness: 20 mil, 0.020 inch.
      e. Connections: Brush on welding adhesive.

2.06 ACCESSORIES

A. General Requirements:
   1. Provide required accessories in accordance with and subject to the recommendations of the insulation manufacturer.
   2. Furnish compatible materials which do not contribute to corrosion, soften, or otherwise attack surfaces to which applied, in either the wet or dry state.
   3. Comply with ASTM C795 requirements for materials to be used on stainless steel surfaces.
   4. Supply materials that are asbestos free.

PART 3 EXECUTION

3.01 EXAMINATION

A. Test piping for design pressure, liquid tightness, and continuity prior to applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. Exposed Piping: Locate insulation and cover seams in least visible locations.

D. Insulated Pipes Conveying Fluids Below Ambient Temperature:
   1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.

E. Glass Fiber Insulated Pipes Conveying Fluids Below Ambient Temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with FSK jacket and vapor barrier.

F. For hot piping conveying fluids 150 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

G. For hot piping conveying fluids over 150 degrees F, insulate flanges and unions at equipment.

H. Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:
   1. Provide standard jackets, with vapor barrier, factory-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with FSK jacket, vapor barrier and PVC covers.

I. Inserts and Shields:
1. Application: Piping 1-1/2 inches diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert location: Between support shield and piping and under the finish jacket.
4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 84 00.

3.03 SCHEDULE

A. Refer to Drawings for specific service thickness and applications.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping.

B. Refrigerant.

C. Moisture and liquid indicators.

1.02 RELATED REQUIREMENTS

A. Section 238126.13-Small Capacity Air Source Heat Pumps and Fan Coil Units.

B. Section 23 07 16 - HVAC Equipment Insulation.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Errata (2025).

B. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023, with Errata (2024).

C. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2022.

D. ASME B31.9 - Building Services Piping; 2020.

E. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.

F. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2023.

G. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.

H. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Include data on pipe materials, fittings, valves, and accessories.

C. Shop Drawings: Indicate schematic layout of refrigerant piping, including equivalent, critical dimensions, and sizes. Indicate explicitly that actual lengths are within manufacturer's installation requirements.

D. Installer's qualification statement.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure integrity of system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Provide pipe hangers and supports in accordance with MSS SP-58 unless indicated otherwise.

C. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

2.02 REGULATORY REQUIREMENTS

A. Comply with ASME B31.5 for installation of piping system.

B. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

C. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

2.03 PIPING

A. Refer to Drawings for schedule of specific piping material applications to the project.

B. Copper Tube: ASTM B280, H58 hard drawn or O60 soft annealed.
   1. Type: ACR.
   2. Fittings:
      a. ASME B16.26 cast copper fittings for flared copper tubes.
      b. ASME B16.50 wrought copper suitable for brazing.
      c. Long radius elbows suitable for application.
      d. Annealed Bends: Mandrel bent.
   3. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.

C. Pipe Supports and Anchors:
   1. The material in contact with the pipe shall be compatible with the piping material so that neither shall have a deteriorating action on the other. Non-metallic wear pads shall be implemented where galvanic corrosion potential exists.
   2. Provide hangers and supports that comply with MSS SP-58.
      a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   4. Copper Pipe Support: Carbon steel ring, adjustable, copper plated, vibtation isolation insert.
   5. Vertical support: Cush clamp with vibration isolation insert.
   6. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
   7. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
      a. Bases: High density, UV tolerant, polypropylene or reinforced PVC.
      b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
      c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
      d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
      e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.

2.04 MOISTURE AND LIQUID INDICATORS

A. Indicators: Single port type, UL listed, with copper or brass body, flared or soldered ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.05 VALVES

A. Ball Valves:
   1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.

B. Service Valves:
   1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or soldered ends, for maximum pressure of 500 psi.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 APPLICATION

A. Refer to Drawings for schedule of specific piping material applications to the project.

3.03 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.

B. Provide all maufacturer recommended piping accessories.

C. Slope and arrange pipe as prescribed by the manufacterur's requirements.

D. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

E. Install piping to conserve building space and avoid interference with use of space.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Pipe Hangers and Supports:
   1. Install in accordance with MSS SP-58.
   2. Provide vibration isolation for all piping supports, including horizontal, vertical and concealed runs within the building.
   3. Support horizontal piping in accordance with MSS SP-58 or IMC Table 305.4.
   4. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   5. Place hangers within 12 inches of each horizontal elbow.
   6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   8. Provide copper plated hangers and supports for copper piping.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Flood piping system with nitrogen when brazing.

J. Insulate piping.

K. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Test refrigeration system in accordance with ASME B31.5.

C. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test and repair piping until no leakage.

END OF SECTION

SECTION 23 81 26.13
SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air-source heat pumps.

B. Indoor air handling (fan and coil) units for ductless systems.

C. Controls.

1.02 REFERENCE STANDARDS

A. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Errata (2025).

B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

C. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
   1. Explicity indicate performance at project specific conditions including both altitude effects and temperature conditions indicated on Drawings.
   2. Provide written confirmation that maximum lineset lineset lengths specified by manufacturer will not be exceeded as applied to project specific installation.

C. Design Data: Indicate refrigerant pipe sizing.

D. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

E. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

F. Project Record Documents: Record actual locations of components and connections.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum 10 years of documented experience.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of experience and approved by manufacturer.

1.05 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 AIR SOURCE HEAT PUMPS - ONE TO ONE UNITS

A. General: Horizontal discharge outdoor units. 3 to 5 ton nominal cooling and heating capacity model number 37MBRAQ.
   1. System description
      a. Outdoor air-cooled split system compressor sections suitable for on-the-ground, rooftop, wall hung or balcony mounting. Units consist of a rotary compressor, an air-cooled coil, pro-peller-type draw-through outdoor fan, reversing valve (hp), accumulator (hp units), metering device(s), and a control box. Units discharge air horizontally as shown on the contract drawings. Units function as the outdoor component of an air-to-air heat pump system.
      b. Units are to be used in a refrigeration circuit matched to duct-less heat pump fan coil units.
      c. Single-zone ductless outdoor units

2. Agency listings
    a. Unit construction complies with ansi/ashrae 15, latest revision, and with the nec.
    b. Units are evaluated in accordance with the ul standard 60335-2-40/ csa c22.2 no. 60335-2-40.
    c. Units are listed in cec directory.
    d. Unit cabinet is capable of withstanding the 500-hour salt spray test per federal test standard no. 141 (method 6061).
    e. Air-cooled condenser coils are leak tested at 550 psig.
3. Delivery, storage, and handling
    a. Units are shipped in one piece and are stored and handled per the manufacturer's recommendations.
4. Equipment
    a. General
        1) Factory assembled, single piece, air-cooled outdoor unit. Contained within the enclosure are the factory wiring, piping, controls, and the compressor.
    b. Unit Cabient
        1) The unit cabinet is constructed of galvanized steel, bonderized and coated with baked-enamel finish on the inside and outside.
        2) the unit access panels are removable and provide full access to the compressor, fan, and the control components.
        3) The outdoor compartment is isolated and has an acoustic lining to assure a quiet operation.
    c. Fans
        1) The outdoor fans are direct-drive propeller type, and discharge air horizontally. The fan draws air through the outdoor coil.
        2) Outdoor fan motors are totally-enclosed, single phase motors with class e insulation and permanently lubricated ball bearings. The motor is protected by internal thermal overload protection.
        3) The shaft has an inherent corrosion resistance.
        4) Fan blades are non-metallic and statically and dynamically balanced.
        5) Outdoor fan openings are equipped with a pvc metal/mesh coated protection grille over the fan.
    d.
        1) The compressor is the fully hermetic variable speed rotary type.
        2) The compressor is equipped with an oil system, operating oil charge, and motor.
        3) The motor is nema rated class e, suitable for operation in a refrigerant atmosphere.
        4) The compressor assembly is installed on rubber vibration isolators.
    e. Outdoor Coil
        1) The coil is constructed of aluminum hydrophilic pre-coated fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated and sealed.
    f. Refrigerant components
        1) Refrigerant circuit components include multiple brass external liquid line service valves with a service gauge connection port, multiple suction line service valves with a service gage connection port, accumulator, reversing valve, and electronic expansion valves.
    g. Safety
        1) Operating safety features are factory selected, assembled, and tested. The minimum functions include the following:
            (a) Compressor discharge over temperature protection.
            (b) System low voltage protection.
            (c) Compressor overload protection.
            (d) Compressor over current protection.
            (e) Ipm module protection.

h. Electrical requirements
    1) Units operate on single-phase, 60 hz power at 208/230v.
    2) The unit electrical power is a single point connection.
    3) All power and control wiring must be installed per nec and all local electrical codes.
    4) Units have multiple terminal blocks to connect to multiple indoor units.

5. Performance Requirements: See Drawings for additional requirements.

2.02 INDOOR DUCTLESS CONSOLE UNITS

A. General. Indoor Console, floor/ceiling mount, direct-expansion can coils matched with a heat pump outdoor unit. 1.5 to 5 ton nominal cooling and heating capacity.

1. Manufacturer:
    a. Carrier: 45MCFA.
2. Agency listings
    a. Unit is rated per ahri standards 210/240 and listed in the ahri directory as a matched system.
3. Delivery, storage, and handling
    a. Store and handle per the unit manufacturer's recommendations.
4. Equipment
    a. General
        1) Indoor, direct-expansion, floor-mounted fan coil. Unit is complete with a cooling/heating coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit is furnished with an integral mounting bracket and mounting hardware.
    b. Unit Cabinet:
        1) Cabinet discharge and inlet grilles are attractively styled, high-impact polystyrene. Cabinet is fully insulated for improved thermal and acoustic performance.
    c. Fans:
        1) Fan is the tangential direct-drive blower type with an air intake in the center of the unit and discharge at the top and bottom front. An automatic, motor-driven vertical air sweep is standard.
        2) Air sweep operation is user selectable. The vertical sweep may be adjusted (using the remote control) and the horizontal air direction may be set manually.
    d. Coil:
        1) Coil is a copper tube with aluminum fins and galvanized steel tube sheets. Fins are bonded to the tubes by mechanical expansion and specially golden hydrophilic pre-coated for enhanced wet-ability. A drip pan under the coil has a drain connection for hose attachment to remove condensate. The condensate pan has an internal trap.
    e. Motor
        1) The motor has an open drip-proof, permanently lubricated ball bearing with overload protection. The fan motor has 4-speeds.
    f. Controls:
        1) Controls consist of a microprocessor-based control system which controls the space temperature, determines the optimum fan speed, and runs self diagnostics. The temperature control ranges from 62°f to 86°f (17°c to 30°c) in increments of 1°f or 1°c, and have 46°f heating mode (heating setback). The wireless remote controller has the ability to act as the temperature sensing location for room comfort.
        2) The unit shall have the following functions as a minimum:
            (a) An automatic restart after power failure at the same operating conditions as at failure.

(b) A timer function to provide a minimum 24-hour timer cycle for system auto start/stop.
(c) Temperature-sensing controls to sense the return air temperature.
(d) Indoor coil freeze protection.
(e) Wireless infrared remote control to enter set points and operating conditions.
(f) Automatic air sweep control to provide on or off activation of air sweep louvers.
(g) Dehumidification mode to provide increased latent removal capability by modulating system operation and set point temperature.
(h) Fan-only operation to provide room air circulation when no cooling is required.
(i) Diagnostics to conduct continuous checks of unit operation and warn of possible malfunctions. Error messages appear on the unit.
(j) Fan speed control is user-selectable: high, medium, low, or microprocessor controlled automatic operation during all operating modes.
(k) Automatic heating-to-cooling changeover in heat pump mode. Control includes a deadband to prevent rapid mode cycling between heating and cooling.
(l) Indoor coil high temperature protection is provided to detect excessive indoor discharge temperature when the unit is in heat pump mode.

g. Filters:
1) Unit has a filter track with factory-supplied cleanable filters.

h. Electrical Requirements:
1) Indoor fan motor to operate on 208-230v as specified. Power is supplied from the outdoor unit.

i. Operating Characteristics:
1) The 45mcfa system has a minimum seer (seasonal energy efficiency ratio) and hspf at ahri conditions, as listed on the specifications table of the outdoor unit.

j. Refrigerant Lines:
1) All units should have refrigerant lines that can be oriented to connect from the left, right or back of unit. Both refrigerant lines need to be insulated.

k. Refrigerant leak detection
1) This system comes with a refrigerant leak detection and mitigation system.

5. Special Features (Accessories):
a. Condensate pump. The condensate pump shall remove condensate from the drain pan when gravity drainage cannot be used. Pump shall be designed for quiet operation. Pump shall consist of two parts: an internal reservoir/sensor assembly, and a remote sound-shielded pump assembly. A liquid level sensor in the reservoir shall stop cooling operation if the liquid level in the reservoir is unacceptable.

6. Performance Requirements: See Drawings for additional requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.

B. Verify that proper power supply is available and in correct location.

C. Verify that proper fuel supply is available for connection.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.

B. Utilize factory startup of equipment by manufacturer.

C. Provide vibration isolation springs on all units mounted to the building, structure, wall, or roof.

D. Install in accordance with NFPA 90A and NFPA 90B.

E. Install condensate drains and disposal in accordance with applicable codes, to a permanent indoor location.

F. Provide thermostat or room sensor as indicated on Drawings.

G. Install refrigeration systems in accordance with ASHRAE Std 15.

END OF SECTION

SECTION 26 01 26
TESTING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Field testing, cleaning, adjusting, and lubrication of electrical equipment and wiring systems.

1.02 REFERENCE STANDARDS

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.

B. IEEE C2 - National Electrical Safety Code(R) (NESC(R)); 2023.

C. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. NFPA 70E - Standard for Electrical Safety in the Workplace; 2024.

F. ANSI / IEEE C2 , National Electrical Safety Code.

G. ANSI C62.33, Standard Test Specifications for Varistor Surge-Protective Devices.

H. IEEE 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.

I. IEEE 118, Standard Test Code for Resistance Measurement.

J. IEEE 400, Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.

K. NEMA AB 4, Guideline for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.

L. NEMA WC 7, Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

1.03 SUBMITTALS

A. Quality Control Submittals: Within 30 days after completion of test and prior to substantial completion of project, submit test or inspection reports and certificates for each electrical item tested.

1.04 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Notify Owner’s Representative at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS

2.01 NOT USED

PART 3 EXECUTION

3.01 GENERAL

A. Tests and inspection shall establish that:
   1. Electrical equipment is operational within industry and manufacturer's tolerances.
   2. Installed system operates as .
   3. Installation conforms to requirements of contract documents and NFPA 70, NFPA 70E, and ANSI C2.

B. Perform inspection and testing in accordance with NETA ATS and manufacturer's recommendations.

C. Set, test, and calibrate protective relays, circuit breakers, and other applicable devices as required.

D. Verify nameplate data for conformance to contract documents.

E. Ensure equipment is mounted level, properly aligned, and properly anchored. Correct mounting if required.

F. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations or as otherwise specified.

G. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

H. Provide proper lubrication of applicable moving parts.

I. Inform Owner’s Representative of working clearances not in accordance with NFPA 70.

J. Investigate and repair or replace:
   1. Electrical items that fail tests.
   2. Active components not operating in accordance with manufacturer's instructions.
   3. Damaged electrical equipment.

3.02 ENCLOSURES

A. Remove foreign material and moisture from enclosure interior.

B. Vacuum and wipe clean enclosure interior.

C. Remove corrosion found on metal surfaces.

D. Repair or replace, as determined by Owner’s Representative, door and panel sections having dented surfaces.

E. Repair or replace, as determined by Owner’s Representative, poor fitting doors and panel sections.

F. Repair or replace improperly operating latching, locking, or interlocking devices.

G. Replace missing or damaged hardware.

H. Provide matching paint and touch up scratches and mars.
   1. If required due to extensive damage, as determined by Owner’s Representative, refinish the entire assembly.

3.03 LOW-VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Inspect each individual exposed power cable for:
   1. Physical damage.
   2. Proper connections in accordance with single-line diagram.
   3. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
   4. Color coding conformance with specifications.
   5. Proper circuit identification.

B. Inspect mechanical connections for:
   1. Proper lug type for conductor material.
   2. Proper lug installation.
   3. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.

C. Inspect shielded instrumentation cables for:
   1. Proper shield grounding.
   2. Proper terminations.
   3. Proper circuit identification.

D. Inspect control cables for:
   1. Proper termination.
   2. Proper circuit identification.

3. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

E. Perform the following tests for conductors No. 2 and Larger:
   1. Insulation Resistance Tests:
      a. Utilize 1,000-volt d-c megohmmeter for 600-volt insulated conductors.
      b. Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for one minute.
      c. Evaluate ohmic values by comparison with conductors of same length and type.
      d. Investigate values less than 50 megohms.
   2. Continuity test by ohmmeter method to ensure proper cable connections.

3.04 GROUNDING SYSTEMS

A. Visually inspect the following for proper connection and tightness:
   1. Equpment grounding terminations in distribution equipment and switches.
   2. Ground bus terminations in distribution equipment and switches.
   3. Accessible connections to grounding electrodes.
   4. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Sleeves for raceways and cables.
   2. Sleeve seals.
   3. Grout.
   4. Common electrical installation requirements.

1.02 SUBMITTALS

A. See Section 01 33 00 - Submittals Procedures.

B. Product Data: For sleeve seals.

PART 2 PRODUCTS

2.01 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.02 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Sealing Elements: [EPDM] [NBR] interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   2. Pressure Plates: [Plastic] [Carbon steel] [Stainless steel]. Include two for each sealing element.
   3. Connecting Bolts and Nuts: [Carbon steel with corrosion-resistant coating] [Stainless steel] of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.03 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 EXECUTION

3.01 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Scope of electrical work:
   1. Coordinate all line voltage wiring and conduit systems required by all divisions and ensure that they are captured in the electrical subcontractor’s scope of work. Every attempt will be made to reflect these requirements on the electrical sheets, but ensure that the electrical subcontractor receives a complete drawing set, and understands the complete project scope.

2. Provide complete and functional electrical and lighting systems. Include all required labor and materials, regardless of whether such materials are specifically called out on the drawings, unless the drawings explicitly designate certain items as being provided by others.
3. Provide temporary construction power as required by the general contractor.
4.

B. Performance of electrical work:
1. Comply with NECA 1.
2. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
3. 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.
4. Install equipment to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
5. Obtain and follow manufacturer's wiring diagrams for all equipment.
6. Give right-of-way to piping systems being installed at a required slope.
7. When installing or modifying service or metering equipment, coordinate with utility company to ensure that their current standards are met. If any discrepancy is found between utility standards and contract documents, submit RFI for direction.
8. Coordinate with other trades for cutting, patching, drilling, roof flashing, or other penetration requirements created by electrical work.

3.02 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors [2 inches (50 mm)] above finished floor level.

G. Size pipe sleeves to provide [1/4-inch (6.4-mm)] annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [steel] [cast-iron] pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.03 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.04 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Through-Penetration Firestop Systems."

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.

B. Metal-clad cable.

C. Variable-frequency drive cable.

D. Wiring connectors.

E. Electrical tape.

F. Oxide inhibiting compound.

G. Wire pulling lubricant.

H. Cable ties.

1.02 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

B. Section 26 05 05 - Selective Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.

C. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2024).

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2023.

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).

E. ASTM B800 - Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes - Annealed and Intermediate Tempers; 2005 (Reapproved 2021).

F. ASTM B801 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation; 2018 (Reapproved 2023).

G. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2024.

H. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

I. NECA 104 - Standard for Installing Aluminum Building Wire and Cable; 2012.

J. NECA 120 - Standard for Installing Armored Cable (AC) and Type Metal-Clad (MC) Cable; 2018.

K. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.

L. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

M. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

N. NFPA 79 - Electrical Standard for Industrial Machinery; 2021.

O. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

P. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

Q. UL 267 - Outline of Investigation for Wire-Pulling Compounds; Current Edition, Including All Revisions.

R. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

S. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

T. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

U. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

V. UL 2277 - Outline of Investigation for Flexible Motor Supply Cable and Wind Turbine Tray Cable; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
   3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 33 00 - Submittals Procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

C. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Engineer and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

1. Exceptions:
    a. Use variable-frequency drive cable for connection between variable-frequency motor controllers and associated motors.

C. Nonmetallic-sheathed cable is not permitted.

D. Underground feeder and branch-circuit cable is not permitted.

E. Service entrance cable is not permitted.

F. Armored cable is not permitted.

G. Metal-clad cable is permitted only as follows:
1. Where not otherwise restricted, may be used:
    a. Where exposed and run parallel to building lines for branch circuits up to 20 A.
    b. Where concealed in hollow stud walls, above accessible ceilings, and under raised floors for branch circuits up to 20 A.
2. In addition to other applicable restrictions, may not be used:
    a. Where not approved for use by the authority having jurisdiction.
    b. Where exposed to damage.
    c. For damp, wet, or corrosive locations, unless provided with a PVC jacket listed as suitable for those locations.
    d. For isolated ground circuits, unless provided with an additional isolated/insulated grounding conductor.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.

H. Conductor Material:
1. Provide copper conductors except where aluminum conductors are specifically indicated or permitted for substitution. Conductor sizes indicated are based on copper unless specifically indicated as aluminum. Conductors designated with the abbreviation "AL" indicate aluminum.
    a. Where aluminum conductors are substituted for copper, comply with the following:
        1) Submit RFI for approval before proceeding.
        2) Size aluminum conductors to provide, when compared to copper sizes indicated, equivalent or greater ampacity and equivalent or less voltage drop.
        3) Increase size of raceways, boxes, wiring gutters, enclosures, etc. as required to accommodate aluminum conductors. Contractor is responsible for verifying the feasibility of increased enclosure sizes necessitated by their substitutions..
        4) Provide aluminum equipment grounding conductor sized according to NFPA 70.
        5) Equip electrical distribution equipment with compression lugs for terminating aluminum conductors where required.
2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
3. Tinned Copper Conductors: Comply with ASTM B33.

4. Aluminum Conductors (only where specifically indicated or permitted for substitution): AA-8000 series aluminum alloy conductors recognized by ASTM B800 and compact stranded in accordance with ASTM B801 unless otherwise indicated.

I. Minimum Conductor Size:
   1. Branch Circuits: 12 AWG, copper only.

J. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

K. Conductor Color Coding:
   1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
   2. Color Coding Method: Integrally colored insulation.
      a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
   3. Color Code:
      a. 480Y/277 V, 3 Phase, 4 Wire System:
         1) Phase A: Brown.
         2) Phase B: Orange.
         3) Phase C: Yellow.
         4) Neutral/Grounded: Gray.
      b. 208Y/120 V, 3 Phase, 4 Wire System:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
         4) Neutral/Grounded: White.
      c. 240/120 V High-Leg Delta, 3 Phase, 4 Wire System:
         1) Phase A: Black.
         2) Phase B (High-Leg): Orange.
         3) Phase C: Blue.
         4) Neutral/Grounded: White.
      d. 240/120 V, 1 Phase, 3 Wire System:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Neutral/Grounded: White.
      e. Equipment Ground, All Systems: Green.
      f. Isolated Ground, All Systems: Green with yellow stripe.
      g. Travelers for 3-Way and 4-Way Switching: Pink.
      h. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
      i. For control circuits, comply with manufacturer's recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding:
   1. Feeders and Branch Circuits:
      a. Size 10 AWG and Smaller: Solid.
      b. Size 8 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation:
   1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
      a. Installed Underground: Type XHHW-2.

2.04 METAL-CLAD CABLE

A. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

B. Conductor Stranding:
   1. Size 10 AWG and Smaller: Solid.
   2. Size 8 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

E. Grounding: Full-size integral equipment grounding conductor.

F. Armor: Steel, interlocked tape.

G. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

2.05 VARIABLE-FREQUENCY DRIVE CABLE

A. Description: Flexible motor supply cable listed and labeled as complying with UL 2277 in accordance with NFPA 79; specifically designed for use with variable frequency drives and associated nonlinear power distortions.

B. Conductor Stranding: Stranded.

C. Insulation Voltage Rating: 1000 V.

D. Insulation: Use only thermoset insulation types; thermoplastic insulation types are not permitted.

E. Grounding: Full-size integral equipment grounding conductor or symmetrical arrangement of multiple conductors of equivalent size.

F. Provide metallic shielding.

G. Jacket: PVC or Chlorinated Polyethylene (CPE).

2.06 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.

C. Wiring Connectors for Splices and Taps:
   1. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
   2. Connectors for Aluminum Conductors: Use compression connectors.

D. Wiring Connectors for Terminations:
   1. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
   2. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
   3. Aluminum Conductors: Use compression connectors for all connections.

E. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

F. Mechanical Connectors: Provide bolted type or set-screw type.

G. Compression Connectors: Provide circumferential type or hex type crimp configuration.

2.07 ACCESSORIES

A. Electrical Tape:

1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.

B. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.

C. Wire Pulling Lubricant:
1. Listed and labeled as complying with UL 267.
2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
3. Suitable for use at installation temperature.

D. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

A. Circuiting Requirements:
1. Unless dimensioned, circuit routing indicated is diagrammatic.
2. When circuit destination is indicated without specific routing, determine exact routing required.
3. Arrange circuiting to minimize splices.
4. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
5. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:
   a. Increase size of conductors as required to account for ampacity derating.
   b. Size raceways, boxes, etc. to accommodate conductors.
6. Dedicated Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

B. Install products in accordance with manufacturer's instructions.

C. Perform work in accordance with NECA 1 (general workmanship).

D. Install aluminum conductors in accordance with NECA 104.

E. Install metal-clad cable (Type MC) in accordance with NECA 120.

F. Installation in Raceway:
1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.

2. Pull all conductors and cables together into raceway at same time.
3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

I. Terminate cables using suitable fittings.
1. Metal-Clad Cable (Type MC):
a. Use listed fittings.
b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

J. Variable-Frequency Drive Cable: Terminate shielding at both variable-frequency motor controller and associated motor using glands or termination kits recommended by manufacturer.

K. Install conductors with a minimum of 12 inches of slack at each outlet.

L. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

M. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

N. Make wiring connections using specified wiring connectors.
1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.
4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
5. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.
6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

O. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.

P. Insulate ends of spare conductors using vinyl insulating electrical tape.

Q. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

R. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

S. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is only required for services and feeders. The resistance test for parallel conductors listed as optional is not required.

   1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

C. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground rod electrodes.

1.02 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.

B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify exact locations of underground metal water service pipe entrances to building.
   2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
   3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

B. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

B. Do not use products for applications other than as permitted by NFPA 70 and product listing.

C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

E. Grounding Electrode System:
   1. Provide connection to required and supplemental grounding electrodes indicated from grounding electrode system.
      a. Provide continuous grounding electrode conductors without splice or joint.
      b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.

F. Service-Supplied System Grounding:
   1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
   2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

G. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
   1. Provide grounding electrode system for each separate building or structure.
   2. Provide equipment grounding conductor routed with supply conductors.
   3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
   4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

H. Separately Derived System Grounding:
   1. Separately derived systems include, but are not limited to:
      a. Transformers (except autotransformers such as buck-boost transformers).
      b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
      c. Generators, when neutral is switched in the transfer switch.
   2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest appropriate grounding electrode. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
   3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
   4. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
   5. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
   6. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

I. Bonding and Equipment Grounding:
   1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.

2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.

J. Communications Systems Grounding and Bonding:
1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
1. Use insulated copper conductors unless otherwise indicated.
a. Exceptions:
1) Use bare copper conductors where installed underground in direct contact with earth.
2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:
1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as indicated.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Make grounding and bonding connections using specified connectors.
1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.

4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

D. Identify grounding and bonding system components in accordance with Section 26 05 53.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

D. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.

F. MFMA-4 - Metal Framing Standards Publication; 2004.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
   2. Coordinate work to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
   4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
   5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 03 30 00.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.
   1. Fiberglass Channel/Strut Framing Systems: Include requirements for strength derating according to ambient temperature.

1.06 QUALITY ASSURANCE

A. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Comply with the following. Where requirements differ, comply with most stringent.
      a. NFPA 70.
      b. Requirements of authorities having jurisdiction.
   2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.
   3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
   4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported with minimum safety factor of 25%. Include consideration for vibration, equipment operation, and shock loads where applicable.
   5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   6. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
      a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
   1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
   2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Metal Channel/Strut Framing Systems:
   1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
   2. Comply with MFMA-4.

D. Fiberglass Channel/Strut Framing Systems:
   1. Description: Factory-fabricated, continuous-slot, fiberglass channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
   2. Flammability: Fire retardant with NFPA 101, Class A flame spread index, maximum of 25, when tested in accordance with ASTM E84; self extinguishing in accordance with ASTM D635.

E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.

F. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
   1. Description: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring attachment to roof structure and not penetrating roofing assembly, with support fixtures as specified.
   2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
   3. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
   4. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

G. Anchors and Fasteners:

1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Wood: Use wood screws.
8. Plastic and lead anchors are not permitted.
9. Powder-actuated fasteners are not permitted.
10. Hammer-driven anchors and fasteners are not permitted.
11. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
    a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
    b. Comply with MFMA-4.
    c. Channel Material: Use galvanized steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install hangers and supports in accordance with NECA 1.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.

E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

F. Equipment Support and Attachment:
    1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
    2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
    3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
    4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

G. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

H. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 26 05 33.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2020.

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.

C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit; 2018.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.

F. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2025.

G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

H. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit; 2018.

I. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.

J. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.

K. NEMA TC 14 (SERIES) - Reinforced Thermosetting Resin Conduit and Fittings Series; 2015.

L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

M. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

N. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

O. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.

P. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

Q. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

R. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

S. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

T. UL 797A - Electrical Metallic Tubing - Aluminum and Stainless Steel; Current Edition, Including All Revisions.

U. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
   3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
   4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
   5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2-inch (53 mm) trade size and larger.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:
   1. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, galvanized steel electrical metallic tubing (EMT), stainless steel electrical metallic tubing (EMT), rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
   2. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), galvanized steel electrical metallic tubing (EMT), stainless steel electrical metallic tubing (EMT), rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
   3. Where rigid polyvinyl chloride (PVC) conduit is provided, transition to schedule 80 rigid PVC conduit where emerging from underground.
   4. Where rigid polyvinyl (PVC) conduit larger than 2-inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit (RMC) elbows, stainless steel rigid metal conduit (RMC) elbows, galvanized steel intermediate metal conduit (IMC) elbows, stainless steel intermediate metal conduit (IMC) elbows, PVC-coated galvanized steel rigid metal conduit (RMC) elbows, or concrete-encased PVC elbows for bends.

D. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

E. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

F. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

G. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless

steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

H. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

I. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).
   1. Locations subject to physical damage include, but are not limited to:
      a. Where exposed below 8 feet, except within electrical and communication rooms or closets.

J. Exposed, Exterior, Not Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

K. Exposed, Exterior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or stainless steel intermediate metal conduit (IMC).
   1. Exterior locations subject to severe physical damage include, but are not limited to:
      a. Where exposed to vehicular traffic below 12 feet.

L. Corrosive Locations Above Ground: Use stainless steel rigid metal conduit (RMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), stainless steel electrical metallic tubing (EMT), or reinforced thermosetting resin conduit (RTRC).

M. Fished in Existing Walls, Where Necessary: Use flexible metal conduit (FMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

2.02 CONDUIT - GENERAL REQUIREMENTS

A. Comply with NFPA 70.

B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.

C. Provide conduit, fittings, supports, and accessories required for complete raceway system.

D. Provide products listed, classified, and labeled as suitable for purpose intended.

E. All conduit sizes shown on drawings are minimums, unless otherwise indicated.

F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:
   1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.04 STAINLESS STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC stainless steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6A.

B. Fittings:
   1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
   2. Material: Use stainless steel with corrosion resistance equivalent to conduit.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.05 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:
   1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.06 STAINLESS STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:
   1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.

2.07 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil, 0.040 inch.

C. PVC-Coated Boxes and Fittings:
   1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
   2. Nonhazardous Locations: Use boxes and fittings listed and labeled as complying with UL 514A, UL 514B, or UL 6.
   3. Material: Use steel or malleable iron.
   4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil, 0.040 inch.

D. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil, 0.015 inch.

2.08 FLEXIBLE METAL CONDUIT (FMC)

A. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.

2.09 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use compression/gland or set-screw type.
   a. Do not use indenter type connectors and couplings.

2.10 STAINLESS STEEL ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT stainless steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797A.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Connectors and Couplings: Use compression/gland or set-screw type.

2.11 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

B. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.12 REINFORCED THERMOSETTING RESIN CONDUIT (RTRC)

A. Description: NFPA 70, Type RTRC reinforced thermosetting resin conduit complying with NEMA TC 14 (SERIES).

B. Supports: As recommended by manufacturer.

C. Fittings: Same type and manufacturer as conduit to be connected.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install conduit in accordance with NECA 1.

C. Galvanized Steel Rigid Metal Conduit (RMC): Install in accordance with NECA 101.

D. Intermediate Metal Conduit (IMC): Install in accordance with NECA 101.

E. PVC-Coated Galvanized Steel Rigid Metal Conduit (RMC): Install using only tools approved by manufacturer.

F. Rigid Polyvinyl Chloride (PVC) Conduit: Install in accordance with NECA 111.

G. Conduit Routing:
   1. Unless dimensioned, conduit routing indicated is diagrammatic.
   2. When conduit destination is indicated without specific routing, determine exact routing required.
   3. Unless otherwise approved, do not route exposed conduits:
      a. Across floors.
      b. Across roofs.

c. Across top of parapet walls.

4. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
5. Arrange conduit to maintain adequate headroom, clearances, and access.
6. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
7. Route conduits above water and drain piping where possible.
8. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
9. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
   a. Heaters.
   b. Flues.
10. Group parallel conduits in same area on common rack.

H. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 26 05 29.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with most stringent requirements.

I. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
5. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
6. Secure joints and connections to provide mechanical strength and electrical continuity.

J. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
6. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
7. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07 84 00.

K. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide minimum concrete cover of 3 inches on all sides unless otherwise indicated.

L. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
   1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
   2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
   3. Where calculated in accordance with NFPA 70 for reinforced thermosetting resin conduit (RTRC) conduit installed above ground to compensate for thermal expansion and contraction.
   4. Where conduits are subject to earth movement by settlement or frost.

M. Conduit Sealing:
   1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
      a. Where conduits enter building from outside.
      b. Where service conduits enter building from underground distribution system.
      c. Where conduits enter building from underground.
      d. Where conduits may transport moisture to contact live parts.
   2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
      a. Where conduits pass from outdoors into conditioned interior spaces.
      b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.

D. Correct deficiencies and replace damaged or defective conduits.

3.04 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 26 05 43
UNDERGROUND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Direct-buried conduit, ducts, and duct accessories.
   2. Concrete-encased conduit, ducts, and duct accessories.
   3. Handholes and boxes.

1.02 REFERENCE STANDARDS

A. ANSI/SCTE 77 - Specification for Underground Enclosure Integrity; 2017.

B. IEEE C2 - National Electrical Safety Code(R) (NESC(R)); 2023.

C. NEMA TCB 2 - Guidelines for the Selection and Installation of Underground Nonmetallic Raceways; 2017.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. NFPA 70E - Standard for Electrical Safety in the Workplace; 2024.

1.03 SUBMITTALS

A. Product Data: For ducts and conduits, duct-bank materials, manholes, handholes, and boxes, and their accessories.

B. Shop Drawings: For factory-fabricated handholes and boxes other than precast concrete
   1. Include dimensioned plans, sections, elevations, accessory locations, and fabrication and installation details.
   2. Include duct entry provisions, including locations and duct sizes.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Comply with IEEE C2 .

B. Conduit Accessories:
   1. Provide matching fittings from same manufacturer as the associated conduit.
   2. Duct separators shall be factory fabricated rigid PVC interlocking spacers.
   3. Warning tape: comply with Section 26 05 53 .

2.02 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. General requirements: Comply with ANSI/SCTE 77 . Comply with tier requirements in "Underground Enclosure Application" Article.

B. Units shall be designed for flush burial and have open bottom unless otherwise indicated.

C. Covers:
   1. Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   2. Nonskid finish shall have a minimum coefficient of friction of 0.50.
   3. Molded lettering reading "ELECTRIC."

D. Fiberglass handholes and boxes shall be molded of fiberglass-reinforced polyester resin, with covers made of polymer concrete.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Install ducts according to NEMA TCB 2.

B. Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes, to drain in both directions.

C. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.

D. Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

E. Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall, without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition.

F. Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

G. Install 100-lbf test nylon cord in empty conduits.

H. Warning tape: comply with Section 26 05 53.

3.02 DIRECT BUIRED DUCT BANKS

A. Earthwork:
   1. Excavate trench bottom to provide firm and uniform support for duct bank.
   2. Place minimum 3 inches of pipe bedding material as a bed for duct bank. Place pipe bedding material to a minimum of 6 inches above top level of duct bank.
   3. After installing first tier of ducts, 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.
   4. After placing last tier, hand place backfill to 4 inches over ducts 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.

B. Duct Spacers:
   1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
   2. Space separators close enough to prevent sagging and deforming of ducts, with not less than four spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.

C. Spacing:
   1. Install top of duct bank at least 36 inches below finished grade unless otherwise indicated.
   2. Provide a minimum of 2 inches between conduits for like services and 6 inches between power and signal conduits.

D. Risers:
   1. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
   2. Couple steel conduits to ducts with adapters designed for this purpose.
   3. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.03 CONCRETE ENCASED DUCT BANKS

A. Concrete:

1. Excavate trench bottom to provide firm and uniform support for duct bank.
2. Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
3. 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.
4. Install a minimum of 3 inches of concrete cover at top and bottom, and a minimum of 2 inches on each side of duct bank.
5. Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

B. Duct Spacers:
1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than four spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. 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.

C. Spacing:
1. Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
2. Unless otherwise indicated, provide a minimum of 2 inches between conduits for like services and 4 inches between power and signal conduits.

D. Risers:
1. Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
2. Couple steel conduits to ducts with adapters designed for this purpose.
3. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

3.04 HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. 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.

E. Field cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.05 FIELD QUALITY CONTROL

A. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

B. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct.

C. Test grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 05 26 - Grounding and Bonding for Electrical Systems.

3.06 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Underground warning tape.

E. Warning signs and labels.

1.02 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

B. Section 26 05 73 - Power System Studies: Arc flash hazard warning labels.

1.03 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:
   1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
   2. Do not install identification products until final surface finishes and painting are complete.

1.05 SUBMITTALS

A. See Section 01 33 00 - Submittals Procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is outside the r recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Existing Work: Unless specifically excluded, identify existing elements to remain whose designations are changed as part of the new work.

B. Identification for Equipment:
   1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
      a. Switchboards:
         1) Identify ampere rating.
         2) Identify voltage and phase.

3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Use identification nameplate to identify main overcurrent protective device.
5) Use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.

b. Motor Control Centers:
1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Use identification nameplate to identify main overcurrent protective device.
5) Use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.

c. Panelboards:
1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces.
6) Schedules for existing panelboards shall contain all new circuiting as installed, and all existing circuit information available. For example, if a circuit was not modified in this project, the new printed schedule should contain the same text as the existing schedule. If no information is available, write “unknown” in the schedule. Printing schedules from the construction drawing is not acceptable; re-attaching old schedules is not acceptable.
7) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. _____ .

d. Transformers:
1) Identify kVA rating.
2) Identify voltage and phase for primary and secondary.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Identify load(s) served. Include location when not within sight of equipment.

e. Transfer Switches:
1) Identify voltage and phase.
2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
3) Identify load(s) served. Include location when not within sight of equipment.
4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.

2. Service Equipment:
a. Use identification nameplate to identify each service disconnecting means.

3. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.

4. Use identification nameplate to identify switchboards and panelboards utilizing a high leg delta system in accordance with NFPA 70.

5. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.

6. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.
7. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.
   a. Service equipment.
   b. Industrial control panels.
   c. Motor control centers.
   d. Elevator control panels.
   e. Industrial machinery.
8. Arc Flash Hazard Warning Labels: Comply with Section 26 05 73.

C. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
   a. Within boxes when more than one circuit is present.
4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
5. Use underground warning tape to identify direct buried cables.

D. Identification for Raceways:
1. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
2. Use underground warning tape to identify underground raceways.
3. Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of ductbank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

E. Identification for Boxes:
1. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
1. Materials:
   a. Indoor Clean, Dry Locations: Use plastic nameplates.
   b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates.
   c. In locations exposed to sunlight, moisture, or corrosive gases, use only labeling products rated for that environment and guaranteed not to fade, degrade, or detach.
2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
   a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:
   1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
   2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:
   1. Minimum Size: 1 inch by 2.5 inches.
   2. Legend:
      a. Equipment designation or other approved description.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height:
      a. Equipment Designation: 1/2 inch.
      b. Other Information: 1/4 inch.
      c. Exception: Provide minimum text height of 1 inch for equipment located more than 8 feet above floor or working platform.

2.03 WIRE AND CABLE MARKERS

A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

C. Legend: Power source and circuit number or other designation indicated.

D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

E. Minimum Text Height: 1/8 inch.

F. Color: Black text on white background unless otherwise indicated.

2.04 UNDERGROUND WARNING TAPE

A. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
   1. Exception: Use foil-backed detectable type tape where required by serving utility or where directed by Owner.

B. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.

C. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

D. Legend: Type of service, continuously repeated over full length of tape.

E. Color:
   1. Tape for Buried Power Lines: Black text on red background.
   2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.05 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:
   1. Materials:
      a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
      b. Outdoor Locations: Use factory pre-printed rigid aluminum or rigid plastic signs.
   2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.

C. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
   a. Do not use labels designed to be completed using handwritten text.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   1. Surface-Mounted Equipment: Enclosure front.
   2. Flush-Mounted Equipment: Inside of equipment door.
   3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   4. Elevated Equipment: Legible from the floor or working platform.
   5. Branch Devices: Adjacent to device.
   6. Interior Components: Legible from the point of access.
   7. Conduits: Legible from the floor.
   8. Boxes: Outside face of cover.
   9. Conductors and Cables: Legible from the point of access.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
   1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 26 05 73
POWER SYSTEM STUDIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Short-circuit study.

B. Protective device coordination study.

C. Arc flash and shock risk assessment.
   1. Includes arc flash hazard warning labels.

D. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.02 RELATED REQUIREMENTS

A. Section 26 05 53 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.

B. Section 26 24 19 - Motor-Control Centers.

1.03 REFERENCE STANDARDS

A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2023.

B. IEEE 141 - IEEE Recommended Practice for Electric Power Distribution for Industrial Plants; 1993 (Reaffirmed 1999).

C. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems; 2001, with Errata (2003).

D. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis; 1997.

E. IEEE 551 - IEEE Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems; 2006.

F. IEEE 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations; 2018, with Errata (2019).

G. NEMA MG 00001 - Motors and Generators; 2024.

H. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. NFPA 70E - Standard for Electrical Safety in the Workplace; 2024.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Existing Installations: Coordinate with equipment manufacturer(s) to obtain data necessary for completion of studies.
   2. Coordinate the work to adjust protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
   3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Scheduling:
   1. Arrange access to existing facility for data collection with Owner.
   2. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Study reports, stamped or sealed and signed by study preparer.

C. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.
   1. Include characteristic time-current trip curves for protective devices.
   2. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
   3. Include documentation of listed series ratings upon request.
   4. Identify modifications made in accordance with studies that:
      a. Can be made at no additional cost to Owner.
      b. As submitted will involve a change to the contract sum.

D. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.

E. Project Record Documents: Revise studies as required to reflect as-built conditions.
   1. Include required protective device settings.
   2. Include hard copies with operation and maintenance data submittals.
   3. Certification that field adjustable protective devices have been set in accordance with requirements of studies.

1.06 POWER SYSTEM STUDIES

A. Scope of Studies:
   1. Perform analysis of new electrical distribution system.
   2. Include in selective coordination study all overcurent protective devices required to be coordinated by NEC Article 701 (Legally Required Standby Systems).
   3. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).
   4. Provide arc flash hazard labels at all switchboards, panelboards, stand-alone controllers, and each section of each motor control center.
   5. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
      a. Known Operating Modes:
         1) Utility as source.
         2) Generator as source.
         3) Maintenance settings.

B. General Study Requirements:
   1. Comply with NFPA 70.
   2. Perform studies utilizing industry standard computer software complying with specified requirements; manual calculations are not permitted.

C. Data Collection:
   1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
      a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
         1) Obtain up-to-date information from Utility Company.
      b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.
      c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 00001 code letter designation.
      d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.

e. Protective Devices:
   1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
   2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.

D. Short-Circuit Study:
1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.
2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
   a. Maximum utility fault currents.
   b. Maximum motor contribution.
   c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.

E. Protective Device Coordination Study:
1. Comply with applicable portions of IEEE 242 and IEEE 399.
2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source).
3. Analyze protective devices and associated settings for suitable margins between time-current curves to provide adequate protection for equipment and conductors while achieving full selective coordination.

F. Arc Flash and Shock Risk Assessment:
1. Comply with NFPA 70E.
2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
3. For equipment with main devices mounted in separate compartmentalized sections, perform calculations on both the line and load side of the main device.
4. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
   a. Maximum and minimum utility fault currents.
   b. Maximum and minimum motor contribution.
   c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

G. Study Reports:
1. General Requirements:
   a. Identify date of study and study preparer.
   b. Identify study methodology and software product(s) used.
   c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
   d. Identify base used for per unit values.
   e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
   f. Include conclusions and recommendations.
2. Short-Circuit Study:
   a. For each scenario, identify at each bus location:

1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
2) Fault point X/R ratio.
3) Associated equipment short circuit current ratings.

b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.

3. Protective Device Coordination Study:
   a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
   b. For each graph include (where applicable):
      1) Partial single-line diagram identifying the portion of the system illustrated.
      2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
      3) Conductors: Damage curves.
      4) Transformers: Inrush points and damage curves.
      5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.
      6) Motors: Full load current, starting curves, and damage curves.
      7) Capacitors: Full load current and damage curves.
   c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.
      1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
      2) Include ground fault pickup and delay.
      3) Include fuse ratings.
      4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
   d. Identify cases where either full selective coordination or adequate protection is not achieved, along with specific recommendations.
   e. Identify where cables may not be protected against high short circuits, and make specific recommendations for correction of problems. General statements such as “Using larger cables or changing the breaker size or type, in most instances, will resolve this problem” are not acceptable.
4. Arc Flash and Shock Risk Assessment:
   a. For the worst case for each scenario, identify at each bus location:
      1) Calculated incident energy and associated working distance.
      2) Calculated arc flash boundary.
      3) Bolted fault current.
      4) Arcing fault current.
      5) Clearing time.
      6) Arc gap distance.
   b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.
   c. Include recommendations for reducing the incident energy at locations where the calculated maximum incident energy exceeds 8 calories per sq cm.

1.07 QUALITY ASSURANCE

A. Study Preparer Qualifications: Professional electrical engineer licensed in Colorado and with minimum five years experience in preparation of studies of similar type and complexity using specified computer software.
   1. Study preparer may be employed by manufacturer of electrical distribution equipment.
   2. Study preparer may be employed by field testing agency.

B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.
   1. Products:
      a. EasyPower LLC: www.easypower.com/#sle.
      b. ETAP/Operation Technology, Inc: www.etap.com/#sle.
      c. Power Analytics Corporation: www.poweranalytics.com/#sle.
      d. SKM Systems Analysis, Inc: www.skm.com/#sle.
   2. At owner's request, provide the following at no additional cost:
      a. Contact information for the individual who performed the study.
      b. Responses to owner questions and suggestions.
      c. Re-evaluation of any part of the coordination and arc flash analysis to improve coordination or to reduce arc flash risk category or to eliminate cable protection inadequacy.

PART 2 PRODUCTS

2.01 ARC FLASH HAZARD WARNING LABELS

A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
   1. Materials: Comply with Section 26 05 53.
   2. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
      a. Include the following information:
         1) Arc flash boundary.
         2) Available incident energy and corresponding working distance.
         3) Site-specific PPE (personnel protective equipment) requirements.
         4) Nominal system voltage.
         5) Equipment identification.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install arc flash warning labels in accordance with Section 26 05 53.

3.02 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Adjust equipment and protective devices for compliance with studies and recommended settings.

C. Notify Engineer of any conflicts with or deviations from studies. Obtain direction before proceeding.

3.03 CLOSEOUT ACTIVITIES

A. Training: Include as part of the base bid training for Owner's personnel on electrical safety pertaining to arc flash and shock hazards.
   1. Use site-specific hazard labels and assessment report as training reference, supplemented with additional training materials if required.
   2. Provide minimum of two hours of training.

END OF SECTION

SECTION 26 24 19
MOTOR-CONTROL CENTERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Low-voltage (600 V and less) standard (non-arc-resistant) NEMA motor control centers.

B. Overcurrent protective devices for motor control centers and associated units, including overload relays.

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 05 73 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

F. Section 26 22 00 - Low-Voltage Transformers: For integration into equipment specified in this section, where indicated.

G. Section 26 24 16 - Panelboards: For integration into equipment specified in this section, where indicated.

H. Section 26 29 23 - Variable-Frequency Motor Controllers.

1.03 REFERENCE STANDARDS

A. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NECA 402 - Standard for Installing and Maintaining Motor Control Centers; 2020.

D. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

E. NEMA ICS 2.3 - Industrial Control and Systems: Instructions for the Handling, Installation, Operation, and Maintenance of MCCs Rated Not More Than 600 Volts; 2019.

F. NEMA ICS 6 - Industrial Control and Systems: Enclosures; 1993 (Reaffirmed 2016).

G. NEMA ICS 18 - Motor Control Centers; 2001 (Reaffirmed 2007).

H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 845 - Motor Control Centers; Current Edition, Including All Revisions.

J. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.
3. Coordinate the work to provide motor controllers and associated wiring suitable for interface with control devices to be installed.
4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
6. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
7. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 33 00 - Submittals Procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor control centers, enclosures, units, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, unit arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of motor control centers and adjacent equipment with all required clearances indicated.
2. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
3. Include documentation of listed series ratings upon request.
4. Include documentation demonstrating selective coordination upon request.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store motor control centers in accordance with manufacturer's instructions, NECA 402, and NEMA ICS 2.3.

B. Store in a clean, dry space having a uniform temperature to prevent condensation. Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully to avoid damage to internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Source Limitations: Furnish motor control centers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 MOTOR CONTROL CENTERS

A. Provide motor control centers consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Dead-front standard (non-arc-resistant) type motor control center assemblies complying with NEMA ICS 18, and listed and labeled as complying with UL 845; ratings, configurations and features as indicated on the drawings.

D. Configuration:
   1. Arrangement: Front-mounted units only (no rear-mounted units or back-to-back configuration).
   2. NEMA Classification and Wiring Type: NEMA ICS 18, Class I, Type B (B-T for units size 3 or smaller).

E. Service Conditions:
   1. Provide motor control centers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
      a. Altitude: 5100 feet.
      b. Ambient Temperature: Between 32 degrees F and 104 degrees F.

F. Short Circuit Current Rating:
   1. Provide motor control centers and associated units with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

G. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

H. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.

I. Bussing:
   1. Horizontal Main Bus: Size for a maximum temperature rise of 117 degrees F over an ambient temperature of 104 degrees F, in compliance with NEMA ICS 18 and UL 845 requirements.
   2. Vertical Bus: Minimum size of as indicated on drawings, in compliance with NEMA ICS 18 requirements.
   3. Provide solidly bonded equipment ground bus through full length of motor control center, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
   4. Phase and Neutral Bus Material: Copper.
   5. Ground Bus Material: Copper.

J. Conductor Terminations: Suitable for use with the conductors to be installed.
   1. Line Conductor Terminations:
      a. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
      b. Main and Neutral Lug Type: Mechanical.

K. Enclosures:
   1. Comply with NEMA ICS 6.
   2. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1 or Type 2 (drip-proof).
   3. Finish: Manufacturer's standard unless otherwise indicated.

L. Future Provisions:
   1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

M. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

1. Where overcurrent protective devices equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
    a. Use zero sequence or residual ground fault detection method unless otherwise indicated.
    b. Provide test panel and field-adjustable ground fault pick-up and delay settings.

N. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.

O. Instrument Transformers:
1. Comply with IEEE C57.13.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers: Connect secondaries to shorting terminal blocks.
4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.03 MOTOR CONTROL CENTER UNITS

A. Feeder Units: Circuit breaker type.

B. Variable-Frequency AC Drive Units: Comply with Section 26 29 23.

C. Distribution Equipment Units: Where incorporation of low-voltage distribution equipment within motor control center units is indicated, provide suitable components complying with applicable specified requirements.
1. Low-Voltage Transformers: See Section 26 22 00.
2. Panelboards: See Section 26 24 16.

2.04 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:
1. Interrupting Capacity (not applicable to motor circuit protectors):
    a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
    b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
    c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the motor control centers and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive motor control centers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install motor control centers in accordance with NECA 1 (general workmanship), NECA 402, and NEMA ICS 2.3.

C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.

D. Provide required support and attachment in accordance with Section 26 05 29.

E. Install motor control centers plumb and level.

F. Unless otherwise indicated, mount motor control centers on properly sized 4 inch high concrete pad constructed in accordance with Section 03 30 00.

G. Provide grounding and bonding in accordance with Section 26 05 26.

H. Install all field-installed devices, components, and accessories.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Set field-adjustable motor controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.

K. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 05 73.

L. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

M. Provide filler plates to cover unused spaces.

N. Identify motor control centers in accordance with Section 26 05 53.

3.03 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of motor control center covers and doors.

3.04 CLEANING

A. Clean dirt and debris from motor control center enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred surfaces to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of motor controllers to Owner, and correct deficiencies or make adjustments as directed.

B. Training: Train Owner's personnel on operation, adjustment, and maintenance of motor control center and associated devices.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

3.06 PROTECTION

A. Protect installed motor control centers from subsequent construction operations.

END OF SECTION

SECTION 26 29 23
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.

1.02 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Variable-frequency drive cable.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 05 73 - Power System Studies: Additional criteria for selection and adjustment of equipment and associated protective devices specified in this section.

F. Section 26 24 19 - Motor-Control Centers.

1.03 REFERENCE STANDARDS

A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

D. NEMA ICS 6 - Industrial Control and Systems: Enclosures; 1993 (Reaffirmed 2016).

E. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives; 2020.

F. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems; 2022.

G. NEMA ICS 7.2 - Application Guide for AC Adjustable Speed Drive Systems; 2021.

H. NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems; 2005.

I. NEMA MG 00001 - Motors and Generators; 2024.

J. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.

M. UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy (Ed. 2); Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate work to avoid placement of ductwork, piping, equipment, and other obstructions within dedicated equipment spaces and working clearances required by NFPA 70.
   2. Coordinate work to provide motor controllers suitable for use with motors.
   3. Coordinate work to provide controllers and associated wiring suitable for interface with control devices.

4. Coordinate arrangement of electrical equipment with dimensions and clearance requirements.
5. Verify with manufacturer that conductor terminations are suitable for use with conductors.
6. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 33 00 - Submittals Procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Derating Calculations: Indicate ratings adjusted for applicable service conditions.

D. Manufacturer qualification statement.

E. Installer qualification statement.

F. Field quality control test reports.

G. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum twenty years documented experience.

C. Installer Qualifications: Company with minimum five years documented experience with variable-frequency motor control systems of similar size, type, and complexity; manufacturer's authorized installer.

D. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

1.09 WARRANTY

A. Provide minimum 2 year extended manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Source Limitations: Furnish variable-frequency motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.

B. Provide products listed, classified, and labeled as suitable for purpose intended.

C. Controller Assemblies: Comply with NEMA ICS 7, NEMA ICS 7.1, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.

D. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA ICS 7.2, NEMA MG 00001 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
   1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 00001 design letter or inverter duty rating for induction motors.
   2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
   3. Motor nameplate data.
   4. Requirements for speed control range, speed regulation, and braking.
   5. Motor suitability for bypass starting method, where applicable.

E. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.

F. Operating Requirements:
   1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
   2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
   3. Efficiency: Minimum of 96 percent at full speed and load.
   4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
   5. Overload Rating:
      a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
      b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.

G. Power Conversion System: Microprocessor-based, pulse width modulation type consisting of rectifier/converter, DC bus/link, and inverter.
   1. Rectifier/Converter: Diode-based, 6-pulse type unless otherwise indicated.

H. Control System:
   1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
   2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
   3. Control Functions:
      a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
         1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.
         2) Vector Control: Provide selectable autotuning function.
      b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
      c. Selectable braking control; DC injection or flux braking.
      d. Adjustable minimum/maximum speed limits.
      e. Adjustable pulse width modulation switching carrier frequency.
      f. Adjustable motor slip compensation.
      g. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.
   4. Status Indications:
      a. Motor run/stop status.
      b. Motor forward/reverse status.
      c. Local/remote control status.

d. Output voltage.
e. Output current.
f. Output frequency.
g. DC bus voltage.
h. Motor speed.

5. Protective Functions/Alarm Indications:
   a. Overcurrent.
   b. Motor overload.
   c. Undervoltage.
   d. Overvoltage.
   e. Controller overtemperature.
   f. Input/output phase loss.
   g. Output short circuit protection.
   h. Output ground fault protection.
6. Inputs:
   a. Digital Input(s): Three.
   b. Analog Input(s): Two.
7. Outputs:
   a. Analog Output(s): One.
   b. Relay Output(s): Two.
8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.
   a. Serial Communications: RS-485; support for Modbus RTU protocol.
   b. Ethernet Communications: Support for Modbus TCP protocol.
   c. Remote Monitoring Capabilities:
      1) Motor run/stop status.
      2) Hand-off-auto status.
      3) Fault information.
9. Features:
   a. Password-protected security access.
   b. Event log.

I. Power Conditioning/Filtering:
   1. Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.
   2. Reactor Impedance: 3 percent, unless otherwise indicated or required.

J. Controllers for Installation Within Motor Control Centers (MCCs): Suitable for installation in equipment to be provided in accordance with Section 26 24 19.

K. Service Conditions:
   1. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.

L. Short Circuit Current Rating:
   1. Provide controllers with listed short circuit current rating not less than available fault current at installed location as determined by short circuit study performed in accordance with Section 26 05 73.
   2. Provide line/input reactors where specified by manufacturer for required short circuit current rating.

M. Selectivity: Where requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

N. Conductor Terminations: Suitable for use with conductors to be installed.

O. Enclosures:
   1. Comply with NEMA 4.

2. NEMA EN 10250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
3. Finish: Manufacturer's standard unless otherwise indicated.
4. Cooling: Forced air or natural convection as determined by manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings of controllers are consistent with indicated requirements.

C. Verify that mounting surfaces are ready to accept controllers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install controllers in accordance with NECA 1 (general workmanship).

C. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.

D. Do not exceed manufacturer's recommended maximum cable length between controller and motor.

E. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

F. Provide required support and attachment in accordance with Section 26 05 29.

G. Install controllers plumb and level.

H. Provide grounding and bonding in accordance with Section 26 05 26.

I. Install field-installed devices, components, and accessories.

J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

K. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

L. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 05 73.

M. Identify controllers in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

A. Provide services of manufacturer's authorized representative to observe installation and assist in programming and startup. Include manufacturer's reports with submittals.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.17. Insulation-resistance test on control wiring listed as optional is not required.

D. Test for proper interface with other systems.

E. Correct deficiencies and replace damaged or defective controllers or associated components.

F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.

B. Training: Train Owner's personnel on operation, adjustment, and maintenance of controllers and associated devices.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Instructor: Manufacturer's authorized representative.

3.07 PROTECTION

A. Protect installed controllers from subsequent construction operations.

3.08 MAINTENANCE

A. Provide trouble call-back service upon notification by Owner:
   1. Include allowance for call-back service during normal working hours at no extra cost to Owner.
   2. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION

SECTION 26 32 13
ENGINE GENERATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Packaged engine generator system and associated components and accessories.

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 36 00 - Transfer Switches.

1.03 REFERENCE STANDARDS

A. ASTM D975 - Standard Specification for Diesel Fuel; 2024a.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NECA/EGSA 404 - Standard for Installing Generator Sets; 2014.

D. NEMA MG 00001 - Motors and Generators; 2024.

E. NFPA 30 - Flammable and Combustible Liquids Code; 2024, with Errata (2025).

F. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2024, with Amendment.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. NFPA 110 - Standard for Emergency and Standby Power Systems; 2025.

I. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.

J. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.

K. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.
   1. Include characteristic trip curves for overcurrent protective devices.
   2. Include alternator thermal damage curve upon request.

B. Shop Drawings: Include dimensioned plan views and sections indicating
   1. Locations of system components, required clearances, pad layout, and field connection locations.
   2. Overall dimensions of complete assembly including generator, fuel tank, and air intake and exhaust accessories.
   3. System interconnection schematic diagrams showing all factory and field connections.

C. Accessory Power Requirements:
   1. Clearly indicate the quantity of circuits required from building for all generator accessories.
   2. For each required circuit, state the voltage, full load amperage, and connection location.

D. Derating Calculations: Indicate ratings adjusted for site elevation as indicated below.

E. Load Acceptance Calculations: Demonstrate acceptance of loads in the steps shown below in 2.01 (G), and show transient performance within the limits indicated.

F. Specimen Warranty: Submit sample of manufacturer's warranty.

G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

H. Manufacturer's factory emissions certification.

I. Manufacturer's certification that products meet or exceed specified requirements.

J. Source quality control test reports.

K. EPA emissions certification.

L. Manufacturer’s detailed field testing procedures.

M. Field quality control test reports.

N. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

1.05 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 110 (Standard for Emergency and Standby Power Systems)
   3. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
   4. NFPA 30 (Flammable and Combustible Liquids Code).
   5. UL 2200 (Stationary Engine Generator Assemblies)

B. Source Limitations:
   1. Furnish engine generator sets, components, and accessories produced by a single manufacturer and obtained from a single supplier.
   2. In the event that a specific accessory is not available from the generator set manufacturer, provide documentation that the proposed accessory product is approved by the generator manufacturer for use with the specific generator being furnished.

C. Manufacturer Qualifications:
   1. Company engaged in manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for minimum of 10 years.
   2. Technical support services available 24 hours per day, 7 days per week, 365 days per year from manufacturer or their representative.
   3. Maintain records of each product, by serial number, for minimum of 20 years.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with engine generator systems of similar size, type, and complexity; manufacturer's authorized installer.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

F. Exhaust Emissions Requirements:
   1. Comply with federal (EPA), state, and local regulations applicable at the time of startup.
   2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer. Where such modifications are made, provide field emissions testing as necessary for certification.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.08 WARRANTY

A. Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

B. Provide information about any extended warranties available beyond the minimum required.

PART 2 PRODUCTS

2.01 PACKAGED ENGINE GENERATOR SYSTEM

A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. System Description:
   1. Application: Standby, Legally Required (NEC 701).
   2. Configuration: Single packaged engine generator set operated independently .

D. Packaged Engine Generator Set:
   1. Type: Diesel (compression ignition).
   2. Voltage: 480Y/277 V, 3 phase, 60 Hz.
   3. Main Line Circuit Breaker:
      a. Type: Electronic trip with long time and short time delay and instantaneous pickup.
      b. Trip Rating: Select according to generator set rating.

E. Generator Set General Requirements:
   1. Prototype tested in accordance with NFPA 110 for Level 2 systems.
   2. Factory-assembled, with components mounted on suitable base.
   3. List and label engine generator assembly as complying with UL 2200.
   4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
   5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.
   6. Main Line Circuit Breakers: Provide factory-installed line side connections with suitable lugs for load side connections.

F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the intended installation location:
   1. Environment: Exterior, Not Covered
   2. Location: Palisade, CO
   3. Altitude: 5100 feet.
   4. Ambient Temperature: Between 0 and 104 degrees F.

G. Starting and Load Acceptance Requirements:
   1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.

2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 60 seconds.
4. Load Table: Supports the following loads in the following steps. For calculation purposes, assume VFDs are 6 pulse unless stated otherwise in the table below.

Step One:	***Quantity***	***Load***	***Starter***
	2	Heat Pump, 5 ton	ACL
	1	Lighting and Elec. Heat 4 kVA	N/A
Step Two:	***Quantity***	***Load***	***Starter***
	1	Pump #3 50 HP, 480V/3PH	VFD
Step Three:	***Quantity***	***Load***	***Starter***
	1	Pump #2 40 HP, 480V/3PH	VFD
Step Four:	***Quantity***	***Load***	***Starter***
	1	Pump #1 25 HP, 480V/3PH	VFD
Step Five:	***Quantity***	***Load***	***Starter***
	1	Actuator 2 HP, 480V/3PH	ACL

   a. Maximum Voltage Deviation with Load Step: 20 percent.
   b. Maximum Frequency Deviation with Load Step: 10 percent.
   c. Maximum THDV : 10 percent.

2.02 ENGINE AND ENGINE ACCESSORY EQUIPMENT

A. Cold Weather Starting Acessories:
   1. Provide electric heating acessories sufficient for manufacturer to warrant engine starting at the extreme low ambient temperature indicated above, after the equipment and fuel tank have been at that temperature for multiple days. These may include but are not limited to:
      a. Battery heater
      b. Coolant heater
      c. Oil pan heater
      d. Fuel filter heater
      e. Enclosure heater
      f. Fuel tank heater
   2. Provide a winterized enclosure if necessary for starting at the extreme low temperature noted above, with the heating accessories being provided.

B. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.

C. Engine Fuel System - Diesel (Compression Ignition):
   1. Fuel Source: Diesel, ASTM D975 No. 2-D or approved cold weather diesel blends.
   2. Fuel Storage: Sub-base fuel tank.
   3. Engine Fuel Supply: Provide engine-driven, positive displacement fuel pump with replaceable fuel filter(s), water separator, check valve to secure prime, manual fuel priming pump, and relief-bypass valve. Provide fuel cooler where recommended by manufacturer.
   4. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
   5. Sub-Base Fuel Tank:

a. Provide sub-base mounted, double-wall fuel tank with secondary containment; listed and labeled as complying with UL 142.
b. Tank Capacity: Size for minimum of 24 hours of continuous engine generator operation at maximum load indicated above, but not larger than permissible by applicable codes.
c. Features:
1) Direct reading fuel level gauge.
2) Normal atmospheric vent.
3) Emergency pressure relief vent.
4) Fuel fill opening with lockable cap.
5) Dedicated electrical conduit stub-up area.
d. Provide the following enhanced spill protection features:
1) Spill protection box at fuel inlet
2) Spill sensor between inner and outer tank wall, communicating with SCADA.

D. Engine Starting System:
1. System Type: Electric, with DC solenoid-activated starting motor(s).
2. Battery(s):
a. Battery Type: Lead-acid.
b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
4. Battery Charger:
a. Provide dual rate battery charger with automatic float and equalize charging modes; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 12 hours while carrying normal loads.
c. Recognized as complying with UL 1236.
d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
f. Provide alarm output contacts as necessary for alarm indications.

E. Engine Speed Control System (Governor):
1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

F. Engine Lubrication System:
1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.

G. Engine Cooling System:
1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.

H. Engine Air Intake and Exhaust System:

1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.

2.03 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 00001; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

B. Exciter:
   1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
   2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
   3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.

C. Temperature Rise: Comply with UL 2200.

D. Insulation System: NEMA MG 00001, Class H; suitable for alternator temperature rise.

E. Enclosure: NEMA MG 00001, drip-proof.

2.04 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.

B. Control Panel:
   1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
   2. Generator Set Control Functions:
      a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
      b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
      c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
      d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
      e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
      f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
      g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
   3. Generator Set Status Indications:
      a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
      b. Current (Amps): For each phase.
      c. Frequency (Hz).
      d. Real power (W/kW).
      e. Reactive power (VAR/kVAR).
      f. Apparent power (VA/kVA).
      g. Power factor.
      h. Duty Level: Actual load as percentage of rated power.
      i. Engine speed (RPM).
      j. Battery voltage (Volts DC).
      k. Engine oil pressure.
      l. Engine coolant temperature.
      m. Engine run time.
      n. Generator powering load (position signal from transfer switch).
   4. Generator Set Protection and Warning/Shutdown Indications:

a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
   1) Overcrank (shutdown).
   2) Low coolant temperature (warning).
   3) High coolant temperature (warning).
   4) High coolant temperature (shutdown).
   5) Low oil pressure (shutdown).
   6) Overspeed (shutdown).
   7) Low fuel level (warning).
   8) Low coolant level (warning/shutdown).
   9) Generator control not in automatic mode (warning).
   10) High battery voltage (warning).
   11) Low cranking voltage (warning).
   12) Low battery voltage (warning).
   13) Battery charger failure (warning).
b. In addition to NFPA 110 requirements, provide the following protections/indications:
   1) High AC voltage (shutdown).
   2) Low AC voltage (shutdown).
   3) High frequency (shutdown).
   4) Low frequency (shutdown).
   5) Overcurrent (shutdown).
c. Provide contacts for local and remote common alarm.
d. Provide lamp test function that illuminates all indicator lamps.

5. Other Control Panel Features:
   a. Event log.

2.05 GENERATOR SET ENCLOSURE

A. Enclosure Type: Sound attenuating, weather protective.

B. Enclosure Material: Steel or aluminum.

C. Hardware Material: Stainless steel.

D. Color: Manufacturer's standard.

E. Access Doors: Lockable, with all locks keyed alike.

F. Openings: Designed to prevent bird/rodent entry.

G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.

H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.

2.06 SOURCE QUALITY CONTROL

A. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

B. Generator Set production testing to include, at a minimum:
   1. Operation at rated load and rated power factor.
   2. Load pick-up.
   3. Transient and steady state voltage and frequency performance.
   4. Operation of safety shutdowns.

C. Diesel Fuel Storage Tanks: Perform pressurized leak test prior to shipment.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.

C. Verify that rough-ins for field connections are in the proper locations.

D. Verify that mounting surfaces are ready to receive equipment.

E. Verify that conditions are satisfactory for installation.

3.02 INSTALLATION

A. Provide crane service for offloading generator.

B. Provide first fuel tank fill (winter blend diesel).

C. Perform work in accordance with NECA 1 (general workmanship).

D. Install products in accordance with manufacturer's instructions.

E. Install generator sets and associated accessories in accordance with NECA/EGSA 404.

F. Arrange equipment to provide minimum clearances and required maintenance access.

G. Unless otherwise indicated, mount generator set on properly sized, minimum 6 inch high concrete pad constructed in accordance with Section 03 30 00.

H. Provide required support and attachment in accordance with Section 26 05 29.

I. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.

J. Provide grounding and bonding in accordance with Section 26 05 26.

K. Identify system wiring and components in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

A. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

B. Notify Owner and Engineer at least two weeks prior to scheduled inspections and tests.

C. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

D. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.

E. Preliminary inspection and testing to include, at a minimum:
   1. Inspect each system component for damage and defects.
   2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
   3. Check for proper oil and coolant levels.

F. Prepare and start system in accordance with manufacturer's instructions.

G. Perform acceptance test in accordance with NFPA 110.

H. Inspection and testing to include, at a minimum:
   1. Verify compliance with starting and load acceptance requirements.
   2. Verify voltage and frequency; make required adjustments as necessary.
   3. Verify phase sequence.
   4. Verify control system operation, including safety shutdowns.
   5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).

I. Provide field emissions testing where necessary for certification.

J. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

B. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

C. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters and fill fuel storage tank.

3.06 PROTECTION

A. Protect installed engine generator system from subsequent construction operations.

3.07 MAINTENANCE

A. Provide trouble call-back service upon notification by Owner:
   1. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site; include hourly rate, milage cost, and definition of normal working hours in maintenance contract.

END OF SECTION

SECTION 26 36 00
AUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Low-voltage automatic transfer switches.

1.02 RELATED REQUIREMENTS

A. Section 26 32 13 - Engine Generators.

1.03 ABBREVIATIONS AND ACRONYMS

A. ATS: Automatic transfer switch.

B. MTS: Manual (Non-automatic) transfer switch.

1.04 REFERENCE STANDARDS

A. IEC 60947-6-1 - Low-Voltage Switchgear and Controlgear – Part 6-1: Multiple Function Equipment – Transfer Switching Equipment; 2021.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NEMA ICS 10 Part 1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment; 2020.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. UL 891 - Switchboards; Current Edition, Including All Revisions.

F. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

G. UL 1558 - Switchgear; Current Edition, Including All Revisions.

1.05 SUBMITTALS

A. Provide sufficient information to determine compliance with contract documents. Identify submittal data with specific equipment tags and/or service descriptions to which they pertain. Identify specific model numbers, options, and features of equipment proposed.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.
   1. Include characteristic trip curves for each overcurrent protective device.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing factory and field connections.

D. Operation and Maintenance Data: Provide detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

E. Warranty Information: Include full text of manufacturer's standard warranty terms, warranty length, any extended warranties available as options, and added cost for extended warranties.

F. Executed warranty.

G. Project Record Documents:
   1. Construction, installation, schematic, and wiring diagrams updated to as-installed and commissioned state.
   2. Configured settings/parameters for adjustable components updated to as-installed and commissioned state, noted if different from factory default.

1.06 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70.
2. Requirements of local authorities having jurisdiction.
3. Applicable local codes.

B. Manufacturer Qualifications:
1. Company engaged in manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for minimum of 10 years.
2. Service, repair, and technical support services available 24 hours per day, 7 days per week, 365 days per year from manufacturer or their representative.
3. Maintain records of each product, by serial number, for minimum of 20 years.

C. Warranty: Include a 5 year warranty in the base bid price.

D. Installer Qualifications: Firm with minimum 10 years experience with transfer switches of similar type and scope.

E. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Prior to delivery to project site, verify suitable storage space is available to store materials in well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres.

B. Protect materials during delivery and storage and maintain within manufacturer's written storage requirements. At minimum, store indoors in clean, dry space with uniform temperature to prevent condensation and protect electronics from potential damage from electrical and magnetic energy.

C. Deliver materials to project site in manufacturer's original wrappings and containers, labeled with manufacturer's name and equipment tag number. Include shipping costs.

D. If the associated generator is supplied by a different manufacturer, coordinate communication details with generator manufacturer and installer to ensure proper operation.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide manufacturer warranty for defects in material and workmanship for five years from date of shipment. Provide replacements for parts determined to be defective at no charge during warranty period.
1. Except for circuit breakers in service entrance transfer switches and soft load transition switches, provide replacements for parts determined to be defective at no charge for 5 years from date of shipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Source Limitations: Provide automatic transfer switches, controllers, and accessories produced by single manufacturer and obtained from single supplier.

2.02 LOW-VOLTAGE AUTOMATIC TRANSFER SWITCHES

A. Provide a service entrance rated power transfer switch with automatically initiated transfer between utility and generator sources, suitable for use with legally required standby systems per NEC Article 701.
1. Neutral Configuration: solid neutral.
2. Phase Poles: Three.
3. Minimum Ampere Rating: 225 A.

4. Voltage: 480V.

B. Comply with NEMA ICS 10 Part 1 and IEC 60947-6-1; list and label as complying with UL 1008 and, where applicable, UL 891 or UL 1558.

C. Transition Type:
   1. Automatic Transition Configuration, Utility Service Entrance Breaker: delayed transition.

D. Service Entrance Rated Transfer Switches:
   1. Overcurrent Protective Device:
      a. For utility connection, provide stationary-mounted circuit breaker with current ratings and number of poles as indicated.
   2. Configuration:
      a. Switches Rated 400 A or Less: Provide single enclosure including utility source service disconnect circuit breaker and generator source feeder disconnect circuit, power transfer switch, and grounding/bonding provisions.
      b. Or, provide multi-section switchboard with the following sections:
         1) Service equipment section containing utility source service disconnect circuit breaker and grounding/bonding provisions.
         2) Non-service section containing power transfer switch and controls.
   3. Grounding/Bonding Provisions:
      a. Provide means to disconnect utility source neutral connection from generator and load neutral connections for maintenance.
      b. Provide ground bus for connection of grounding conductor to grounding electrode.
      c. Provide pressure disconnect link for neutral-to-ground bonding jumper to connect normal neutral connection to ground bus.

E. Transfer Switch Construction:
   1. Electrically operated, mechanically held.
   2. Positively locked, unaffected by momentary outages, such that contact pressure is maintained at constant value and contact temperature rise is minimized for maximum reliability and operating life.
   3. Designed to allow inspection of contacts without disassembly of operating linkages and disconnection of power conductors.
   4. Stationary and Moveable Contacts: Removable and replaceable without removing power conductors and/or bus bars.
   5. Devices utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

F. Transition Modes:
   1. Delayed Transition:
      a. Transfer load between power sources using break-before-make switch with user-defined interruption period in both directions.
      b. Delay: Adjustable from 0 to 6 minutes with 1-second resolution.
      c. Provide both electrical and mechanical interlocks to prevent both sets of main contacts from being closed at same time.

G. Withstand and Closing Ratings:
   1. Rate to close on and withstand 30,000 A RMS symmetrical short circuit current at terminals with overcurrent protection indicated.
   2. Label with UL 1008 time-based ratings, or appropriate short-time rating(s) as applicable. Transfer switches which have only series or specific-breaker ratings are not acceptable.
   3. Include 0.3-second, 18-cycle, short-time rating as standard for switch sizes 600 through 4,000 A for selective coordination purposes.

H. Pilot Devices:
   1. Provide industrial-grade switches and pilot lights to facilitate viewing and replacement.
   2. Provide three-position momentary switch for test/automatic/reset modes.

a. Test Position: Simulates utility source failure.
b. Reset Position: Bypass time delays on either transfer to generator or retransfer to utility.

3. Provide industrial-grade LED indicating lights visible without opening inner enclosure doors, to indicate the following:
   a. Switch connected to utility.
   b. Switch connected to generator source.
   c. True source availability of generator source as determined by voltage sensing trip/reset settings.
   d. True source availability of utility source as determined by voltage sensing trip/reset settings.

I. Controller:
1. Construction:
   a. Provide single, built-in microprocessor for controller's sensing and logic.
   b. Provide capability for serial communication.
2. Voltage Sensing: True RMS, accurate to within plus/minus 2 percent of nominal voltage.
3. Frequency Sensing: Accurate to within plus/minus 0.2 percent.
4. Provide the following integral features, capable of being activated through keypad programming:
   a. Engine Exerciser:
      1) Enables user to program at least three different exercise routines.
      2) Programmable Routine Parameters:
         (a) Enable/disable routine.
         (b) Enable/disable transfer of load during routine.
         (c) Start Time: By time of day, day of week, and week of month (first, second, third, fourth, alternate, or every week).
         (d) Duration of run.
      3) At end of specified duration, transfer load back to utility source and run generator for specified cool down period.
   b. System Status: Provide system status screen for controller LCD display.
   c. Self-Diagnostics: Provide diagnostics screen for detecting system errors. Provide information on status input signals to controller, which may prevent load transfer commands from being completed.

J. Data Logging: Log data, storing at least 50 events in nonvolatile memory, retained in event of total power loss; include the following:
1. Event Logging:
   a. Data, time and reason for transfer from utility to generator.
   b. Data, time and reason for transfer from generator to utility.
   c. Data, time and reason for engine start.
   d. Data and time engine stopped.
   e. Data and time generator source available.
   f. Data and time generator source not available.
   g. Data and time for utility source voltage surges, sags, and swells

K. Communications:
1. Provide digital status interface through manufacturer supplied communication module using one of the following communication protocols:
   a. Modbus/TCP
   b. Modbus/RTU
   c. Profibus
   d. Profinet
2. Provide digital status indication of the following:
   a. Availability of utility source

b. Availability of generator source
c. Switch position
d. Switch and generator alarm information
e. Power metering information (voltage and current per phase, real, reactive and apparent power and energy usage, power factor, total harmonic distortion)

3. Provide relay contacts to indicate the following:
   a. Utility source available
   b. Generator source available
   c. Connected to utility source
   d. Connected to generator source
   e. Signal before transfer (for selective load disconnection prior to transfer)
   f. Alarm condition

L. Voltage, Frequency, and Phase Rotation Sensing:
1. Voltage and Frequency Sensing: Continuously monitored on utility and generator sources with the following minimum pickup and dropout/trip capabilities:
   a. Undervoltage
   b. Overvoltage
   c. Under Frequency
   d. Over Frequency
   e. Voltage Unbalance
2. Voltage and Frequency Settings: Field adjustable via display/keypad or remotely via serial communications port access.
3. When activated by keypad or through serial port, capable of sensing phase rotation of both utility and generator sources and rejecting source if phase rotation does not match rotation reference selected in settings.
4. Source Status Screens: For utility and generator sources, display digital readout of voltage on each phase, frequency, and phase rotation.
5. Include selectable algorithm to:
   a. Prevent repeated transfer cycling to source which experiences primary-side, single-phase failures on grounded-wye-to-grounded-wye transformer then regenerates voltage when unloaded.
   b. Inhibit retransfer to utility source upon detection of single-phasing condition until dedicated timer expires, alternate source fails, or utility source fails and is restored during time delay period; time delays adjustable via display/keypad.

M. Time Delays:
1. Provide adjustable time delay for override of momentary utility source outages and delay of transfer and engine starting signals.
2. Provide adjustable time delay on transfer to generator for controlled timing of load transfer to generator source.
3. Provide adjustable time delay on shut down of engine generator for cool down.

N. Provide auxiliary contacts consisting of one contact which is closed when transfer switch is connected to utility source and one contact which is closed when transfer switch is connected to generator source.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine equipment exterior and interior for damage, including but not limited to, structure, moisture, and mildew.

B. Examine for conditions detrimental to completion of work.

C. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install equipment in accordance with manufacturer’s written instructions.

B. Install transfer switches in accordance with NECA 1.

C. Unless otherwise indicated, install and anchor floor-mounted transfer switches on raised concrete pad 4 inches high; see Section 03 30 00.

3.03 FIELD QUALITY CONTROL

A. Manufacturer Services: Provide services of manufacturer's field representative to perform functional testing, commissioning, and first parameter adjusting.
   1. Replace damaged or malfunctioning equipment and report discrepancies or installation issues.
   2. Identify transfer switches with label indicating inspection/testing agency and date of service.

B. Operational Readiness Testing:
   1. Inspect and test equipment and associated systems for conformance to Contract Documents, including equipment manufacturer’s recommendations, and readiness for operation.
      a. Visually inspect for physical damage and proper installation.
      b. Perform tests in accordance with manufacturer's instructions.
      c. Perform tests to verify compliance with Contract Documents.
      d. Perform tests to verify equipment is ready for operation.
      e. Touch-up paint chips and scratches with manufacturer-supplied paint.

C. Correct deficiencies and replace damaged or defective transfer switches or associated components.

3.04 CLOSEOUT ACTIVITIES

A. Functional Demonstration Testing: Demonstrate proper operation of transfer switches and associated systems to Owner's designated representative and Engineer, observing and documenting compliance with Contract Documents.

B. Training:
   1. Train Owner's personnel on operation and maintenance of system.
      a. Accommodate minimum of four attendees.
      b. Training Reference: Use submitted operations and maintenance manuals.
      c. Location: Project site.
   2. Provide sufficient time and detail in each session to cover the following at minimum:
      a. Operation theory.
      b. Major equipment components.
      c. Equipment operation.
      d. Equipment configurations.
      e. Maintenance, troubleshooting, and repair.
      f. Component-level parts replacement.

3.05 PROTECTION

A. Protect installed transfer switches from subsequent construction operations.

END OF SECTION

SECTION 27 05 00
COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Sleeves for pathways and cables.
   2. Sleeve seals.
   3. Grout.
   4. Common communications installation requirements.

1.02 SUBMITTALS

A. Product Data: For sleeve seals.

PART 2 PRODUCTS

2.01 SLEEVES FOR PATHWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.02 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
   1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] or comparable product by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
      e. <insert manufacturer's name>
   3. Sealing Elements: [EPDM] [NBR] interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of pathway or cable.
   4. Pressure Plates: [Plastic] [Carbon steel] [Stainless steel]. Include two for each sealing element.
   5. Connecting Bolts and Nuts: [Carbon steel with corrosion-resistant coating] [Stainless steel] of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.03 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 EXECUTION

3.01 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: 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.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.02 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors [2 inches (50 mm)] above finished floor level.

G. Size pipe sleeves to provide [1/4-inch (6.4-mm)] annular clear space between sleeve and pathway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

3.03 PROMPTLY PACK GROUT SOLIDLY BETWEEN SLEEVE AND WALL SO NO VOIDS REMAIN. TOOL EXPOSED SURFACES SMOOTH; PROTECT GROUT WHILE CURING.

A. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants."

B. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

C. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [steel] [cast-iron] pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

E. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.04 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve

seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.05 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Through-Penetration Firestop Systems."

END OF SECTION

SECTION 28 05 00
COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Sleeves for raceways and cables.
   2. Sleeve seals.
   3. Grout.
   4. Common electronic safety and security installation requirements.

1.02 SUBMITTALS

A. Product Data: For sleeve seals.

PART 2 PRODUCTS

2.01 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.02 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] or comparable product by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
      e. <insert manfacturer's name>
   3. Sealing Elements: [EPDM] [NBR] interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   4. Pressure Plates: [Plastic] [Carbon steel] [Stainless steel]. Include two for each sealing element.
   5. Connecting Bolts and Nuts: [Carbon steel with corrosion-resistant coating] [Stainless steel] of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.03 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 1 EXECUTION

3.01 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: 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.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.02 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Electronic safety and security penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors [2 inches (50 mm)] above finished floor level.

G. Size pipe sleeves to provide [1/4-inch (6.4-mm)] annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [steel] [cast-iron] pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.03 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.04 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Through-Penetration Firestop Systems."

END OF SECTION

SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Clearing and grubbing.

B. Repair and restoration.

C. Debris removal.

1.02 REFERENCE STANDARDS

A. 29 CFR 1910.266 - Logging Operations; Current Edition.

B. ANSI Z133 - American National Standard for Arboricultural Operations - Safety Requirements; 2017.

1.03 FIELD CONDITIONS

A. Ambient Conditions: Terminate work during hazardous environmental conditions according to 29 CFR 1910.266.

B. Temporary Erosion and Sediment Control: Comply with other requirements specified in Section 01 57 13 - Temporary Erosion and Sediment Control.

PART 2 PRODUCTS

2.01 MATERIALS

A. Sedimentation barriers, vehicle tracking pads and other temporary erosion and sediment control products: See Section 01 57 13 - Temporary Erosion and Sediment Control.

PART 3 EXECUTION

3.01 PREPARATION

A. Coordinate work with utility companies; notify before starting work and comply with local requirements; obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. Protect existing structures and other elements that are to remain.

E. Install sedimentation barriers, vehicle tracking pads and other temporary erosion and sediment control features according to Section 01 57 13 - Temporary Erosion and Sediment Control before starting clearing operations.

3.02 CLEARING AND GRUBBING

A. Clearing: Cut trees, stumps, shrubs, downed timber, and other vegetation for removal within project area according to 29 CFR 1910.266. Follow recommendations of ANSI Z133 and best local practices for species involved.

B. Do not remove or damage vegetation beyond the limits of construction.

C. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum subsoil disturbance.

D. Scalping. Scalp areas where excavation or embankment is to be made. Remove brush, roots, sod, grass, residue or agricultural crops, sawdust, and other vegetable matter from the surface of the ground.

E. Grubbing: Remove stumps, roots, buried timber, and other vegetation minimum depth 12 inches (30 cm) from ground. Remove rocks minimum depth 6 inches (15 cm) from ground.

3.03 REMOVED VEGETATION PROCESSING

A. Do not burn, bury, landfill, or leave on-site, except as indicated on drawings.

B. Existing Stumps: Treat as specified for other vegetation removed; remove stumps and roots to depth of 24 inches.

C. Shrubs: Remove vegetation and root system.

D. Hedges. Pull or grub hedges, ensuring complete and permanent removal. Remove scattered hedge or shrubs not classified as hedge in the same manner as specified for hedge.

E. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; give preference to on-site uses.

F. Dead Wood: Remove all dead trees (standing or down), limbs, and dry brush on entire site; treat as specified for vegetation removed.

3.04 REPAIR AND RESTORATION

A. Remaining Existing Facilities, Utilities, and Site Features: If damaged due to this work, repair or replace to original condition.

B. Fill holes left by removal of stumps and roots, using suitable fill material selected, placed and compacted per requirements of Section 31 23 23 - Fill, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.

3.05 DEBRIS REMOVAL

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and windblown debris from public and private lands.

END OF SECTION

SECTION 31 22 00
GRADING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Rough grading.

B. Fine grading.

PART 2 EXECUTION

2.01 EXAMINATION

A. Verify survey bench mark and intended elevations for grading areas are as indicated.

B. Verify the absence of standing or ponding water.

2.02 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Stake and flag locations of known utilities.

C. Provide temporary means and methods to remove standing or ponding water from areas prior to grading.

D. Protect site features to remain, including but not limited to bench marks, survey control points, and fences.

2.03 ROUGH GRADING

A. Excavate and fill subgrade material to elevations indicated on plans.

B. Replace displaced subgrade in accordance with Section 31 23 23.

C. Remove and replace unsuitable materials as specified fill.

2.04 FINE GRADING

A. Scrape and spread subgrade material uniformly smooth and without disruptions as indicated on drawings.

2.05 CLEANING

A. Leave site clean and raked, ready to receive work.

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Excavating for building volume below grade, footings, slabs-on-grade, paving, site structures, and utilities within the building.

B. Trenching for utilities outside the building to utility main connections.

C. Temporary excavation support and protection systems.

1.02 RELATED REQUIREMENTS

A. Document 01171-0018: Geotechnical report; bore hole locations and findings of subsurface materials.

B. 01 57 13 - Temporary Erosion and Sediment Control

C. Section 01 70 00 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring. General requirements for dewatering of excavations and water control.

D. Section 31 10 00 - Site Clearing: Vegetation and existing debris removal.

E. Section 31 22 00 - Grading: Grading.

F. Section 31 23 33 - Trenching and Backfilling: Excavating for utility trenches outside the building to utility main connections.

G. Section 31 23 16.26 - Rock Removal: Removal of rock during excavating.

H. Section 31 23 23 - Fill: Fill materials, backfilling, and compacting.

I. Section 31 37 00 - Riprap.

1.03 REFERENCE STANDARDS

A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.

B. CDOT Std Spec - Colorado Department of Transportation Standard Specifications for Road and Bridge Construction; 2023.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Temporary Support and Excavation Protection Plan.

C. Project Record Documents: Record drawings at project closeout according to 01 70 00 - Execution and Closeout Requirements. Show locations of installed support materials left in place, including referenced locations and depths, on drawings.

D. Shoring Installer's Qualification Statement.

E. Field Quality Control Submittals: Document visual inspection of load-bearing excavated surfaces.

1.05 QUALITY ASSURANCE

A. Temporary Support and Excavation Protection Plan:
   1. Indicate sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property.
   2. Include drawings and calculations for bracing and shoring.
   3. Bracing and shoring design to meet requirements of OSHA’s Excavation Standard, 29 CFR 1926, Subpart P.

B. Designer Qualifications: For design of temporary shoring and bracing, employ a Professional Engineer experienced in design of this type of work and licensed in Colorado.

1.06 REGULATORY COMPLIANCE

A. Complete all work within the rights-of-way of the Federal Government, the Colorado Department of Transportation (see CDOT Std Spec), County Governments or Municipal Governments in compliance with requirements issued by those agencies. All such requirements shall take precedence over these Specifications. Secure and pay for all required permits and the work necessary to meet agency permit requirements and standards.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fill and Bedding to Correct Over-Excavation:
   1. See Section 31 23 23 for corrective fill materials at general excavations.
   2. See Section 31 23 33 for corrective bedding materials at utility trenches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench mark and intended elevations for the work are as indicated.

B. Survey existing adjacent structures and improvements and establish exact elevations at fixed points to act as benchmarks.
   1. Resurvey benchmarks during installation of excavation support and protection systems and notify Owner if any changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

C. Determine the prevailing groundwater level prior to excavation. If the proposed excavation extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by Engineer. If the proposed excavation extends more than 1 foot into the prevailing groundwater, control groundwater intrusion with a comprehensive dewatering procedures, or as directed by Geotechnical Engineer.

D. Existing underground utilities, except service lines, known to the Engineer are shown on the Drawings. Locations are approximate and may prove to be inaccurate.

E. Examine soil conditions and characteristics within the limits of construction prior to excavation.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. See Section 31 10 00 for clearing, grubbing, and removal of existing trees, shrubs, plants, other vegetation and debris.

C. Locate, identify, and protect from damage all existing utilities to remain.
   1. Notify all public and private companies who may have utilities within the project limits before commencing work.
   2. Coordinate excavation work to be performed with utility owners
   3. Obtain required permits from utility owners.
   4. Contractor shall be solely responsible for work and cost to repair damage to any existing utility as a result of performing the Work.

D. Notify utility company to remove and relocate utilities.
   1. Make arrangements for and pay for all costs to relocate utilities as indicated on the Drawings.
   2. Notify the Owner and Engineer and make arrangements for any necessary relocations due to utility obstructions not shown on the Drawings. The Owner will pay the costs for such relocations.

E. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, curbs, and other existing improvements from excavating equipment and vehicular traffic.

F. Protect plants, lawns, rock outcroppings, and other features to remain.

G. Restore damaged improvements and property to original condition or better, as determined by the Engineer, at no additional cost.

H. When construction occurs within streets, make provisions at cross streets and walks for free passage of vehicles and pedestrians. Do not block streets or walks without prior approval. Show pedestrian routing plans on Traffic Control Plans.

I. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by Engineer.

3.03 TEMPORARY EXCAVATION SUPPORT AND PROTECTION

A. Excavation Safety: Comply with OSHA's Excavation Standard, 29 CFR 1926, Subpart P.
   1. Excavations in stable rock or in less than 5 feet in depth in ground judged as having no cave-in potential do not require excavation support and protection systems.
   2. Depending upon excavation depth, time that excavation is open, soil classification, configuration and slope of excavation sidewalls, design and provide an excavation support and protection system that meets the requirements of 29 CFR 1926, Subpart P:
      a. Sloping and benching systems.
      b. Support systems, shield systems, and other protective systems.
   3. Design, install, and maintain all sheeting and shoring systems in strict compliance with local, state and federal safety regulations. Contractor is solely responsible for non-compliance.

B. Leave excavation support and protection systems, used as formwork or within 10 feet of existing foundations, permanently in place, unless otherwise noted.
   1. Cut off top 4 feet below grade, abandon remainder.

C. Excavation support and protection systems not required to remain in place may be removed subject to approval of Owner or Owner's Representative.
   1. Remove temporary shoring and bracing in a manner to avoid harmful disturbance to underlying soils and damage to buildings, structures, pavements, facilities and utilities.

3.04 EXCAVATING

A. Excavate to accommodate new structures and construction operations.
   1. Excavate to the specified elevations.
   2. Excavate to the length and width required to safely install, adjust, and remove any forms, bracing, or supports necessary for the installation of the work.
   3. Cut utility trenches wide enough to allow inspection of installed utilities.
   4. See Section 31 23 16.26 for required excavation clearances for pipes in utility trenches.
   5. Hand trim excavations. Remove loose matter.

B. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

C. Notify the Engineer of unsuitable materials which ar not capable of supporting superimposed loadings and discontinue affected Work in area until notified to resume work..
   1. If, in the opinion of the Engineer, unsuitable soil excavation is required to an extent which the Contractor could not have reasonably been expected to anticipate based on information provided in the Bidding Documents, Drawings, Specifications, geotechnical investigation reports or other data provided in the Project Manual, then a change in Contract Price for Unsuitable Soil Excavation shall be negotiated between Owner & Contractor.
   2. The following are examples of information conveyed which positively indicate that the Contractor shall expect to remove a certain quantity of unsuitable soils:
      a. Inclusion of a Bid Item, with an estimated quantity, for Unsuitable Soil Excavation in the Bid Schedule.
      b. Identification within a geotechnical investigation report provided to the Contractor of certain depths within boreholes located across a certain area of a certain type of soil,

which the geotechnical professional recommends be removed prior to placement of structural fill and/or construction of structures or load-bearing surfaces.

3. No payment shall be made to the Contractor for unsuitable material excavated prior to notification of the Engineer and issuance of a Change Order authorizing its removal.

D. Do not interfere with 45 degree bearing splay of foundations.

E. Remove boulders, and rock up to 3 cubic yards measured by volume. See Section 31 23 16.26 for removal of larger material.

F. Provide temporary means and methods, as required, to remove all water from excavations until directed by Engineer. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control.
   1. All water removal operations are subject to approval by the Engineer.
   2. Removal of water by well point, sump or trench diversions, intermittent pumping, or sump with submersible pumps is considered incidental to excavation work for this project.

G. Stockpiling excavated material
   1. Stockpile excavated material suitable for use as fill or backfill until it is needed. Segregate usable backfill materials from stockpiled topsoil and unsuitable materials.
   2. Confine stockpiles within approved areas.
   3. Do not obstruct roads or streets, pedestrian walkways, emergency access or access to fire hydrants and water valves.
   4. Do not obstruct natural drainage courses and street gutters.
   5. Do not stockpile excavated material adjacent to trenches and other excavations unless excavation sideslopes and excavation support systems are designed, constructed, and maintained for stockpile loads.
   6. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work if the weight of stockpiled material could induce settlement.

3.05 SUBGRADE PREPARATION

A. See Section 31 23 23 for subgrade preparation at general excavations.

B. See Section 31 23 33 for subgrade preparation at utility trenches.

3.06 FILLING AND BACKFILLING

A. Do not fill or backfill until all debris, water, unsuitable soil materials, obstructions, and deleterious materials have been removed from excavation.

B. Install underground warning tape at buried utilities.

C. See Section 31 23 23 for fill, backfill, and compaction requirements at general excavations.

D. See Section 31 23 33 for fill, backfill, and compaction requirements at utility trenches.

E. See Section 31 22 00 for rough and final grading and topsoil replacement requirements.

F. Maintain dewatering facilities and operations until all backfill is in place at least 24 inches above anticipated water levels.

3.07 REPAIR

A. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 31 23 23.

3.08 TOLERANCES

A. Top Surface of Excavation under Paved or Base Course areas: Plus or minus 1/2 inch (0.04 ft) from required elevations.

B. Top Surface of Excavation under Structures: Plus or minus 1/4 inch (0.02 ft) from required elevations.

C. Top Surface of Excavation in areas upon which a subbase material is required, upon which finished landscaping improvements, including sod or lawn seeding: Plus or minus 1 inch (0.08 ft) from required elevations.

D. Top Surface of Excavation in areas where no additional construction will occur, other than topsoil placement and native seeding: Plus or minus 6 inches (0.50 ft) from required elevations.

3.09 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.

B. Provide for visual inspection of load-bearing excavated surfaces by Engineer before placement of foundations.

3.10 CLEANING

A. Stockpile excavated material to be re-used in area designated on site in accordance with Section 31 22 00.

B. Remove excavated material that is unsuitable for re-use from site.

C. Remove excess excavated material from site.

3.11 PROTECTION

A. Divert surface flow from rains or water discharges from the excavation.

B. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.

C. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition.

D. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

E. Keep excavations free of standing water and completely free of water during concrete placement.

F. Protect open excavations from pedestrians, vehicles and public.

G. Stockpile excavated material so as not to endanger the Work or public safety.

H. Maintain existing vehicular and pedestrian traffic with minimum disruption.

I. Maintain emergency access and access to existing fire hydrants and water valves.

J. Maintain natural drainage courses and street gutters.

END OF SECTION

SECTION 31 23 16.26
ROCK REMOVAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Removal of identified rock during excavation.

1.02 RELATED REQUIREMENTS

A. Section 31 23 23 - Fill: Fill materials.

1.03 PRICE AND PAYMENT PROCEDURES

A. See Section 01 20 00 - Measurement and Payment, for additional unit price requirements.

B. Inclusion of a bid item for Rock Excavation indicates such excavation is anticipated. Notify Engineer prior to any rock excavating. If the Engineer determines rock excavation is required and the Contractor could not have reasonably been expected to determine the existence of such material during their site investigation, then a contract price for Rock Excavation shall be negotiated between the Owner and the Contractor. No payment shall be made for materials excavated prior to notification of the Engineer and negotiation of payment for extra work.

1.04 DEFINITIONS

A. Rock Excavation: Removal of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting, jack hammering or the use of rippers, including all boulders or other detached stones having a volume in excess of 3 cubic yards. Unless specified in the Contract, rock excavation is material that meets one of the following field test criteria to be conducted by the Contractor:

1. Ripping Test: Material that cannot be broken down by one pass with a single tooth ripper mounted to a crawler type tractor in low gear with a minimum net flywheel power rating of 235 horsepower; or material that cannot be broken down with a 48,000 pound tracked excavator using a bucket with rock teeth.
2. Seismic Test: Material that has a seismic velocity of 6,000 feet per second or greater. The Contractor shall submit the qualifications of the individual performing or interpreting the seismic testing to the Engineer a minimum of 14 days prior to testing. The ripping test will be used to resolve differences if seismic velocities fall below 6,000 feet per second.
3. Handling Test: Any boulder or detached stone having a volume of 3 cubic yards or more that cannot be readily broken down with the excavation equipment described above in 1.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify site conditions and note subsurface irregularities affecting work of this section.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum.

3.03 ROCK REMOVAL

A. Excavate and remove rock by mechanical methods only; use of explosives is prohibited.

B. Mechanical Methods: Drill holes and utilize expansive tools to fracture rock.

C. Form level bearing at bottom of excavations.

D. Remove shaled layers to provide sound and unshattered base for footings.

E. In utility trenches, excavate to 6 inches below invert elevation of pipe and 24 inches wider than pipe diameter.

F. Remove excavated materials from site.

G. Correct unauthorized rock removal in accordance with backfilling and compacting requirements of Section 31 23 23.

H. Rock shall be removed to a minimum depth of 4" below grade.
   1. For payment purposes, maximum depth to be paid for shall be 12" below required grade.

3.04 FIELD QUALITY CONTROL

A. Independent agency field inspection will be provided under provisions of Section 01 40 00 - Quality Requirements.

END OF SECTION

SECTION 31 23 19
DEWATERING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Controlling groundwater, site drainage, and storm flows during construction to protect excavations from surface and subsurface water for construction of foundations and installation of pipes in trenches.

B. Design and installation of dewatering system to protect excavation from subsurface water and to allow construction of foundations and dampproofing or waterproofing of new construction in dry conditions.

1.02 RELATED REQUIREMENTS

A. Section 01 57 13 - Temporary Erosion and Sediment Control.

B. Section 31 23 16 - Excavation.

C. Section 31 23 23 - Fill.

D. Section 31 23 33 - Trenching and Backfilling.

1.03 PRICE AND PAYMENT PROCEDURES

A. Allowances:
   1. See Section 01 21 00 - Allowances for allowances affecting this section.

B. Unit Prices:
   1. See Section 01 20 00 - Measurement and Payment for additional requirements.

C. By submitting a bid, the Contractor acknowledges that they have investigated the risk arising from storm and ground waters and prepared their bid accordingly, assuming all said risk.

1.04 REFERENCE STANDARDS

A. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012 (Reapproved 2021).

1.05 ADMINISTRATIVE REQUIREMENTS

A. Regulatory Requirements:
   1. Discharge of groundwater is to conform with Colorado Department of Public Health and Environment (CDPHE) and other agency requirements.
   2. Contractor is responsible for obtaining and maintaining necessary permits, including sampling and testing.

1.06 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Water Control Plan:
   1. Submit at least 2 weeks prior to the work.
   2. Include the minimum items in the plan:
      a. Descriptions of proposed groundwater and surface water control facilities including:
         1) primary dewatering equipment, standby equipment, power supply
         2) communications protocol
         3) inflow measurement devices
         4) pollution control measures, best management practices
         5) discharge locations
         6) sampling and testing protocol
      b. Drawings showing locations, dimensions, and relationships of elements of each system and compatibility with proposed construction.
      c. Design calculations demonstrating adequacy of proposed dewatering systems and components.

d. Approved permits

3. If system is modified during installation or operation, revise or amend and resubmit Water Control Plan.

1.07 FIELD CONDITIONS

A. Verification of Conditions: Investigate and become familiar with all site conditions that may affect the work including surface water, potential flooding conditions, level of groundwater and the time of year the work is to be done.

B. Existing Groundwater Data: A series of test holes were made for Owner by their separate geotechnical consultant. Log and report are believed to be accurate; however, neither Owner nor Engineer guarantees information contained therein nor do they prevail at other locations on site. Contractor may, at his own expense, conduct additional geotechnical investigations. For access to the site, contact the Owner.

C. Existing Conditions: The Contractor is cautioned that the work involves construction in and around drainage channels, local rivers, variable or unknown groundwater, and areas of local drainage. These areas are subject to inundation.

PART 2 PRODUCTS

2.01 MATERIALS

A. Onsite materials may be used within the limits of construction to construct temporary dams and berms. Materials such as plastic sheeting, sand bags and storm sewer pipe may also be used.

B. Provide all necessary materials for installation and complete operation of dewatering system.

C. Provide spare pumps, hoses, etc. as required.

D. All pumps shall be in good working condition at the time of installation.

PART 3 EXECUTION

3.01 GENERAL

A. Provide suitable equipment and labor to remove water, and keep the excavation dewatered so that construction can be carried on under dewatered conditions.

1. Water control shall be accomplished such that no damage is done to adjacent channel banks or structures.
2. Continuously control water during course of construction, including weekends and holidays and during periods of work stoppages, and provide adequate backup systems to maintain control of water.

B. Conduct operations in such a manner that storm or other waters may proceed uninterrupted along their existing drainage courses.

C. Pumps and generators used for dewatering and water control shall be quiet equipment enclosed in sound deadening devices.

3.02 CONSTRUCTION

A. Protection of In-Place Conditions: Do no affect existing surface or subsurface drainage patterns of adjacent property.

B. Surface Water Control:

1. Surface water control generally falls into the following categories:
   a. Normal low flows along the channel.
   b. Storm/flood flows along the channel.
   c. Flows from existing storm drain pipelines.
   d. Local surface inflows not conveyed by pipelines.
2. Contractor shall coordinate, evaluate, design, construct, and maintain temporary water conveyance systems to accomplish surface water control.

a. These systems shall not worsen flooding, alter major flow paths, or worsen flow characteristics during construction. Contractor is responsible to ensure that any such worsening of flooding does not occur.
b. Contractor is solely responsible for determining the methods and adequacy of water control measures.

3. At a minimum, Contractor shall be responsible for diverting the quantity of surface flow around the construction area so that the excavations will remain free of surface water for the time it takes to install these materials, and the time required for curing of any concrete or grout. Contractor is cautioned that the minimum quantity of water to be diverted is for erosion control and construction purposes and not for general protection of the construction site.
   a. It shall be Contractor's responsibility to determine the quantity of water which shall be diverted to protect the work from damage caused by stormwater.
4. Contractor shall, at all times, maintain a flow path for all channels.
   a. Temporary structures such as berms, sandbags, pipeline diversions, etc., may be permitted for the control of channel flow, as long as such measures are not a major obstruction to flood flows, do not worsen flooding, or alter historic flow routes.

C. Groundwater Control:
1. Contractor shall install adequate measures to maintain the level of groundwater below the foundation subgrade elevation and maintain sufficient bearing capacity for all structures, pipelines, earthwork, and rockwork.
   a. Such measures may include, but are not limited to, installation of perimeter subdrains, pumping from drilled holes or by pumping from sumps excavated below the subgrade elevation.
   b. Dewatering from within the foundation excavations shall not be allowed.
2. The foundation bearing surfaces are to be kept dewatered and stable until the structures or other types of work are complete and backfilled.
   a. Disturbance of foundation subgrade by Contractor operations shall not be considered as originally undisturbede foundation subgrade and shall be repaired at Contractor's expense.
3. Contractor shall dispose of groundwater as follows:
   a. Obtain discharge permit for water disposal from authorities having jurisdiction.
   b. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.
   c. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed work, or adjacent property.
   d. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

3.03 PROTECTION

A. Do no affect existing surface or subsurface drainage patterns of adjacent property.

3.04 REMOVAL

A. Remove all temporary water control facilities when they are no longer needed or at the completion of the project.

3.05 RESTORATION

A. Repair any damage to adjacent property resulting from the alteration of surface or subsurface drainage patterns at no additional cost.

B. Backfill all excavations made as part of dewatering operations with the same type material as was removed and compact to minimum 95 percent of maximum density in accordance with ASTM D698, except where replacement by other materials is required.

C. Any temporary dewatering trenches or well points shall be restored following dewatering operations to reduce permeability in those areas as approved by Engineer.

END OF SECTION

SECTION 31 23 23
FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Filling, backfilling, and compacting for building volume below grade, footings, slabs-on-grade, paving, and utilities within the building.

B. Backfilling and compacting for utilities outside the building to utility main connections.

C. Filling holes, pits, and excavations generated as a result of removal (demolition) operations.

1.02 DEFINITIONS

A. Borrow Material: Material from required excavations or from designated borrow areas on or off the site.

B. Compaction:
   1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698 or ASTM D1557.
   2. Verification that the proper ASTM D698 or ASTM D1557 Proctor Curve is being used for the individual test may require collecting a soil sample from the location of the test for running of a one-point Proctor Test to correlate to the full Proctor Curve. This verification shall be done on soil materials other than imported materials that have been processed through a controlled screening process for consistency.
   3. Apply corrections for oversize material to as-compacted field dry density or maximum dry density, as determined by the Engineer.

C. Embankment Material: Fill materials required to raise existing grade in areas other than under structures and pavements.

D. Finish Grade Elevations: Indicated on drawings.

E. Imported Material: Materials obtained from sources off-site that are suitable for specified use.

F. Optimum Moisture Content: Moisture content in accordance with ASTM D698 or ASTM D1557.

1.03 REFERENCE STANDARDS

A. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2020.

B. ASTM C231/C231M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method; 2022.

C. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012 (Reapproved 2021).

D. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)); 2012 (Reapproved 2021).

E. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders; 2016, with Editorial Revision (2018).

F. ASTM D6023 - Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM); 2016.

G. ASTM D6103/D6103M - Standard Test Method for Flow Consistency of Controlled Low Strength Material (CLSM); 2017, with Editorial Revision (2021).

H. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2023.

I. CDOT Std Spec - Colorado Department of Transportation Standard Specifications for Road and Bridge Construction; 2023.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Materials Sources: Submit name of imported materials source.

C. Concrete for Fill (Flow-fill): Mix design for approval prior to placement including the following test data:
   1. ASTM C231/C231M, Air Content
   2. ASTM D6023, Unit Weight
   3. ASTM C143/C143M, Slump or ASTM D6103/D6103M, Flow Consistency
   4. ASTM D4832, 28-day Compressive Strength
   5. Removability Modulus (RM)

D. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used, including manufactured fill.

E. Compaction Density Test Reports.

1.05 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. When fill materials need to be stored on site, locate stockpiles where indicated.
   1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
   2. Prevent contamination.
   3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. General Fill: Subsoil excavated on-site or Imported borrow.
   1. Graded.
   2. Free of debris, organic matter and frozen material.
   3. Free of material cemented together in pieces larger than permitted by specified gradation.
   4. Free of rocks larger than 6 inches in the top 12 inches of fill and free of rocks larger than 12 inches in the remainder of the fill.
   5. Minimum of 50% by dry weight shall pass No. 4 sieve.

B. Structural Fill - Structure Backfill (Class 1): Complying with CDOT Std Spec.

C. Concrete for Fill: Lean concrete complying with CDOT Standard Specifications for Structure Backfill (Flow-fill).
   1. Self-leveling low strength concrete material composed of cement, fly ash, aggregates, water, chemical admixtures or cellular foam for air-entrainment.
   2. Slump:
      a. 7 to 10 inches, when tested per ASTM C143/C143M, or
      b. 6 inch minimum flow consistency when tested per ASTM D6103/D6103M.
   3. Miniimum compressive strength of 50 psi at 28 days when tested per ASTM D4832.
   4. Flash fill is a rapid setting Flow-fill that may be used when approved by the Engineer.
   5. Flow-fill placed in areas that require future excavation, such as utility backfill shall have a Removability Modulus (RM) of 1.5 or less and the unit weight of the placed Flow-fill shall not exceed the unit weight of the approved mix design by more than 2.0 pcf.
      a. Removability Modulus, RM, is calculated as follows:

$$RM = \frac{W^{1.5} \times 104 \times C^{0.5}}{10^6}$$

Where:
W = unit weight of concrete (pcf)
C = 28-day concrete compressive strength (psi)

D. Granular Fill - Aggregate Base Course (Class 6): Coarse aggregate, complying with CDOT Std Spec.

E. Screened Rock - Filter Material (Class A): Free draining granular material, complying with CDOT Std Spec.

F. Bedding - Filter Material (Class A), Free draining granular material, complying with CDOT Std Spec.

G. Manufactured Fill - Geofoam: See Section 31 23 23.43.

2.02 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest.

D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the Work are as indicated.

B. Identify required lines, levels, contours, and datum locations.

C. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.

D. Verify structural ability of unsupported walls to support imposed loads by the fill.

E. Verify underground tanks are anchored to their own foundations to avoid flotation after backfilling.

F. Verify areas to be filled are not compromised with surface or ground water.

3.02 PREPARATION

A. See Section 31 10 00 - Site Clearing for clearing, grubbing, and removal of existing trees, shrubs, plants, other vegetation and debris.

B. Strip topsoil from all areas to be disturbed by construction. Topsoil to be stockpiled separately from other excavated material.

C. Scarify subgrade surface to a depth of 6 inches to identify soft spots.

D. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

E. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

F. Plow, step, or bench sloped surfaces steeper than 4:1 on which fill or backfill is to be placed in such a manner that fill material will adequately bond with existing surfaces.

G. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

H. Do not begin embankments until construction below grade has been approved, underground utility systems have been inspected, tested and approved and trash and debris have been cleaned from the excavation.

3.03 FILLING

A. Fill to contours and elevations indicated indicated creating smooth and uniform surfaces.

B. Use suitable materials removed from the excavation before using materials obtained from borrow areas.

C. Do not fill with frozen materials.

D. Employ a placement method that does not disturb or damage other work.

E. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

F. Maintain optimum moisture content of fill materials to attain required compaction density.

G. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.

H. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth. Place material in successive uniform loose layers not exceeding 4 inches in areas not accessible or permitted for the use of self-propelled rollers or hand operated tampers.

I. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

J. Correct areas that are over-excavated.
   1. Load-bearing foundation surfaces: Use structural fill, flush to required elevation, compacted to 98 percent of maximum dry density.
   2. Other areas: Use general fill, flush to required elevation, compacted to minimum 95 percent of maximum dry density.

K. Compaction Equipment:
   1. Perform all compaction with approved equipment well suited to location and material being compacted.
   2. Use heavy vibratory rollers or sheepsfoot rollers where heavy equipment is authorized.
   3. Fill against structures:
      a. Do not deposit fill material or begin compaction with hand-operated equipment against newly constructed masonry or concrete structures until the concrete has developed a compressive strength of 80% of its design strength.
      b. For structures designed to support lateral earth pressure, concrete compressive strengths shall reach full design strength before backfilling operations can begin with heavy equipment, such as skid-steers or self-powered riding compactors.
      c. Select and operate earthmoving and compaction equipment in a manner that does not damage structures.
      d. Do not operate earthmoving or compaction equipment, other than hand-operated types, within a distance equal to the height of backfill above the top of footing.
      e. Compact areas within a distance equal to the height of backfill above the top of the footing in maximum 4-inch lifts with power-driven hand tampers suitable for the material being compacted.
   4. Place and compact backfill around pipes with care to avoid damage.

L. Compaction Density Unless Otherwise Specified or Indicated:
   1. Under, within 5 feet horizontally, or within the area defined by a line extended at an angle of 1:1 of paving, roadways, sidewalks, curb and gutter, slabs-on-grade, utility lines, and similar construction: 95 percent of maximum dry density.
   2. In public or designated rights-of-way: 90 percent of maximum dry density.
   3. In undeveloped, green or undesignated area:85 percent of maximum dry density.
   4. In overcut grading and fill in areas of lot/home construction: 95 percent of maximum dry density.
   5. At other locations: 95 percent of maximum dry density.
   6. Maintain the moisture content of the material being placed and compacted within 2% of optimum condition and uniform through the layer.

M. Proof Rolling:
   1. Proof roll subgrade under paved and graveled travel ways with a heavy rubber-tired roller, loaded tandem axle dump truck, loaded water truck, or other equipment approved by the Engineer.
   2. Perform proof rolling in presence of the Engineer.
   3. Perform proof rolling after specified compaction has been attained.

N. Reshape and re-compact fills subjected to vehicular traffic.

O. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the Engineer. Remove and replace soils deemed

unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

P. Jetting and water inundation are not permitted methods of compaction.

Q. Maintain all embankment and fills in satisfactory condition during the extent of the contract and warranty period. All surface deterioration determined to be the responsibility of the Contractor and all settlement shall be repaired at once by the Contractor upon notice by the Owner. All costs for repair and all liability as a result of surface deterioration or settlement shall be the responsibility of the Contractor.

3.04 FILL AT SPECIFIC LOCATIONS

A. Use general fill unless otherwise specified or indicated.

B. Structural Fill:
   1. Use structural fill.
   2. Maximum depth per lift: 6 inches, compacted.
   3. Compact to minimum 95 percent of maximum dry density.

C. Under Interior Slabs-On-Grade:
   1. Use granular fill.
   2. Depth: 4 inches deep.
   3. Compact to 98 percent of maximum dry density.

D. At Foundation Walls and Footings:
   1. Use structural fill.
   2. Compact each lift to 95 percent of maximum dry density.
   3. Do not backfill against unsupported foundation walls.

3.05 TOLERANCES

A. Top Surface of General Filling: Plus or minus 1 inch (0.08 ft) from required elevations.

B. Top Surface of Filling Under Paved Areas: Plus or minus 1/2 inch (0.04 ft) from required elevations.

C. Top Surface of Filling Under Structures: Plus or minus 1/4 inch (0.02 ft) from required elevations

3.06 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.

B. Excavate as required to facilitate testing. Backfill all test excavations in accordance with this Section.

C. Soil Fill Materials:
   1. Perform compaction density testing on compacted fill in accordance with ASTM D6938.
   2. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698.
   3. If tests indicate work does not meet specified requirements, remove work, replace and retest.
      a. Bear all removal, replacement and retesting costs.
   4. Frequency of Tests: as directed by the Engineer.
   5. Proof roll compacted fill at surfaces that will be under slabs-on-grade and paving.

3.07 CLEANING

A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.

B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

3.08 SURFACE RESTORATION

A. Restore all existing surface improvements and site conditions disturbed or damaged during construction to a condition equal to pre-construction condition. All restoration costs are considered incidental to excavation and backfill and at Contractor's sole expense.
   1. Improvements. Replace, repair or reconstruct all improvements as required. Work will not be accepted until restoration is accepted by Engineer and all affected property owners.
   2. Final Grading. Re-establish existing grade or finish to final grades as modified and shown on the Drawings. Backfill to proper subgrade elevation with backfill material to allow placement of surface improvements or materials.

END OF SECTION

SECTION 31 23 33
TRENCHING AND BACKFILLING

PART 1 GENERAL

1.01 SECTION INCLUDES

Excavating, backfilling and compacting for pipelines, conduits, storm sewers, other utilities and appurtenances as shown on the Drawings and specified herein.

1.02 DEFINITIONS

A. Abbreviations:

CDOT Colorado Department of Transportation
CMP Corrugated Metal Pipe
DIP Ductile Iron Pipe
HDPE High Density Polyethylene
OSHA Occupational Safety and Health Administration
PVC Polyvinyl Chloride
RCP Reinforced Concrete Pipe

B. Bedding classes for concrete pipe are defined in the Concrete Pipe Design Manual published by the American Concrete Pipe Association.

C. Over-excavation: Additional trench excavation required to eliminate point bearing on rocks or when Contractor exceeds planned excavation depth by more than 0.1 feet.

D. Unsuitable Materials: Soils or mixtures of soil and organic matter that are incapable of supporting superimposed loadings.

E. Rock Excavation: Removal of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting, jack hammering or the use of rippers, including all boulders or other detached stones having a volume in excess of 3 cubic yards. Unless specified in the Contract, rock excavation is material that meets one of the following field test criteria to be conducted by the contractor:

1. Ripping Test: Material that cannot be broken down by one pass with a single tooth ripper mounted to a crawler type tractor in low gear with a minimum net flywheel power rating of 235 horsepower; or material that cannot be broken down with a 48,000 pound tracked excavator using a bucket with rock teeth.
2. Seismic Test: Material that has a seismic velocity of 6,000 feet per second or greater. The Contractor shall submit the qualifications of the individual performing or interpreting the seismic testing to the Engineer a minimum of 14 days prior to testing. The ripping test will be used to resolve differences if seismic velocities fall below 6,000 feet per second.
3. Handling Test: Any boulder or detached stone having a volume of 1/2 cubic yard or more that cannot be readily broken down with the excavation equipment described above in 1.

F. Finish Grade Elevations: Indicated on drawings.

G. Subgrade Elevations: 4 inches below finish grade elevations indicated on drawings, unless otherwise indicated.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Materials Sources: Submit name of imported materials source.

C. Concrete for Fill (Flow-fill): Mix design for approval prior to placement including the following test data:

1. ASTM C231/C231M, Air Content
2. ASTM D6023, Unit Weight
3. ASTM C143/C143M, Slump or ASTM D6103/D6103M, Flow Consistency
4. ASTM D4832, 28-day Compressive Strength
5. Removability Modulus (RM)

D. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.

E. Compaction Density Test Reports.

1.04 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. When fill materials need to be stored on site, locate stockpiles where approved.
   1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
   2. Prevent contamination.
   3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 EMBEDMENT MATERIALS

A. 3/4" Screened Rock: Washed rock product meeting following gradation criteria:
   1. Percent passing 1" sieve: 100
   2. Percent passing 3/4" sieve: 75 to 90
   3. Percent passing 1/2" sieve: 20 to 35
   4. Percent passing 3/8" sieve: 5 to 10
   5. Percent passing #4 sieve: < 5

B. Granular Fill: See product specification under Backfill Materials.

C. Concrete Fill - Flow-fill: See product specification under Backfill Materials.

2.02 BACKFILL MATERIALS

A. General Fill: Subsoil excavated on-site.
   1. Uniformly graded to allow proper compaction.
   2. Free of debris, organic matter and frozen material.
   3. Free of rocks larger than 6 inches in the top 12 inches of backfill and free of rocks larger than 12 inches in the remainder of the trench.

B. Structural Fill - Structure Backfill (Class 1): Complying with CDOT Std Spec.

C. Concrete for Fill - Flow-fill: Lean concrete complying with CDOT Std Spec for Structure Backfill (Flow-fill).
   1. Flow-fill shall be a self-leveling low strength concrete material composed of cement, fly ash, aggregates, water, chemical admixtures or cellular foam for air-entrainment. Flow-fill shall have a slump of 7 to 10 inches, when tested per ASTM C143/C143M or a minimum flow consistency of 6 inches when tested per ASTM D6103/D6103M. Flow-fill shall have a minimum compressive strength of 50 psi at 28 days when tested per ASTM D4832.
   2. Flash fill is a rapid setting Flow-fill that may be used when approved by the Engineer.
   3. Flow-fill placed in areas that require future excavation, such as utility backfill shall have a Removability Modulus (RM) of 1.5 or less and the unit weight of the placed Flow-fill shall not exceed the unit weight of the approved mix design by more than 2.0 pcf.
      a. Removability Modulus, RM, is calculated as follows:

$$RM = \frac{W^{1.5} \times 104 \times C^{0.5}}{10^6}$$

      Where:
      W = unit weight of concrete (pcf)
      C = 28-day concrete compressive strength (psi)

D. Granular Fill: - Aggregate Base Course (Class 6): Coarse aggregate, complying with CDOT Std Spec.

E. Topsoil: Topsoil excavated on-site.
   1. Free of roots, rocks larger than 3 inches, subsoil, debris, large weeds and foreign matter.

F. Select Material
   1. Only with Engineer approval, select material may be used in place of specified embedment and backfill materials when application, trench and soil conditions allow.
      a. Select material shall be free from rocks, clods and organic material to the satisfaction of the Engineer.
      b. Develop Bid based upon specified materials. If select material is approved, a change in Contract Price shall be made.

2.03 GEOTEXTILES

A. Geotextile for separation. See Section 31 05 19 - Geosynthetics for Earthwork: geotextile capable of restricting adjacent material mixing.
   1. Product reference: Mirafi 1040N, or Engineer-approved equal.

2.04 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest.

D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

B. Verify the presence of existing utiilities in the project area are as indicated. Underground utilities, except service lines, known to the Engineer have been shown on the Drawings. Locations are approximate only and may prove to be inaccurate.

C. Obtain required permits for work in public right-of-way.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. See Section 31 10 00 for clearing, grubbing, and removal of existing trees, shrubs, plants, other vegetation and debris.

C. See Section 31 22 00 for topsoil removal.

D. Locate, identify, and protect from damage all utilities that remain.
   1. Before commencing with the Work, notify all public and private companies who may have utilities within the project limits. Coordinate all excavation work to be performed with, and obtain all required permits from, utility owners.
   2. Contractor shall be solely responsible for work and cost to repair damage to any existing utility as a result of performing the Work.

E. Notify utility company to remove and relocate utilities.
   1. Make arrangements for and pay for all costs to relocate utilities as indicated on the Drawings.
   2. Notify the Owner and Engineer and make arrangements for any necessary relocations due to utility obstructions not shown on the Drawings. The Owner shall pay the costs for such relocations.

F. Coordinate removal and relocation of utilities indicated in the Drawings.

G. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

H. Protect plants, lawns, rock outcroppings, and other features to remain.

I. Protect from damage all existing improvements, including property adjacent to the site of the Work.

J. Strip existing topsoil from all areas to be disturbed by construction and stockpile topsoil separately from other excavated materials.

K. When construction occurs within streets, make provisions at cross streets and walks for free passage of vehicles and pedestrians. Do not block streets or walks without prior approval. Show pedestrian routing plans on Traffic Control Plans.

L. Restore improvements and/or property damaged as a result of performing the Work to original condition or better (as determined by the Engineer). Bear all costs associated therewith.

M. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by Engineer.

3.03 TRENCHING

A. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

B. Notify Engineer of unexpected utility obstructions encountered that are not shown on the Drawings and require relocation. Coordinate the relocation of these utilities with utility company.

C. Slope banks of excavation in accordance with OSHA requirements.

D. Do not interfere with 45-degree bearing splay of foundations.

E. Cut pipe and conduit trenches to a minimum width equal to the pipe or conduit outside diameter plus16 inches.

F. Cut pipe and conduit trenches to a maximum width equal to the pipe or conduit outside diameter plus 24 inches for pipes or conduits with outside diameter of 24 inches or less, and plus 30 inches for pipes or conduits with outside diameters greater than 24 inches. If maximum trench width is exceeded, higher strength pipe or special bedding including concrete will be provided at no additional cost as directed by the Engineer .

G. Cut culvert pipe trenches to widths shown in CDOT Std Plan.

H. Excavate material to allow installation of all fitting, joint and appurtenance projections without affecting placement of pipe.

I. Hand trim excavations. Remove loose matter.

J. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.

K. Remove lumped subsoil, boulders, and rock up to 3 cubic yards measured by volume. See Section 31 23 16.26 for removal of larger material.

L. Remove excavated material that is unsuitable for re-use from site.

M. Stockpile excavated material to be re-used in approved area on site. Excavated material to be stockpiled in a manner that does not endanger the work or public safety, maintains existing vehicular and pedestrian traffic, maintains emergency access and access to existing fire hydrants and water valves and maintains natural drainage courses and street gutters.

N. Remove excess excavated material from site.

O. Dewater trench excavation and maintain dewatering facilities to keep groundwater level at least 12 inches below the trench bottom to a point such that a firm base for pipe or conduit installation exists. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control. Dewatering system adequacy shall be subject to approval by the Engineer.

P. Determine the prevailing groundwater level prior to trenching. If the proposed trench extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by the Engineer.

Q. Maintain dewatering facilities until backfilling is in place to a level of at least 24 inches above the anticipated water level.

R. Undisturbed Foundation
   1. Where soils are suitable and have adequate strength, as determined by the Engineer, bottom to be graded and hand-shaped such that pipe barrel rests uniformly on undisturbed soil. All rocks or stones, which may result in a point bearing on the pipe, shall be removed.
   2. Undisturbed grades shall be within 0.1 feet ± tolerance. Soils for final pipe grade placed within these limits shall be fine granular (100% passing No. 4 sieve) or may be native materials, hand compacted to 95% percent of maximum dry density.

S. Over-Excavation
   1. When trench is over-excavated to eliminate point bearing by rocks or stones or when undisturbed grade tolerances of 0.1' are exceeded, the bottom of trench grade is to be re-established using granular fill compacted to 95 percent of maximum dry density.
   2. All work to re-establish grade shall be at the Contractor's expense.

T. Rock Excavation
   1. Rock shall be removed to a 4-inch depth below grade. All rock loosened during blasting, jack hammering, or ripping shall be removed from the trench.
   2. See Section 31 23 16.26 for additional requirements.

U. Unsuitable Materials. These are materials which are not capable of supporting superimposed loadings.
   1. Immediately notify the Engineer upon encountering unsuitable materials.
   2. If, in the opinion of the Engineer, unsuitable soil excavation is required to an extent which the Contractor could not have reasonably been expected to anticipate based on information provided in the Bidding Documents, Drawings, Specifications, geotechnical investigation reports or other data provided in the Project Manual, then a change in Contract Price for Unsuitable Soil Excavation shall be negotiated between Owner & Contractor.
   3. The following are examples of information conveyed which positively indicate that the Contractor shall expect to remove a certain quantity of unsuitable soils:
      a. Inclusion of a Bid Item, with an estimated quantity, for Unsuitable Soil Excavation in the Bid Schedule.
      b. Identification within a geotechnical investigation report provided to the Contractor of certain depths within boreholes located across a certain area of a certain type of soil, which the geotechnical professional recommends be removed prior to placement of bedding material and piping/conduits for utility installations, structural fill for structures, and/or base courses for load-bearing surfaces.

3.04 PREPARATION FOR UTILITY PLACEMENT

A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with granular fill.

B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

C. Maintain excavations and prevent loose soil from falling into excavation until ready to backfill.

3.05 EMBEDMENT

A. Unless set forth otherwise in the Drawings, bed PVC, DIP, CMP, HDPE and concrete pipe in 3/4" screened rock.
   1. Use vibratory plate compactor to achieve full uniform settlement of the placed 3/4" screened rock embedment material.
   2. Wrap full cross-section of 3/4" screened rock embedment material in a geotextile for separation.

B. For granular fill or select material embedment material, compact to 95% of maximum dry density.

C. Compact embedment material so as not to damage or deflect piping.

D. Unless set forth otherwise in the Drawings, place and compact embedment material to depths of:
   1. 4" beneath bottom of pipe.
   2. 6" above top of pipe.

E. Notify Engineer immediately upon discovery of improper trenching, unexpected trench conditions, or unsuitable materials for pipe embedment requirements based on field conditions.

3.06 BACKFILLING

A. Backfill to contours and elevations indicated using unfrozen materials.

B. Employ a placement method that does not disturb or damage other work.

C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

D. Backfill equally up each side of the pipe.

E. Maximum loose lifts of backfill material, to be placed in the reverse order as removed, are:
   1. Bedding and select material: 6"
   2. Backfill material:
      a. Where 95% compaction, or greater, is required: 12"
      b. Where less than 95% compaction is required: 24"

F. Maintain optimum moisture content of fill materials to attain required compaction density.

G. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

H. Correct areas that are over-excavated.
   1. Thrust bearing surfaces: Fill with concrete.
   2. Other areas: Use granular fill, flush to required elevation, compacted to minimum 95 percent of maximum dry density.

I. Compaction Density Unless Otherwise Specified or Indicated:
   1. Under pavement, slabs-on-grade, curbs, utility lines, other improvements, and within 5' horizontally of such improvements: 95 percent of maximum dry density.
   2. Within public or designated right-of-way, not under improvements: 90 percent of maximum dry density.
   3. Within undeveloped, green or undesignated area: 85 percent of maximum dry density.
   4. Within areas of over-cut grading for building construction: 95 percent of maximum dry density.

J. Use proper compaction equipment for the prevailing soil conditions.

K. Use mechanical or air operated tamping equipment, except immediately next to the pipe where hand equipment may be necessary.
   1. Take care when compacting under, alongside and immediately above pipe to prevent crushing, fracturing or shifting of the pipe.
   2. Wheel rolling is not considered to be an adequate compaction technique and will not be allowed.

L. No more than150 feet of trench shall be left open at any time. Trench shall be backfilled within 100 feet of the pipe installation at all times.

M. Jetting and water inundation are not permitted methods of compaction.

N. Reshape and re-compact fills subjected to vehicular traffic.

O. Placement of Concrete (Flow-fill) Backfill.
   1. The maximum layer thickness for Flow-fill shall be 3 feet unless otherwise approved by the Engineer. Flow-fill shall not be placed in layers that are too thick to cause damage to culverts, pipes and other structures, or that will cause formwork or soil failures during placement. Flow-fill shall have an indention diameter less than 3 inches and the indention shall be free of visible water when tested in accordance with ASTM D6024/D6024M by the

Contractor prior to placing additional layers of Flow-fill. Testing Flow-fill in accordance with ASTM D6024/D6024M will be witnessed by the Engineer. Damage resulting from placing Flow-fill in layers that are too thick or from not allowing sufficient time between placements of layers shall be repaired at the Contractor's expense.

2. Compaction of Flow-fill shall not be performed.
3. Vibration of Flow-fill may be required.
4. Culverts, pipes and other structures shall be secured to prevent floating and displacement of these items during the placement of the Flow-fill.
5. Flow-fill shall not be allowed to freeze during placement and until it has set sufficiently according to ASTM D6024/D6024M. Frozen Flow-fill shall be removed and replaced at the Contractor's expense.
6. Clay Barrier Water Stops. Because of the presence of ground water, the Drawings may show clay barriers along utility trenches. If groundwater levels at the start of construction are encountered at elevations above the bottoms of certain trench excavations for which the Drawings do not call for clay barriers, notify the Engineer immediately. If the Engineer determines that clay barriers not shown on the Drawings are required or if the Drawings require them, install them as follows, or other in accordance with details on the Drawings if shown:
   a. Over the full trench depth in place of all bedding material and backfill material.
   b. With a minimum barrier thickness of two feet.
   c. On a maximum interval of 500 lineal feet of trench.
7. Contractor shall be entitled to an equitable adjustment in Contract Price for Engineer-directed installation of clay barriers not shown on the Drawings.

3.07 TOLERANCES

A. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1/4 inch from required elevations.

3.08 PROTECTION

A. Sheeting, Shoring and Bracing
   1. Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent any excessive widening or sloughing of the trench which may be detrimental to human safety, to the pipe or appurtenances being installed, or to existing facilities or structures. Damage due to inadequate support shall be repaired by the Contractor at their expense.
   2. Comply with OSHA requirements at all times for trenching and confined space entry.
   3. Underpin adjacent structures, service utilities and pipes which may be damaged by excavation.
   4. Remove support as work progress. Sheeting shall not be removed after the start of backfilling.

B. Weather and Frost
   1. Protect bottom of excavations and soil adjacent to and beneath foundations from frost.
   2. Do not place backfill, fill, or embankment on frozen surfaces.
   3. Do not place frozen materials, snow, or ice in backfill, fill, or embankments.
   4. Do not deposit, tamp, roll, or otherwise mechanically compact backfill in water.

C. Drainage and Groundwater
   1. Protect excavations from surface water all times. At no time shall excavated area be allowed to fill with stormwater runoff.
   2. Grade top perimeter of trenching area or provide temporary drainage structures to prevent surface water from draining into trench.
   3. Remove water encountered in trenches to the extent necessary to provide a firm subgrade, to permit joints to be made in the dry, and to prevent the entrance of water into the pipeline.

4. Maintain the excavation or trench free from water until the structure, or pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.
5. Prevent water from entering into previously constructed pipe.
6. Do not use the pipe under construction for dewatering.

D. Protect unattended excavation areas with barricades or fences as required by governing safety codes and regulations, or as directed by the Engineer.

E. Protect adjacent property from damage. Damage to adjacent property shall be repaired by the Contractor at their expense.

F. Maintain backfill in a satisfactory condition during the extent of the contract and warranty period. All surface deterioration determined to be the responsibility of the Contractor and all settlement shall be repaired by the Contractor as directed by the Engineer.

3.09 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.

B. Perform compaction density testing on compacted fill in accordance with ASTM D6938.

C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("modified Proctor"), AASHTO T 180, or ASTM D698 ("standard Proctor").

D. If tests indicate work does not meet specified requirements, remove work, replace and retest. Costs for retesting to be paid by the Contractor.

E. Frequency of Tests: Minimum of one (1) test every 250' trench per lift or as directed by Engineer. Contractor to excavate to depths required by Engineer for testing and backfill test holes to density specified.

3.10 CLEANING

A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

3.11 SURFACE RESTORATION

A. Restore all existing surface improvements and site conditions disturbed or damaged during construction to a condition equal to pre-construction condition. All restoration costs are considered incidental to excavation and backfill and at Contractor's sole expense.
1. Improvements. Replace, repair or reconstruct all improvements as required. Work will not be accepted until restoration is accepted by Engineer and all affected property owners.
2. Final Grading. Re-establish existing grade or finish to final grades as modified and shown on the Drawings. Backfill to proper subgrade elevation with backfill material to allow placement of surface improvements or materials.
3. Topsoil.
   a. Do not place topsoil until the areas to be covered have been properly prepared and grading operations in the area have been completed.
   b. Place and spread topsoil at locations and to the thickness shown on the plans. Key to the underlying material by the use of harrows, rollers or other equipment suitable for the purpose.
   c. Apply water to the topsoil at the locations and in the amounts designated. Apply in a fine spray by nozzles or spray bars in such manner that it will not wash or erode the topsoil areas.
   d. All loose exposed rock larger than three inches shall be removed from slopes that are to receive topsoil.
   e. See Section 02821, Revegetation and Section 02830 Trees, Plants, Seeding and Erosion Control.

END OF SECTION

SECTION 31 37 00
RIPRAP

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Riprap.

1.02 REFERENCE STANDARDS

A. AASHTO T24 - Standard Method of Test for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete; 2015.

B. ASTM C535 - Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine; 2016.

PART 2 PRODUCTS

2.01 MATERIALS

A. Riprap: Hard, dense, durable stone, angular in shape and resistant to weathering.
   1. Rounded stone or boulders shall not be used as riprap material. Shale shall not be used as riprap material.
   2. Minimum specific gravity of 2.5.
   3. Largest dimension of each piece not greater than 3 times its least dimension.
   4. Gradation meeting the requirements of Table 1. Nominal stone size and total thickness as indicated in plans.

Table 1
RIPRAP GRADATION REQUIREMENTS

Stone Size d50[1] (Inches)	Percent of Material Smaller Than Typical Stone[2]	Typical Stone Dimensions[3] (Inches)	Typical Stone Weight[4] (Pounds)
6	70-100 50-70 35-50 2-10	12 9 6 2	85 35 10 0.4
9	70-100 50-70 35-50 2-10	15 12 9 3	160 85 35 1.3
12	70-100 50-70 35-50 2-10	21 18 12 4	440 275 85 3
18	100 50-70 35-50 2-10	30 24 18 6	1280 650 275 10
24	100 50-70 35-50 2-10	42 33 24 9	3500 1700 650 35

Notes:
1 d50 = nominal stone size
2 based on typical rock mass
3 equivalent spherical diameter
4 based on a specific gravity = 2.5

B. Control of gradation will be by visual inspection. The Contractor shall provide two samples of rock at least 5 tons each, meeting the gradation specified. One sample shall be provided at the construction site and may be a part of the finished riprap covering. The other sample shall be provided at the quarry.

C. These samples will be used as a reference for judging the gradation of the riprap supplied. When it is determined necessary, conformance of the gradation will be verified by dumping and checking the gradation of two random truckloads of stone. Mechanical equipment, a sorting site, and labor needed to assist in checking gradation shall be provided at the Contractor's expense.

D. Material used for riprap may be approved by the Engineer if, by visual inspection, the rock is determined to be sound and durable.

E. The Engineer may require the Contractor to furnish laboratory results if, in the Engineer's opinion, the material is marginal or unacceptable. At the request of the Engineer, the Contractor shall furnish laboratory test results indicating that the material meets the requirements for abrasion resistance or compressive strength as indicated in Table 3.

Table 3

RIPRAP MATERIAL TEST REQUIREMENTS

Test Description	Test Method	Specification Requirement
Abrasion Resistance by Los Angeles Machine	ASTM C535	50% Loss, max.
Unconfined Compressive Strength of Drilled Core Specimen	AASHTO T24	2500 psi, min.

F. Geotextile: See Section 31 05 19.

PART 3 EXECUTION

3.01 PLACEMENT

A. Place geotextile over substrate, lap edges and ends.

B. Place riprap at culvert pipe ends, embankment slopes, _____, and as indicated.

C. Stones with typical stone dimensions that are equal to d50 and larger shall be placed at the top surface with faces and shapes matched to minimize voids and form as smooth a surface as practical.

D. Dumping and backhoe placement alone is not sufficient to ensure a properly interlocked system. The material may be machine-placed and then arranged as necessary by use of an excavator with a multi-prong grappling device or by hand to interlock and form a substantial bond.

END OF SECTION

SECTION 32 11 20
SUBBASE AND AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Subbase course.

B. Aggregate base course.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Test Reports:
   1. Aggregate Composition: Results of laboratory tests on proposed and actual materials used.
   2. Compaction Density: Results of laboratory tests on compacted course.

C. Source Quality Control Submittals: Submit name of imported materials source.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Aggregate Storage: Prevent material intermixing, contamination, and deterioration.

PART 2 PRODUCTS

2.01 MATERIALS

A. Subbase Course:
   1. Class 1, Class 2, and Class 3: Comply with State of Colorado Department of Transportation Standard Specifications (CDOT Std Spec).
      a. Crushed stone, crushed slag, crushed gravel, natural gravel, or crushed reclaimed concrete.
      b. Conform to qualilty requirements of AASHTO M 147, except that the requirements for the ratio of minus 75 µm (No. 200) sieve fraction to the minus 425 µm (No. 40) sieve fraction, stated in 3.2.2 of AASHTO M 147, shall not apply.
      c. Meet the the requirements for the Los Angeles wear test of ASTM C535 for Class 4, 5, 6 and 7.
      d. Graded in accordance with Table 1.
      e. Liquid limit in accordance with Table 1 and plasticity index not exceeding six when testing the aggregate per AASHTO T 89 and AASHTO T 90, respectively.

B. Aggregate Base Course:
   1. Class 6: Comply with State of Colorado Department of Transportation Standard Specifications (CDOT Std Spec).
      a. Crushed stone, crushed slag, crushed gravel, natural gravel, or crushed reclaimed concrete.
      b. Conform to qualilty requirements of AASHTO M 147, except that the requirements for the ratio of minus 75 µm (No. 200) sieve fraction to the minus 425 µm (No. 40) sieve fraction, stated in 3.2.2 of AASHTO M 147, shall not apply.
      c. Meet the the requirements for the Los Angeles wear test of ASTM C535 for Class 4, 5, 6 and 7.
      d. Graded in accordance with Table 1.
      e. Liquid limit in accordance with Table 1 and plasticity index not exceeding six when testing the aggregate per AASHTO T 89 and AASHTO T 90, respectively.

TABLE 1

Sieve Size	Mass Percent Passing Square Mesh Sieves						
	LL not greater than 35			LL not greater than 30			
	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7
150 mm (6")			100				

100 mm (4")		100					
75 mm (3")		95-100					
60 mm (2½")	100						
50 mm (2")	95-100			100			
37.5 mm (1½")				90-100	100		
25 mm (1")					95-100	100	100
19 mm (¾")				50-90		95-100	
4.75 mm (#4)	30-65			30-50	30-70	30-65	
2.36 mm (#8)						25-55	20-85
75 µm (#200)	3-15	3-15	20 max.	3-12	3-15	3-12	5-15

2.02 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. If tests indicate materials do not meet specified requirements, change material and retest.

C. Provide materials of each type from same source throughout the Work.

D. For aggregate materials using classification complying with ASTM D2487, provide testing before delivery to site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

B. Verify substrate has been inspected, and gradients and elevations are correct and material dry.

3.02 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and recompacting.

B. Do not place aggregate on soft, muddy, or frozen surfaces.

C. Grade excavated and filled substrate; see Section 31 22 00.

D. Backfill and compact trench excavations; see Section 31 23 33.

E. Backfill and compact subgrade fill; see Section 31 23 23.

F. Mix aggregate by methods that result in a homogenous mixture.

3.03 PLACEMENT

A. Spread course uniformly over prepared substrate to a total compacted thickness:
   1. Subbase Thickness: According to design drawings.
   2. Aggregate Base Thickness: According to design drawings.

B. Place course in maximum 4 inch 6 inch layers and ____ compact to specified density.

C. Compact each layer to at least 95 percent of maximum density as determined per AASHTO T 180 as modified by CP-23.

D. Compact each reclaimed asphalt pavement (RAP) aggregate layer to at least 95 percent wet density as determined per AASHTO T 180, Method D one-point test.

E. Level and contour surfaces to elevations and gradients indicated.

F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

G. Add water uniformly to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

H. Maintain a uniform surface texture and firmly keyed aggregate of each layer during compaction.

3.04 TOLERANCES

A. Variation From Design Elevation: Within 0.04 feet.

B. Flatness: Maximum variation of 1/2 inch measured with 10 foot straight edge.

C. Correct all irregulariities exceeding the specified tolerances at no additional cost.

3.05 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Subbase Compaction Density Testing: In accordance with ASTM D1556/D1556M, ASTM D2167, or ASTM D6938.

C. Aggregate Base Compaction Density Testing: In accordance with ASTM D1556/D1556M, ASTM D2167, or ASTM D6938.

D. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with AASHTO T 180, ASTM D698 ("standard Proctor"), or ASTM D1557 ("modified Proctor").

E. Frequency of Tests:
   1. Foundations: For each 100 lineal feet or less of trench.
   2. Slabs on Grade: For each 2,000 square feet or less of building area.
   3. Pavement and Walks: For each 2,000 square feet or less.
   4. All other areas: For each 5,000 square feet or less.
   5. Utility Trenches: For each 250 lineal feet or less of trench.

F. Remove, replace, and retest work that does not meet specified requirements. Cost of retesting to be paid by Contractor.

G. Proof roll compacted aggregate at surfaces going underneath flexible paving and rigid paving.

END OF SECTION

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SUMMARY

A. Work under this section shall include furnishing all materials, labor and tools necessary to install galvanized chain link fence and gates.

1.02 SYSTEM DESCRIPTION

A. Fence height: 5 feet nominal, with three strand barb wire on extension arms.

B. Line post spacing: At intervals not exceeding 10 feet for chain link fence.

C. Comply with the requirements of Colorado Department of Transportation – Standard Plan No. M-607-2.

D. Fence shall be galvanzied steel.

1.03 SUBMITTALS

A. Product Data: provide data on posts, chain link fabric, accessories, fittings, and hardware

B. Shop drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, etc.

PART 2 PRODUCTS

2.01 MATERIALS

A. Framing (Steel): Schedule 40 galvanized steel pipe, welded construction, minimum yield strength of 24 ksi, coating conforming to ASTM F1234 Type A on interior and exterior of pipe.

B. Fabric Wire (Steel): ASTM A116 galvanized wire.

C. Barbed Wire: ASTM A121 galvanized steel wire, 12 gauge thick, 3 strands, 4 points at 5 inch on center.

2.02 COMPONENTS

A. Line Posts: 2.38 inch diameter.

B. Corner and Terminal Posts: 3.5 inch.

C. Gate Post: 4.5 inch diameter.

D. Top and Branch Rail: 1.66 inch diameter, plain end, sleeve couple.

E. Gate Frame: 1.66 inch diameter for fittings and truss rod fabrication.

F. Fabric: 2 inch diamond mesh interwoven wire, 9 gauge thick, top salvage knuckle end closed, bottom salvage knuckle end closed.

G. Tension Wire: 7 gauge thick steel, single strand.

H. Tie Wire: Aluminum alloy steel wire

2.03 ACCESSORIES

A. Caps: Cast steel galvanized, sized to post diameter, set screw diameter.

B. Fittings: Sleeve, bands, clips, rail ends, tension bars, fasteners, and fittings, steel.

C. Extension Arms: Cast steel galvanized to accommodate 3 strands of barb wire, single arm, sloped to 45 degrees out from electrical control slab

D. Gate Hardware: Fork latch with gravity drop of center gate stop and drop rod according to detailed width, two 180 degree gate hinges per leaf and hardware for padlock.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install framework, fabric, accessories, and gates in accordance with ASTM F567.

B. Place fabric on outside of posts and rails.

C. Set all post plumb, in concrete footings, with top of footing 2 inches above finished grade. Slope top of concrete for water runoff.

D. Line, corner, gate, and terminal post footing depth below finish grade: 40 inch minimum.

E. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.

F. Provide top rail through line post tops and splice with 6 inch long rail sleeves.

G. Install center and bottom brace rail on corner gate leaves.

H. Do not stretch fabric until concrete foundation has cured for 28 days.

I. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.

J. Position bottom of fabric 2 inches above finish grade.

K. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.

L. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

M. Install bottom tension wire stretched taut between terminal posts.

N. Install extension arms sloped outward and attach barbed wire, tension and secure.

O. Install gate with fabric and match to fence. Install three hinges per leaf, catches, drop bolt retainer and locking clamp.

P. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.

3.02 FIELD QUALITY CONTROL

A. Maximum variation from plumb: ¼ inch.

B. Maximum offset from true position: 1 inch.

C. Components shall not infringe on adjacent property lines.

END OF SECTION

SECTION 33 05 33
HDPE SITE WATER PIPING AND HYDRANTS

PART 1 GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, equipment and incidentals as show, specified, and required to furnish, test, and place in satisfactory service the High Density Polyethylene (HDPE) pipe and fittings as shown.

B. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the HDPE pipe and fittings work.

1.02 SUBMITTALS

A. Submit under provisions of Sections 01 30 00

B. Shop drawings: Submit the following
   1. Details of construction, fabrication, and pipe materials.
   2. Details of piping system including location of supports, restraints, fittings, anchors, vents, low-point drains, termination assemblies and all accessories necessary for piping system.
   3. Pipe laying schedules.
   4. Detailed procedures to be used in joining and installing piping system, including manufacturer's recommendations
   5. Installer's qualifications.
   6. Materials Certificates of Conformance: Submit certificates of conformance with Referenced Standards as required in Article 2.4, below.
   7. Pipe testing procedures.

C. Upon shipment, Contractor shall furnish the HDPE pipe manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the Project are in accordance with the requirements of this Section and a manufacturer's warranty covering materials and workmanship of the HDPE piping.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience producing substantial similar type materials and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. HDPE pipe and fittings shall be the product of a single manufacturer.
   3. The HDPE pipe and fittings manufacturer shall have an established Quality Assurance Program responsible for inspecting incoming and outgoing materials.
   4. The HDPE pipe and fittings manufacturer shall have an established Quality Assurance program responsible for assuring the long-term performance of materials and products.
   5. The HDPE pipe and fitting manufacturer shall maintain permanent Quality Assurance/Quality Control (QA/QC) records.

B. Installer's Qualifications:
   1. Engage a single installer regularly engaged in HDPE piping installation and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to Engineer.
   2. Engage a single installer for the entire HDPE piping system with undivided responsibility for performance and other requirements.

C. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single HDPE pipe and fittings manufacturer.
   2. The HDPE pipe and fittings manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.

3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the HDPE pipe and fittings manufacturer.

1.04 DELIVERY, STORAGE AND HANDLING

A. Installing contractor to store, protect and handle products on site:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
   2. Upon delivery inspect pipe and appurtenances for cracked, gouged, chipped, dented, and other damaged material and immediately remove from Site.
   3. Store materials to allow convenient access for inspection and identification. Store material off the ground using pallets, platforms, or other supports. Protect packaged materials from corrosion and deterioration.
   4. Pipe and fittings other than PVC and CPVC may be stored outdoors without cover. PVC and CPVC pipe and fittings stored outdoors shall be covered.
   5. Handle all pipe, fittings, specials and accessories carefully with approved handling devices. Do not drop or roll material off trucks. Do not otherwise drop, roll or skid piping.
   6. Avoid unnecessary handling of pipe.
   7. Keep pipe interiors free from dirt and foreign matter.
   8. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage.

PART 2 PRODUCTS

2.01 SYSTEM PERFORMANCE

A. HDPE piping system shall be specifically designed, constructed, and installed for the conveyance of water and wastewater.

2.02 PHYSICAL PROPERTIES

A. Materials used for the manufacture of polyethylene pipe and fittings shall meet the physical property requirements assigned to ASTM and PPI classifications for PE3408. 3608 or 4710, as specified for the project.

B. There shall be no evidence of splitting, cracking or breaking when the pipe is tested in accordance with Article 2.4, below.

C. Ring Stiffness Constant (RSC) values for the pipe can be directly related to the pipe's class designation. (Nominal RSC of Class 40 pipe = 40, etc.). The minimum RSC is 90 percent of the nominal.

D. The HDPE pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density and other physical properties.

E. Clean rework or recycled material generated by the manufacturer's own production may be used as long as the pipe or fittings produced meet all the requirements of this Section.

2.03 PIPE AND FITTINGS

A. Dimensions:
   1. Pipe Dimensions: The nominal inside diameter of the pipe shall be true to the specified pipe size in accordance with AWWA C901 and AWWA C906. Standard laying lengths shall be 50 feet ± 2-inches.
   2. Fitting Dimensions: Fittings such as couplings, wyes, tees, adapters, etc. for use in laying pipe shall have standard dimensions that conform to ASTM D 3261.

B. Pipe and fittings shall be produced from identical materials, meeting the requirements of this Section, by the same manufacturer. Special or custom fittings may be exempted from this requirement.

C. Pipe and fittings shall be pressure rated to meet the service pressure requirements specified by Engineer. Whether molded or fabricated, fittings shall be fully pressure rated to at least the same service pressure rating as the pipe to which joining is intended.

D. Molded fittings shall meet the requirements of ASTM D 3261 and this Section. At the point of fusion, the outside diameter and minimum wall thickness of fitting butt fusion outlets shall meet the diameter and wall thickness specifications of the mating system pipe. Fitting markings shall include a production code from which the location and date of manufacture can be determined. The manufacturer shall provide an explanation of the production codes used.

E. Reducing tees with branch diameters of 16-inches or less shall be saddle tees.

F. Marking:
   1. Each standard and random length of pipe and fitting in compliance with this standard shall be clearly marked with the following information.
      a. ASTM or AWWA Standard Designation.
      b. Pipe Size.
      c. Class and Profile Number.
      d. Production Code.
      e. Standard Dimension Ratio (SDR).

2.04 SOURCE QUALITY CONTROL

A. At a minimum, incoming polyethylene materials shall be inspected for density in accordance with ASTM D 1505 and melt flow rate in accordance with ASTM D 1238. All incoming polyethylene materials shall be certified by the supplier. Certification shall be verified by Contractor and Engineer. Incoming materials shall be approved by Manufacturer's Quality Assurance Program before processing into finished goods.

B. Representative samples of polyethylene materials shall be tested against the physical property requirements required herein. Each extrusion line and molding machine shall be qualified to produce pressure rated products by taking representative production samples and performing sustained pressure tests in accordance with ASTM D 1598.

C. Quality Assurance test for representative pipe and fitting samples shall include:

Test	Standard	Pipe	Fittings
Ring ESCR	ASTM F 1248	Yes	Not Applicable
Sustained pressure at 176°F/725 psi hoop stress:			
(fo>1000 h)	ASTM D 1598	Yes	Yes
Sustained pressure at 73°F/1,600 psi hoop stress:			
(fo>1000 h)	ASTM D 1598	Yes	Yes

D. The HDPE pipe and fitting manufacturer shall certify that samples of their production pipe have undergone stress regression testing, evaluation, and validation in accordance with ASTM D 2837 and PPI TR-3.

E. Material shall be listed in the name of the HDPE pipe and fitting manufacturer as required by the Plastics Pipe Institute (PPI) in PPI TR-4.
   1. PPI material listing in the name of the resin supplier is not acceptable in meeting this requirement.

F. Inspection Requirements:
   1. Notification: The HDPE pipe and fitting manufacturer shall notify Contractor in advance of the date, time, and place of testing of the pipe in order that Contractor may be represented at the test.
   2. Access: The Owner's representative shall have free access to the Inspection area of the manufacturer's plant. The manufacturer shall make available to the Owner’s representative, without charge, all reasonable facilities for determining whether the pipe meets the requirements of this Section.
   3. All outgoing materials shall be inspected for diameter, wall thickness, length, straightness, out-of-roundness, concentricity, toe-in, inside and outside surface finish, markings, and end cut. Manufacturer's Quality Control Program shall perform tests of density; melt flow

rate, carbon content, and carbon dispersion. In addition, samples of the pipe provided shall be tested for hoop tensile strength and ductility by either quick burst in accordance with ASTM D 1599 or ring tensile strength in accordance with ASTM D 2290. Molded fittings shall be subject to x-ray inspection for voids, and tests for knit line strength. All fabricated fittings shall be inspected for fusion quality and alignment.

G. Physical Test Requirements:
   1. Sampling: The selection of the sample of pipe shall be as agreed upon by the Engineer, Contractor and the manufacturer. In case of no prior agreement, any sample selected by the manufacturer shall be deemed adequate.
   2. Sample size for flattening test will be one sample for each size and class of pipe for the Project.
   3. Conditioning: Conditioning of samples prior to and during test shall be as agreed upon by the Engineer, Contractor and manufacturer. In case of no prior agreement, the conditioning procedure used by the manufacturer shall be deemed adequate.

H. Test Methods
   1. Flattening: Three specimens of pipe, a minimum of 12-inches long, shall be flattened between parallel plates in a suitable press until the distance between the plates is 40 percent of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is completed within two to five minutes. Remove the load, and examine the specimens for splitting cracking or breaking.
   2. Pipe Ring Stiffness Constant: The pipe ring stiffness constant shall be determined utilizing procedures similar to those outlined in ASTM D 2412. The stiffness of HDPE pipe is defined in terms of the load, applied between parallel plates, which causes one percent reduction of pipe diameter. Test specimens shall be a minimum of two pipe diameters or four feet in length, whichever is less.

2.05 YARD HYDRANTS

A. Size: 1.5"

B. Manufacturer:
   1. Woodford Model U150W

C. Pressure Rating: 125 psi

D. Bury Depth: 4.5'

2.06 SERVICE TAPS

A. Corporation Stops:
   1. Material: Brass or bronze.
   2. Reference Standard: AWWA C800.
   3. Thread inlet: Tapered (CC) Type for 3/4" or IP for greater than 1".
   4. Thread outlet: Copper Service Thread for flared connection or compression connection if local jurisdiction permits.
   5. Manufacturers - flared connection:
      a. Mueller; H-15000N: www.muellercompany.com/#sle.
      b. Ford Meter Box; F600: www.fordmeterbox.com/#sle.
   6. Manufacturers - compression connection:
      a. Mueller; B-25008N: www.muellercompany.com/#sle.

B. Service Clamps:
   1. For use with HDPE:
      a. Materials: Nylon coated ductile iron saddle wih stainless steel straps.
      b. Double strap.
      c. Pressure rating: 150 psi
      d. Manufacturers:
         1) ROMAC Model 202N-H or approved equal

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Pipe may be rejected for failure to conform to these Specifications or following:
   1. Fractures or cracks passing through pipe wall, except single crack not exceeding 2-inches in length at either end of pipe which could be cut off and discarded. Pipes within one shipment shall be rejected if defects exist in more than five percent of shipment or delivery.
   2. Cracks sufficient to impair strength, durability or serviceability of pipe.
   3. Defects indicating improper proportioning, mixing, and molding.
   4. Damaged ends, where such damage prevents making satisfactory joint.
   5. Gouges or scrapes exceeding ten percent of the specified wall thickness.

B. Acceptance of fittings, stubs or other specifically fabricated pipe sections shall be based on visual inspection at Site and documentation of conformance to these Specifications.

C. Contractor to provide as-built of pipe end point and angle point coordinates and elevations prior to backfilling trench, or as otherwise required by the contract documents.

3.02 INSTALLATION

A. General:
   1. Install piping as shown, specified, and as recommended by pipe and fittings manufacturer.
   2. If there is a conflict between manufacturer's recommendations and Contract Documents, request instructions from Engineer before proceeding.
   3. Engineer shall inspect excavations and bedding prior to laying pipe. Notify Engineer in advance of excavating, bedding, pipe laying and backfilling operations.
   4. Minimum cover over buried piping shall be 2 feet, unless otherwise shown or approved by Engineer.

B. Plugs:
   1. Temporarily plug installed pipe at the end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
   2. Install standard plugs in all bells at dead ends, tees, and crosses. Cap all spigot and plain ends.
   3. Fully secure and block plugs, caps, and bulkheads installed for testing to withstand specified test pressure.
   4. Where plugging is required for phasing of the Work or subsequent connection of piping, install watertight, permanent type plugs, caps, or bulkhead acceptable to Engineer.

C. Bedding Pipe: Bed pipe as specified and in accordance with details on Drawings.
   1. Trench excavation and backfill, and bedding materials shall conform to Division 31, as applicable.

D. Laying Pipe
   1. Conform to manufacturer's instructions and requirements of standards and manuals listed below, as applicable:
      a. Thermoplastic Pipe: ASTM D2321, ASTM D2774, ANSI/AWWA C605, AWWA M23, AWWA M45, AWWA, M55.
   2. Install pipe accurately to line and grade shown, unless otherwise approved by Engineer. Remove and reinstall pipes that are not installed correctly.
   3. Slope piping uniformly between elevations shown.
   4. Keep groundwater level in trench at least 4 inches below bottom of pipe before laying pipe. Do not lay pipe in water. Maintain dry trench conditions until jointing and backfilling are complete. Keep clean and protect interiors of pipe, fittings, valves, and appurtenances.
   5. Start laying pipe at lowest point and proceed towards higher elevations, unless otherwise approved by Engineer.

6. Place bell and spigot-type pipe so that bells face the direction of laying, unless otherwise approved by Engineer.
7. Place concrete pipe containing elliptical reinforcement with minor axis of reinforcement in a vertical position.
8. Excavate around joints in bedding and lay pipe so that pipe barrel bears uniformly on trench bottom
9. Deflections at joints shall not exceed 75 percent of amount allowed by pipe manufacturer, unless otherwise approved by the Engineer.
10. For PVC and CPVC piping with solvent welded joints, 2.5-nch diameter and smaller, and copper tubing, snake piping in trench to compensate for thermal expansion and contraction.
11. Carefully examine pipe, fittings, valves, and specials for cracks, damage, and other defects while suspended above the trench before installation. Immediately remove defective materials from the Site.
12. Inspect interior of all pipe, fittings, valves, and specials and completely remove all dirt, gravel, sand, debris, and other foreign material from pipe interior and joint recesses before pipe and appurtenances are moved into excavation. Bell and spigot-type mating surfaces shall be thoroughly wire brushed, and wiped clean and dry immediately before pipe is laid.
13. Field cut pipe, where required, with a machine specially designed for cutting the type of pipe being installed. Make cuts carefully, without damage to pipe, coating or lining, and with a smooth end at right angles to the axis of pipe. Cut ends on push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.
14. Do not place blocking under pipe, unless specifically approved by Engineer for special conditions.
15. Touch up protective coatings in a manner satisfactory to Engineer prior to backfilling.
16. Notify Engineer in advance of backfilling operations.
17. On steep slopes, take measures acceptable to Engineer to prevent movement of pipe during installation.
18. Exercise care to avoid flotation when installing pipe in cast in-place concrete, and in locations with high groundwater.

E. Jointing Pipe
1. HDPE Pipe Joints, Butt Fusion Welded Joints:
   a. HDPE pipe and fittings joints shall be heat fused by a qualified technician; trained by the manufacturer’s representative in accordance with the manufacturer’s recommended fusion procedures. Training must have occurred within the previous 12 months, or submittals verifying experience within the previous 12 months for all technicians performing heat fusion on polyethylene pipe and fittings.
   b. Weld in accordance with manufacturer's recommendation for butt fusion methods. Personnel operating fusion equipment shall be certified by the HDPE pipe manufacturer.
   c. The first butt fusion weld of each day’s production welding and for each separate operator shall be tested by bent strap test method. No production welds shall be performed until successful completion of bent strap test.
      Butt fusion equipment for joining procedures shall be capable of meeting conditions recommended by HDPE pipe manufacturer including, but not limited to, temperature requirements, alignment, and fusion pressures. The equipment used for the heat fusion joints shall be capable of recording the heating and fusion pressures used to join the HDPE pipe, recording heater temperature, and storing this information for future retrieval (data logger). Each field fusion shall be recorded by such equipment and this information shall be made compiled into daily log reports. Log reports shall be submitted to Contractor and Engineer daily. Reports shall also include the results of the bent strap tests.
   d. Do not bend pipe to greater degree than minimum radius recommended by manufacturer for type and grade. Shop Drawings shall address locations and

deflections of required fittings to prevent installation that exceeds a greater degree of bending than the manufacturer's recommended minimum bending radius for each size and class of HDPE pipe.

e. Do not subject pipe to strains that will overstress or buckle piping or impose excessive stress on joints.
f. Branch saddle fusions shall be joined in accordance with manufacturer's recommendations and procedures. Branch saddle fusion equipment shall be of size to facilitate saddle fusion within trench.
g. Before butt fusing pipe, inspect each length for presence of dirt, sand, mud, shavings, and other debris or animals. Remove debris from pipe.
h. Cover open ends of fused pipe at the end of each day's Work. Cap to prevent entry by animals or debris.
i. Install joints per manufacturer's instructions using a hydraulic butt fusion machine or manual machine equipped with torque wrench. Equipment shall be able to achieve and maintain a heating tool temperature range of 400 to 450 degrees F and an interface pressure of 60 to 90 psi.
j. Clean interior and exterior of pipe and fitting ends with clean, dry, lint-free cloth.
k. Align ends to be joined in the fusion machine without forcing ends into alignment. Adjust alignment as necessary and tighten clamps to prevent slippage.
l. Place facing tool between ends to be joined and face them to provide a clean, smooth, parallel mating surface. If stops are present, face ends down to the stops. Remove all shavings after facing without touching ends.
m. Re-check alignment of ends and check for slippage against the fusion pressure. There shall be no detectable gaps between ends. Align outside diameters.
n. Heating tool shall maintain the manufacture's recommended temperature range. Place the tool between ends to be joined. Move ends against heating tool to achieve full contact. Hold ends against heating tool without force until the following melt bead size is formed:

Pipe Diameter (inches)	Required Melt Bead Size (inches)
2 to 4	1/8 to 3/16
4 to 12	3/16 to 1/4
12 to 24	1/4 to 7/16
24 to 54	7/16 to 9/16

o. Upon forming proper melt bead size, quickly separate ends and remove heating tool. Quickly inspect melted ends and bring ends together applying joining force recommended by manufacturer, using 60 to 90 psi interfacial pressure to form a double bead rolled over surface of pipe on both ends.

F. Upon completing the joint, inspect to verify a double bead has been formed on both sides, uniformly rounded and consistent in size all around joint. Remove faulty joints and re-joint.

G. Backfilling
1. Conform to applicable requirements of Division 2.
2. Place backfill as Work progresses. Backfill by hand and use power tampers until pipe is covered by at least one foot of backfill.

H. Pipe Placement
1. Grade control equipment shall be of type to accurately maintain design grades and slopes during installation of pipe.
2. Dewatering: Remove standing water in trench before pipe installation.
3. Unless otherwise specifically stated, install pipe in accordance with manufacturer's recommendations.
4. Maximum lengths of fused pipe to be handled as one section shall be placed according to manufacturer's recommendations as to pipe size, pipe SDR, and topography so as not to cause excessive gouging or surface abrasion, but shall not exceed 400 feet.

5. Cap pipe sections longer than single joining (usually 50 feet) on both ends during placement, except during fusing operations.
6. Notify Engineer prior to installing pipe into trench and allow time for Engineer's inspection.
   a. Correct irregularities found during inspection.
7. Complete tie-ins within trench whenever possible to prevent overstressed connections.
8. Allow pipe sufficient time to adjust to trench temperature prior to testing, segment tie-ins or backfilling activity.
9. Install reducers adjacent to laterals and tees.
10. To reduce branch saddle stress, install saddles at slope equal to and continuous with lateral piping.
11. Pipe shall be snaked in trench to allow a minimum of 12-inches/100 feet for thermal contraction and expansion.
12. Allow extra length at future connection points to be cut to fit after backfill and prior to tie-in.

3.03 TRACER WIRE AND MARKING TAPE

A. Tracer Wire
   1. Tracing wire is required on all water mains and services.
   2. Tape electrical tracing wire to the top of the pipe at 5-foot intervals to prevent dislocation of the wire during backfilling.
   3. Extend wire to ground surface at all valves, fire hydrants, and other locations shown on drawings.
   4. Bring the tracing wire up on the outside of the valve box.
   5. When the wire is within 4" of the top of the lid, bring the wire back inside the box and securely fasten.
   6. Provide sufficient slack in the wire outside of the box to compensate for any future adjustment to the valve box.

B. Marking Tape
   1. Magnetic marking tape is required for all pipe.
   2. Place magnetic marking tape in the backfill 2 feet above the top of the pipe
   3. Provide magnetic marking tape width shall be 3/4 of pipe diameter.

C. Magnetic tape is required for all pipe and shall be 2 feet above the top of pipe.

3.04 DISINFECTION OF POTABLE WATERLINES

A. General:
   1. Flush and disinfect potable waterlines in accordance with the procedure set forth in AWWA C651, Disinfecting Water Mains.
   2. Provide all temporary blow-offs, pumps, chlorination equipment, chlorine and all other necessary apparatus required.

B. Pipe Cleaning:
   1. If the pipe contains dirt or heavy encrusted matter that, in the opinion of the Engineer, will not be removed during the flushing operation, clean and swab the interior of the pipe with a five percent (50,000 ppm) chlorine solution.

C. Preliminary Flushing:
   1. Flush pipeline prior to disinfection, except when the tablet method is used, to remove all remaining foreign material.
   2. The flushing operation shall develop a minimum velocity of 2.5 ft./sec.

D. Chlorine Application:
   1. Apply chlorine using the continuous feed method.
   2. On large diameter lines where this would not be practical, the slug method may be used.
   3. The tablet method may be used on short extensions (up to 2,500 feet) of small diameter mains (12" and smaller).
   4. Continuous Feed Method:

a. Introduce water into the line at a constant rate while adding chlorine at a minimum concentration of 25 mg/l.
b. Maintain the chlorinated water in the pipeline for a minimum of 24 hours after which period the treated water shall contain no less than 10 mg/l of chlorine throughout the entire length.

5. Slug Method:
   a. Introduce water with a minimum chlorine concentration of 100 mg/l at a constant measured rate into the pipeline.
   b. Apply column or slug of chlorinated water that will, as it passes along the line, expose all interior surfaces for a period of three hours.
   c. Check the application at the upstream end of the line.
6. Tablet Method:
   a. Do not use this method if trench water or foreign material has entered the line or if the water is below 5ºC (41ºF).
   b. Because preliminary flushing cannot be used, only use this method when scrupulous cleanliness has been exercised.
   c. Place tablets in each section of pipe in sufficient number to produce a dose of 25 mg/l initial residual with a 0.2 mg/l residual after 24 hours.
   d. Refer to Table 2 of AWWA C651, latest edition, for the required minimum number of tablets.
   e. All tablets within the main must be attached at the top of the pipe.
   f. Introduce water into the pipeline at a rate no greater than 1 ft./sec. and retain the water in the pipeline for a period of 24 hours after which period the treated water shall show detectable chlorine residual at each sampling point.

E. Final Flushing:
1. After the applicable retention period, heavy chlorinated water should not remain in prolonged contact with pipe.
2. Prevent damage to the pipe lining or to prevent corrosion damage to the pipe itself by flushing the heavily chlorinated water from the main fittings, valves, and branches until chlorine measurements show that the concentration in the water leaving the main is no higher than prevailing concentrations in the distribution system or which is acceptable for domestic use.
3. Inspect the environment to which the chlorinated water is to be discharged prior to discharge.
4. If there is any possibility that the chlorinated discharge will cause damage to the environment, then apply a neutralizing chemical to the discharge water to neutralize the residual chlorine.

F. Bacteriologic Tests, Standard Conditions:
1. After final flushing and before the new water main is connected to the distribution system, collect two consecutive sets of acceptable samples, taken at least 24 hours apart, from the new main.
2. Collect at least one set of samples from every 1,200 feet of the new water main, plus one set from the end of the line and at least one set from each branch.
3. A minimum of two sampling points is required for any segment over 500 feet in length.
4. Test all samples for bacteriological (chemical and physical) quality in accordance with Standard Methods for the Examination of Water and Wastewater and show absence of coliform organisms.
5. Collect samples in sterile bottles from sampling points furnished and installed by the Contractor in the main.

G. Final Connections to Existing Mains:
1. When connections to existing mains are made without a new valve at the connection point, install, flush, disinfect, and pass bacteriological sampling for the water main and appurtenances prior to permanent connections being made to the active, existing system.

2. Disinfect final connections or those portions of the new system installed that have not been disinfected as part of a previous disinfection procedure in accordance with Section 4.10 of AWWA C651.

3.05 LEAKAGE TESTS

A. General:
   1. Test all piping.
   2. When authorities having jurisdiction are to witness tests, notify Engineer and authorities having jurisdiction in writing at least 48 hours in advance of testing.
   3. Conduct all tests in presence of Engineer.
   4. Remove or protect pipeline-mounted devices that could be damaged by the testing.
   5. Provide all apparatus and services required for testing, including:
      a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain Owner's operations.
      b. Temporary bulkheads, bracing, blocking, and thrust restraints.
   6. Provide air if an air test is required, power if pumping is required, and gases if gases are required.
   7. Owner will provide water required for hydrostatic testing. Contractor shall provide means to convey water for hydrostatic testing into the pipe being tested.
   8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.

B. Hydrostatic Testing:
   1. Preparation for Testing:
      a. For HDPE pipe, follow procedures described in ASTM F2164. Test duration, including time to pressurize, time for initial expansion, time at test pressure, and time to depressurize, shall not exceed eight hours. If re-testing of a test section or pipeline is required, at least eight hours shall elapse between tests.
      b. Prior to testing, ensure that adequate thrust protection is in place and all joints are properly installed.
   2. Test Procedure:
      a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in the pipe being tested.
      b. Expel air from pipe as required. Obtain approval of Engineer prior to tapping pipe for expelling air.
      c. Examine exposed joints and valves, and make repairs to eliminate visible leakage.
      d. After the specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
      e. HDPE Pipe: After filling pipeline, gradually pressurize pipe to test pressure and maintain required test pressure for three hours for pipe to expand. During expansion, add fluid to maintain required test pressure. Begin timed test period after expansion period and other requirements are met.
   3. Timed test period shall not begin until after the pipe has been filled, exposed to the required wetting period, air has been expelled, and pressure stabilized.
      a. Timed Test Period: After the stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. For HDPE pipe, after three hour expansion phase, reduce test pressure by ten psig and do not add liquid. The test pressure shall then remain steady for one hour, indicating no leakage.
      b. Pump from a test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at the test pump at 15 minute intervals for duration of test.

4. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to the pipe segment being tested to maintain pressure within five psi of the test pressure during the timed test period. Allowable leakage rates for piping are:
   a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.

END OF SECTION

SECTION 33 31 00
SLUDGE AND DRAIN PIPE

PART 1 GENERAL

1.01 SUMMARY

A. Work under this section shall include furnishing all materials, labor and tools necessary to perform all installation, cleaning and testing of all sanitary sewerlines and appurtenances as specified herein and shown on the Drawings.

1.02 SUBMITTALS

A. Product data including catalog sheets and descriptive literature shall be submitted for all materials and equipment specified. Submittals shall state manufacturer's compliance with all published standards referenced herein.

1.03 PROTECTION OF WORK

A. All pipe, fittings and equipment shall be carefully handled, stored and protected in such a manner as to prevent damage to materials. At no time shall such materials be dropped or dumped into trench.

B. Precaution shall be taken to prevent foreign matter from entering the pipe and fittings prior to and during installation. Place no debris, tools, clothing or other materials in the pipe during installation.

C. At such time as pipe installation is suspended, either temporarily or overnight, the open end of the pipe shall be sealed with a watertight plug to prevent entrance of trench water, debris or foreign matter. A mechanical-type fitting shall be used for this seal. At no time shall duct tape or any other tape be used for this seal.

D. Under no circumstances shall trench water be allowed to enter the pipeline. When water is present in the trench, the seal shall remain in place until such time the trench is pumped dry. Whenever trench water becomes evident, adequate measures shall be taken to prevent pipe flotation. Contractor shall bear all costs associated with keeping trench free of liquids.

E. If, in the opinion of the Engineer, the Contractor is incapable of keeping the pipe free of foreign matter during installation, the Engineer shall require the Contractor to cover the pipe ends with close woven bags until the start of the jointing operation.

PART 2 PRODUCTS

2.01 DUCTILE FITTINGS

A. Fittings
   1. Type - All fittings shall be mechanical joint, except where specifically shown or detailed otherwise.
   2. Reference Standard - ANSI/AWWA C153, latest edition, for mechanical "compact" joints.
   3. Material - Ductile iron, DIP fittings, sleeves and valves shall be polyethylene encased.
   4. Pressure Rating - 350 psi.

B. Protective Coating
   1. Polyethylene Film Envelope - Polyethylene encasement shall conform to AWWA C105, latest edition, or ANSI A.21.5. Film shall be Class C with a nominal thickness of 8 mils. Tape for securing the film shall have a minimum thickness of 8 mils and a minimum width of 2 inches. The polyethylene film shall be free of streaks, pinholes, tears or blisters.

C. Protective Lining
   1. Type – “Epoxy lined”
      a. Reference Standard - ANSI A 21.4/AWWA C104, latest edition.
      b. Thickness – Standard.

2.02 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS (GRAVITY MAIN)

A. PVC Pipe, through 15" diameter.

1. Material Reference Standard - ASTM D1784.
2. Pipe Reference Standard - ASTM D3034.
3. Class - SDR35.
4. Markings - Manufacturer's name, nominal size, PVC classification, Type PSM, SDR-35, PVC gravity sewer pipe, ASTM D3034 and code number, green coloring dyed into PVC.

B. PVC Pipe, 18" to 48" diameter.
1. Material Reference Standard - ASTM D1784.
2. Pipe Reference Standard - ASTM F679
3. Markings - Manufacturer's name, nominal size, PVC cell classification, PS 46 PVC Sewer Pipe and ASTM F679. Green coloring dyed into PVC.
4. Variance - PVC piping meeting the stiffness requirement of ASTM F679, but not meeting wall thickness requirement will be allowed under this specification. Manufacturers will be required to provide a list of at least five (5) similar projects with references in which pipe has been successfully used and laboratory testing data showing the pipe meets the structural requirements of ASTM F679.

C. Fittings
1. Type - PVC push-joint.
2. Materials - ASTM D1784.
3. Reference Standard - ASTM D3034 or ASTM F679.

D. Joints
1. Type - push-on rubber gasket.
2. Gasket reference standard - ASTM F477

E. Restraint-type Glands

2.03 FORCE MAIN

A. PVC Pipe
1. Materials - ASTM D 1784, Type 1, Grade 1, PVC 1120
2. Reference Standard - AWWA C900.
3. Thickness: (DR18).
4. Markings - Manufacturer's name, nominal size, AWWA pressure rating
5. Size - Shall conform to outside diameter of DIP.

B. Fittings
1. DIP Restrained mechanical joints except where specifically shown or detailed otherwise.
2. Reference Standard - AWWA/ANSI C153/A 21.53.
3. Pressure Rating - 250 psi.
4. Gasket Reference Standard - AWWA C-111.

2.04 CONCRETE FOR THRUST BLOCKS AND ENCASING OF PIPE

A. Concrete for thrust blocks and for encasing the sewer pipeline shall have 28 day compressive strength of not less than 3000 psi.

2.05 MANHOLES

A. Concrete Rings/Cones
1. Type – Precast.
2. Reference Standard - ASTM C478.
3. Size - Five-foot inside diameter

B. Manhole Bases
1. Shall be precast or cast-in-place, depending upon local jurisdiction standards with integrally cast-in water stops. Tee tops of base shall be at least 12 inches above top of pipe.
2. Reference Concrete Standard - ASTM C150 Type II modified or Type V.

C. Manhole Steps

1. Manhole steps shall conform to ASTM C-478-94 and shall be steel reinforced copolymer polypropylene with materials conforming to the following:
   a. The deformed steel reinforcing bar shall be □" conforming to ASTM A-615 Grade 60.
   b. The copolymer polypropylene shall conform to ASTM D4101-92b PP0344B33534Z02.
   c. Manufacturer's Reference: M.A. Industries Model PS2-PFDF, or approved equal.

D. Joints
   1. Type - Rub'r Nek preformed gasket as manufactured by K.T. Snyder Co., Inc., Houston, Texas or equal.
   2. Cement Mortar Material Reference Standard - One part Portland Cement, Type II, modified with three parts of sand. Cement mortar to be used with concrete grade rings only.

E. Grade Adjustment Rings
   1. Type - Precast ASTM C150 Type II modified concrete.
   2. Size - Not less than 6" wide x heights to allow for two-inch adjustments.
   3. Alternate - HDPE grade rings.
   4. Manufacturer's reference: Ludtech, Inc., or approved equal.

F. Frame and Cover
   1. Material Reference - Grey Iron, ASTM A48-83, Class 35B.
   2. Cover - Stamped with "SEWER", machined bearing surface with ring.
   3. Type - Heavy, weight of cover greater than 140 pounds.
   4. Manufacturer Reference - Castings MH-400-24CI.

2.06 PLUG VALVE

A. See Section 40 05 62

2.07 VALVE BOXES

A. Screw Type – Three Piece
   1. Material - Cast Iron.
   2. Size - 5 1/4 inch diameter.
   3. Type - Three piece adjustable screw type.
   4. Cover - Deep socket type with the work "water" cast in the top.
   5. Base - #160 type with 20.5" bottom opening.

2.08 TRACER WIRE

A. 10 gauge insulated, solid copper. All splices to be watertight, underground type, (Tracer wire is required for all pipes).

2.09 MAGNETIC TAPE

A. Detectable marking tape shall consist of a minimum of 5 mil (0.0005") overall thickness; five-ply composition; ultra-high molecular weight' 100% virgin polyethylene; acid alkaline and corrosion resistant.

B. Elongation properties shall be in accordance with ASTM D882-80A and shall be less than 150% at break. The tape shall have a 20 gauge (0.0020") solid aluminum foil core, encapsulated within 2.55 mil (0.00255") polyethylene backing.

C. Tape color and legend combination shall be in accordance with APWA or local requirements. The color shall be blue. The legend shall read "CAUTION - SEWERLINE BELOW".
   1. The tape tensile strength shall be in accordance with ASTM D882-80A and be not less than 7800 psi.
   2. Tape width shall be 3/4 of the diameter of the pipeline being protected

a. Tape Width	2"	3"	6"	12" or wider
b. Tape Bury Depth	6"- 18"	6"- 28"	6"- 36"	6"- 36"

   3. The tape shall be as manufactured by T. Christy Enterprises, or equal.

4. Magnetic tape is required for all pipe and shall be 2 feet above the top of pipe.

PART 3 EXECUTION

3.01 CLEANING AND INSPECTION

A. Clean all pipe, fittings and related materials thoroughly of all foreign material and inspect for cracks, flaws or other defects prior to installation. Mark all defective, damaged or unsound materials with bright marking crayon or paint and remove from job site.

B. The Contractor shall take all necessary precautions to prevent any construction debris from entering the sewerlines during construction. If this debris should enter the pipeline system, the Contractor shall furnish all labor and materials necessary to clean the system. Under no circumstances will the Contractor flush the debris into an existing sanitary sewer system.

3.02 PLACEMENT OF PIPE

A. All gravity pipe must be installed with a laser. If bending of the beam due to air temperature variations becomes apparent with "in pipe" units, a fan shall be provided to circulate air in the pipe. Air velocity shall not be so excessive as to cause pulsating or vibrating of the beam. If, in the opinion of the Engineer, the beam cannot be accurately controlled, this method of setting line and grade shall be abandoned.

3.03 PIPE EMBEDMENT

A. Placing embedment material - Refer to Section 31 23 33 for placement methods.

B. Embedment Classes - Refer to Section 31 23 33 and Construction Drawings for embedment materials for each class listed below:
   1. Pipe shall be embedded according to applicable details on the Construction Drawings.

3.04 PIPE INSTALLATION

A. Installation of PVC Pipe.
   1. Pipe Handling. Pipe should be carefully lowered into the trench to avoid pipe falling into trench
   2. Pipe Laying. Pipe shall be laid true to line and grade, in an uphill direction, with bell ends facing in the direction of laying. When pipe laying is not in progress, the open end of the pipe shall be closed by a watertight plug.
   3. Jointing the Pipe. The outside of the spigot and the inside of the bell shall be thoroughly wiped clean. Set the rubber ring in the bell with the marked edge facing toward the end of the bell. Lubricate the spigot end using a thin film of the manufacturer-supplied lubricant. Push the pipe spigot into the bell. Position the completed joint so that the mark on the pipe end is in line with the end of the bell.
   4. Pipe Cutting. The cutting of pipe for manholes or for fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or lining and so as to leave a smooth end at right angles to the axis of the pipe. Bevel the end of the pipe with a beveling tool after the pipe is field cut. Place a clearly visible position mark at the correct distance from the end of the field-cut pipe.

3.05 SEWER MANHOLE INSTALLATION

A. General. Manholes shall be furnished and installed to depths and dimensions shown on the Construction Drawings and/or staked in the field. Manholes shall be constructed of precast concrete rings in accordance with details shown on the Construction Drawings.

B. Connections to Manholes. Connection of manhole with pipe shall be made with flexible connector detail. See details on Construction Drawings. In addition, extra care shall be taken by grouting or other means of sealing to assure positive watertight manholes around the inlet or outlet pipes.

C. Manhole Floor and Inverts. Manhole bases shall be constructed to conform to the details shown on the Drawings. The invert channels shall be smooth and semi-circular in shape, conforming to the inside of the incoming and outgoing sewer pipelines. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit.

Changes in size and grade of the channels shall be made gradually and evenly. Where large differences in invert elevations exist, sloped flow channels shall be formed so the wastewater does not undergo a vertical drop. The invert channels may be formed directly in the concrete of the manhole base. The floor of the manhole outside the channel shall be smooth and shall slope toward the channels.

D. Finish Grade and Adjustment. To bring the manhole cover to the correct elevation, the top section of each manhole shall be constructed of pre-cast concrete grade adjustment rings. These rings shall be not less than six inches (6") wide and furnished in heights to allow for two-inch (2") adjustments. Grade adjustment with rings shall be eight inches (8") maximum and two inches (2") minimum. All rings shall be grouted in place.

1. Finish Grade and Adjustment HDPE Alternate. High-density polyethylene grade rings may also be used to bring manhole cover to correct elevation. Grade rings shall be molded from HDPE as defined in ASTM Specification D1248-84. Available thicknesses are 1.25", 1.50", 2.00" 4.00" and a sloped thickness .75" x 1.50". When this alternate is used, pavement slope should be matched using one or more sloped rings. Manufacturer's reference - Ludtech, Inc., or approved equal.

E. Manhole Stubs. All pipe stubs required from manholes are shown on the Drawings. Stubs shall extend approximately 24" from the outside face of the manhole and shall be capped or plugged with manufactured fittings to form a watertight installation.

3.06 CONNECTION TO EXISTING SEWER FACILITIES

A. Connections to existing gravity facilities where live flows exist shall be made only after prior consultation with and receipt of written permission from the Engineer. No bypass of flows to the surface will be allowed in the completion of this connection. Connections shall be made as shown on the Drawings. All connections between pipes of different materials shall be made with approved manufactured connectors.

3.07 LEAKAGE TEST

A. Sewerlines shall be tested using a low-pressure air test only; water tests will not be allowed. Only after the sanitary sewers, including appurtenances and sanitary laterals have been installed, backfilled and cleaned, shall the Contractor proceed with an air test on the installed facilities.

1. Low Pressure Air Test Procedure. The section of sewer line to be tested should be flushed and cleaned prior to conducting the low-pressure air test. This serves to clean out any debris, wet the pipe, and produce more consistent results. Isolate the section of sewer line to be tested by means of inflatable stoppers or other suitable test plugs. One of the plugs should have an inlet tap, or other provision for connecting a hose to a portable air control source.
2. If the test section is below the groundwater level, determine the height of the ground water above the spring line of the pipe at each end of the test section and compute the average. For every foot of groundwater above the pipe spring line, increase the gauge test pressure by 0.43 pounds per square inch. Connect the air hose to the inlet tap and a portable air control source. The air equipment should consist of necessary valves and pressure gauges to control the rate at which air flows into the test section and to enable monitoring of the air pressure within the test section. Also, the testing apparatus should be equipped with a pressure relief device to avoid the possibility of loading the test section with the full capacity of the compressor. Locate valves and gauges above ground.
3. Add air slowly to the test section until the pressure inside the pipe is raised to 5.0 psig greater than the average backpressure of any groundwater that may be over the pipe. After a pressure of 5.0 psig is obtained, regulate the air supply so that the pressure is maintained between 4.5 and 5.0 psig (above the average ground water back pressure) for a period of two minutes. This allows the air temperature to stabilize in equilibrium with the temperature of the pipe walls. The pressure will normally drop slightly until temperature equilibrium is obtained.

4. Determine the rate of air loss by the time/pressure drop method. After the two-minute air stabilization period, the air supply is disconnected and the test pressure allowed to decrease to 4.5 psig. The time required for the test pressure to drop from 4.5 psig to 4.0 psig is determined by means of a stopwatch and this time interval is then compared to the required time in the attached table to determine if the rate of air loss is within the allowable time limit. If the time is equal to or greater than the times indicated in the tables, the pipeline shall be deemed acceptable.

Nominal Pipe Size (Inches)	Minimum Test Time (min/100 feet)
3	0.2
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18/	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0

5. Upon completion of the test, open the bleeder valve to allow air to escape. Plugs should not be removed until all air pressure in the test section has been released. During this time, no one should be allowed in the trench or manhole while the pipe is being decompressed. Air test shall also include service lines and appurtenances.

3.08 MANHOLE INSPECTION

A. During the construction of the manholes, the Contractor shall, in accordance with good practice, ensure that no earth, sand, rocks or other foreign material exists on the joint surfaces during assembly of the section. The Engineer shall check each manhole to determine whether the manhole fulfills the requirements of the Drawings and Specifications.

1. Visual Examination. The Engineer shall visually check each manhole, both exterior and interior, for flaws, cracks, holes, or other inadequacies which might affect the operation or watertight integrity of the manhole. Should any inadequacies be found, the Contractor, at his own expense, shall make any repairs deemed necessary by the Engineer
2. Leakage Test. All manholes shall be tested for leakage and all tests shall be witnessed by the Engineer. The leakage test shall be conducted prior to backfilling around the manhole and shall be carried out in the following manner:
   a. Stubouts, manhole boots and pipe plugs shall be secured to prevent movement while the vacuum is drawn.
   b. Installation and operation of vacuum equipment and indicating devices shall be in accordance with equipment specifications for which performance information has been provided by the manufacturer and approved by the Engineer.
   c. A measured vacuum of 10" of mercury shall be established in the manhole. The time for the vacuum to drop to 9" of mercury shall be recorded.
   d. Acceptance standards for leakage shall be established from the elapsed time for a negative pressure change from 10" to 9" of mercury. The maximum allowable leakage rate for a 4' diameter manhole shall be in accordance with the following:

Manhole Depth	Minimum Elapsed Time for a Pressure Change of 1 inch Hg

10 ft. or less	60 seconds
> 10 ft but < 15 ft	75 seconds
> 15 ft but < 25 ft	90 seconds

e. If the manhole fails the test, necessary repairs shall be made and the vacuum test and repairs shall be repeated until the manhole passes the test or the manhole shall be tested in accordance with the standard exfiltration test and rated accordingly.

f. If a manhole joint mastic is completely pulled out during the vacuum test, the manhole shall be disassembled and the mastic replaced.

END OF SECTION

SECTION 40 05 07
PIPE SUPPORTS AND HANGERS

PART 1 GENERAL

1.01 SUMMARY

A. Work under this Section includes furnishing and installing pipe supports and hangers types shown and indicated on the Drawings and as specified herein.

1.02 REFERENCES

A. Standards listed hereunder and referenced elsewhere in these Specifications shall become part of this Specification and are incorporated herein by reference. The latest edition, amendment or supplement thereto in effect 30 days before date of invitation shall apply.

B. Manufacturer's Standardization Society (SP-69-2003) – ANSI/MSS Edition Pipe Hangers and Supports-Selection and Application.

1.03 SYSTEM DESCRIPTION

A. Design and provide complete system of pipe supports and anchors for all piping.

B. Support all piping to prevent undue strain on any valve, fitting or piece of equipment.

C. Provide support and anchors at changes in direction, change in elevation, and adjacent to flexible couplings.

D. Do not install in equipment access areas or bridge crane runs.

1.04 PERFORMANCE AND DESIGN REQUIREMENTS

A. Design pipe support system components to withstand total dead load.

B. Dead load: Weight of pipe filled with water plus any insulation.
   1. Factor of safety: 5 minimum.

C. Design pipe restraint system components to withstand thrusts created by fluid pressure within pipes.
   1. Factor of safety: 5 minimum.

D. Do not exceed manufacturer’s recommended loads.

E. Brace all piping 2-1/2 inch and larger for seismic Zone 1 forces in accordance with International Building Code.

F. Design and select channels and accessories for 25,000 psi maximum stress and 1/360 of span maximum deflection.

1.05 SUBMITTALS

A. Submit under provisions of Sections 01 30 00.

B. Shop Drawings: Indicated system layout with location and detail hangers. Include location of all pipe supports and hangers for review by Engineer.

C. Product Data: Provide manufacturer’s catalog data including load capacity.

D. Design Data: Indicate loading carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Manufacturer’s Installation Instructions: Indicate special procedures and assembly of components.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Cooper B-Line.
   2. Tolco, a brand of Nibco.
   3. Unistrut Corporation.

4. ITT Grinnell.
5. Or Equal.

2.02 MATERIALS

A. Field and Factory Manufactured Supports and Hangers Piping Systems:
   1. Unless specifically shown or detailed otherwise on the Drawings, pipe support systems shall conform to the following requirements.
   2. All hangers, supports, anchors and materials shall be Stainless Steel.
   3. Type of hanger required for most applications is specified on project drawings.
   4. The supporting systems shall provide for and control the free or intended movement of piping including its movement in relation to that of connected equipment.
   5. Piping supports shall conform to the surrounding structure and adjacent piping and equipment.
   6. Hangers, supports, anchors and restraints shall be selected to withstand all static and dynamic conditions of loading which the piping and associated equipment may be subjected.
   7. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

2.03 CORROSION PROTECTION

A. The material in contact with the pipe shall be compatible with the piping material so that neither shall have a deteriorating action on the other.

B. Exposed ferrous metal surfaces shall be painted in accordance with Section 09900.

2.04 DIMENSION REQUIREMENTS

A. Hangers and supports shall be sized to fit the outside diameter of pipe, tubing or, if specified, the outside diameter of insulation.

B. Hangers for the suspension of 2-inch and larger pipe and tubing shall be capable of vertical adjustment under load.

2.05 PIPING ATTACHMENTS FOR INSULATED LINES

A. The connections to pipe attachments shall be outside the insulation so that movement of the line shall not cause damage to the insulation.

B. Insulation protection shields shall be provided to protect the vapor barrier of insulation. Do not apply hangers, supports or guides directly to horizontal pipe or tubing on vapor barriered lines.

2.06 MULTIPLE SUPPORTS

A. Horizontal banks of piping may be supported on a common base member without regard to the pipe centerline elevation. The particular method of support to be used shall be as shown on the Drawings.

B. In the supporting of multiple pipe runs, provisions shall be made to keep the lines in their relative lateral positions, using clamps or clips. Lines subject to thermal expansion shall be free to roll axially or slide.

2.07 RISER SUPPORTS

A. The selection and location of riser supports shall take into consideration the entire weight of the riser, hydrostatic test load conditions, line temperature and available supporting structure. On a riser subject to expansion, only one support of the rigid type shall be used.

B. Riser clamps shall have a positive means of engagement between the pipe and the clamp.

C. Anchors, guides and restraints shall be located as shown on the Drawings. Should the need or the desirability of relocating, eliminating or adding anchors, guides or restraints arise, such changes shall be approved in advance.

PART 3 EXECUTION

3.01 INSTALLATION

A. Except as otherwise shown on the Drawings, conform to the following:

B. Support vertical lines at bases using either a suitable hanger in a horizontal line near the riser or a base-type fitting set on a pedestal foundation or support.

C. Drilling of holes for anchors, supports, hangers, and piping in the structural work will be permitted only where approved. The Contractor shall notify the Engineer prior to starting the drilling at each location. Install inserts to minimize drilling.

D. Install hangers so as not to interfere with free expansion and contraction of piping. Hang pipe with its weight evenly distributed between hangers so as to prevent excessive deflection and stress in either pipe or the supporting member.

3.02 MAXIMUM HORIZONTAL PIPE HANGER AND SUPPORT SPACING

A. The maximum spacing of hangers and supports is listed in Specfication 40 05 07.01.

END OF SECTION

SECTION 40 05 07.01
PIPE SUPPORT AND HANGER SPACING

Nominal Pipe or Tube Diameter (inches)	Stnd. Wt. Steel Pipe (feet)	Copper Tube (feet)	Ductile Iron Pressure	Ductile Iron (non-pressure)	Plastic
¼	7	5	12' (3.7 m) max. spacing minimum of one (1) hanger per pipe section close to joint on the barrel. Also, at change of direction and branch connections.	10 ft. (3.0 m) maximum, minimum of one (1) hanger per pipe section close to joint on the barrel. Also, at change of and branch connections.	Follow Pipe Manufacturer's recommendations for material and service temperature
⅜	7	5			
½	7	5			
¾	7	5			
1	7	6			
1¼	7	7			
1½	9	8			
2	10	8			
2½	11	9			
3	12	10			
3½	13	11			
4	14	12			
5	16	13			
6	17	14			
8	19	16			
10	20	18			
12	23	19			
14	25				
16	27				
18	28				
20	30				
24	32				
30	33				

Note: Does not apply where span calculations are made, or where there are concentrated loads between supports such as flanges, valves, specialties, etc., or change directions requiring additional supports.

END OF SECTION

SECTION 40 05 19
DUCTILE IRON PROCESS PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior ductile iron piping 4-inches and larger, fittings, joint materials and other necessary appurtenances.

1.02 SYSTEM DESCRIPTION

A. Interior ductile iron, 4-inch and larger, piping complete with all fittings, jointing materials, pipe hanger supports, anchors, encasement, and other necessary appurtenances.

1.03 SUBMITTALS

A. Submit under provisions of Section 01 30 00

B. Shop Drawings: Provide piping layout fabrication and assembly drawings with fittings dimensions. Provide sufficient information to verify compliance with specifications.

C. Product Data: Provide data on pipe materials, pipe fittings, and accessories. Provide manufacturer's catalog information with dimensions, material and assembled weight. Indicate pressure ratings for pipe and appurtenances.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Test Reports: Submit proposed method and reports of field pressure tests under provisions of Section 01 45 23.

1.04 REGULATORY REQUIREMENTS

A. Conform to local codes and ordinances, and laws and regulations of the State.

B. In case of apparent conflict, State and local requirements govern over these specifications.

C. In absence of State and local regulations, Uniform Plumbing Code applies.

1.05 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01 77 00.

B. Accurately record actual locations of piping, fittings, valves, connections, and pipe centerline elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.06 QUALITY ASSURANCE

A. Manufacturer's name and pressure rating marked on piping and fittings.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 01 65 00.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. During loading, transporting, unloading, and installation, exercise care to prevent damage to material:
   1. Use nylon slings only.
   2. Do not drop pipe or fittings.
   3. Do not roll or skid against pipe already on ground.
   4. Repair any damage done to coating or lining.
   5. Handle per manufacturer's instructions.
   6. Store rubber gaskets in cool dark location.
   7. Store all material on wood pallets or timbers.

D. Adequately tag or otherwise mark all piping and fittings as to size.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. American Ductile Iron Pipe

B. Griffin Pipe Products Company

C. Tyler Pipe

D. U.S. Pipe

2.02 DUCTILE IRON PIPE

A. AWWA C151: As listed below except as otherwise specified or indicated on the Drawings:
   1. Where fitted with push-on joints, mechanical joints or mechanical joints with joint restraint device: 4 inch to 12 inch Pressure Class 350; 14inch to 30 inch Pressure Class 250
   2. Where fitted with flanged, grooved or restrained joints: Class 53.

B. Fittings:
   1. Ductile iron: ANSI A21.10/AWWA C110, ASTM A536, Grade 80-60-03 or 70-50-05
      a. 24 inch and below: 350 psi rating, mechanical joint or flanged
      b. Over 24 inch: 250 psi rating
   2. Ductile iron compact fittings: ANSI A21.53/AWWA C153
      a. Mechanical joints, 30” to 48”: 250 psi
      b. 24-inch and below: 350 psi rating, mechanical joint or flanged

C. Ductile iron grooved fittings: ANSI/AWWA C606, AWWA Fittings, conform to AWWA C110 for center-to-center dimensions and AWWA C153 for wall thickness,
      a. 12 inch and below: 350 psi rating, grooved joint
      b. 14 inch to 30 inch: 250 psi rating, grooved joint
   2. Comply with requirements for restrained fittings as indicated on Drawings.

D. Joints:
   1. Mechanical joints: ANSI A21.11/AWWA C111
      a. Bolts and nuts: High strength, low alloy steel, "Cor-Ten" or accepted substitution.
   2. Mechanical joints with tie rods:
      a. Tie rods: ASTM A307, galvanized entire length.
      b. Steel pipe spacers: ASTM A120, standard weight galvanized.
      c. Washers: ANSI A27.2 plain steel, galvanized.
   3. Flanged joints:
      a. Flanges:
         1) General use: ANSI A21.15/AWWA C115 and ANSI B16.1, Class 125.
         2) Where 250 psi working pressure indicated on Drawings or specified: ANSI 21.15/AWWA C115.
         3) Where Class 250 indicated on Drawings or specified: ANSI B16.1, Class 250, flat faced.
      b. Flange bolting:
         1) Material: ASTM A307
            (a) Stainless Steel: For all submerged and enclosed basin headspace applications.
         2) Type: Bolt and nut, bolt-stud and 2 nuts permitted for 1 inch and larger
         3) Bolts and bolt-studs:
            (a) Length: Ends project 1/4 inch to 1/2 inch beyond nuts
            (b) Ends: Chamfered or rounded
            (c) Threading: ANSI B1.1, coarse thread series, Class 2A fit. Bolt studs may be threaded full length. Studs for tapped holes threaded to match holes.
         4) Bolt heads:
            (a) Shape: Hexagonal or square

(b) Dimensions: ANSI B18.2 regular pattern for square, heavy pattern for hexagonal

5) Nuts:

(a) Dimensions: ANSI B18.2 heavy, semi-finished pattern

(b) Threading: ANSI B1.1 coarse thread series, Class 1B fit

4. Push-on joints: ANSI A21.11/AWWA C111, except gaskets shall be neoprene or other synthetic rubber. Natural rubber is not acceptable.
   a. Lubricant: Heavy vegetable soap solution suitable for potable water contact
   b. Pressure rated 350 psi.
5. Threaded connections: ANSI B2.1.NPT: provide boss or tapping saddle at all tapped connections.
6. Mechanical couplings: Dresser "Style 38," Smith-Blair "411" or accepted substitution
7. Grooved couplings:
   a. Standard groove/rigid groove
      1) Pipe ends: Grooved with "radius cut groove"
      2) Couplings: Victaulic "Style 31", Gustin-Bacon "Series 100 Gruvagrip", or accepted substitution
   b. Gaskets: Compatible with pipe material
   c. Vic-Flange Adapters: Victaulic "Style 341", "Style 342", or accepted substitution
8. Flanged coupling adapters:
   a. ANSI B16.5 Class 150/ANSI 16.1 Class 125 Drilling Pattern
      1) Working Pressure: 250 psi
      2) EBBA Iron Megaflange, Series 2100
   b. ANSI 16.5 Class 300/ ANSI B16.1 Class 250 Drilling Pattern
      1) Working Pressure: 400 psi
      2) Ford Uniflange, Series 420
9. Tapping saddles: Bronze with double stainless steel straps and rubber sealing gasket, 200 psi pressure rating
10. Mechanical joint with restraint device:
    a. Multiple wedging action type
    b. Twist off nuts used to insure proper actuating of the restraining device
    c. Working pressure rated to at least 250 psi
    d. EBAA Iron Sales, Inc., MEGA LUG or accepted substitution
    e. Waterline piping:
       1) With conventional thrust block restraint in addition to the mechanical joint restraint device (unless directed otherwise in writing by to Engineer)
11. Wall castings: Mechanical and/or flanged joints, integral or welded weep ring, sufficient space for bolting of connection piping to joint min. 6 inches from embedded wall or with tapped holes for follower bolts and plastic plugs to prevent holes from filling with concrete.

2.03 CORROSION CONTROL

A. Insulating fittings:
   1. Provide at all transitions between metal piping materials, and between interior and exterior piping.
   2. Insulating kits to be used at all transitions, as manufactured by Central Plastics or accepted substitute.
   3. Insulating gaskets:
      a. Glass reinforced epoxy
      b. 1/8 inch min thickness
      c. Buna-N sealing element
   4. Insulating bolt sleeves:
      a. Mylar
      b. 1/32 inch min thickness
   5. Insulating washers:

a. Phenolic laminate
6. 1/8 inch min thickness
a. One washer per flange bolt
7. Backing washers:
a. Steel
b. 1/8 inch min thickness
c. Two washers per flange bolt

2.04 FABRICATION

A. Joints:
1. Except as indicated on Drawings.
a. Buried locations: Restrained mechanical or push-on as indicated on Drawings.
b. Buried fittings: Restrained mechanical as indicated on Drawings.
c. Bells in wall pipe or casting: Mechanical with tapped holes for follower bolts or extended min. 6 inches beyond wall.
d. Bells in structures: Mechanical joint type.
e. Exposed: Flanged or grooved.
2. 12 inches and smaller branch outlets where main line is at least twice the diameter of the branch, tee or a tapping saddle is acceptable.

B. Where restrained joint with groove or grooved couplings are required, increase pipe thickness to provide.
1. Buried: 0.29 inches minimum at bottom of groove.
2. All other: 0.25 inches minimum at bottom of groove.
3. Where tie rods are required, provide as indicated on Drawings.
4. Mark the centerline of each flange and mechanical joint piece.
5. Screw flanges onto screwed-on flanged pipe so that pipe extends completely through and flush with the flange.
6. Finish machine pipe ends and flange faces flat and perpendicular to pipe centerline in a single operation.

C. Fittings and specials:
1. Finish with same lining and coating as abutting pipe.
2. Coat by hand all fittings and specials that cannot be mechanically lined using the same materials and in accordance with AWWA C104.
3. Mark each pipe with pipe class, date of manufacture and manufacturer's name or trademark.
4. Directly thread into wall of pipe outlets up to 2 inches in diameter. Provide integral tee fitting for outlets greater than 2 inches in diameter.

D. Shop Coating and Lining:
1. Shop paint all ferrous interior and exterior surfaces of pipe, fittings and accessory surfaces for corrosion protection
a. Exterior Surfaces
b. Comply with Section 09 90 00 in exposed locations
c. Interior Surfaces:
1) Used for all ductile iron process piping
(a) Ceramic epoxy, Protecto 401 or approved substitution:
(1) 1200 psi minimum tensile strength
(2) 300 percent minimum elongation

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions under provisions of Division 1.

B. Carefully examine pipe and fittings for cracks, damage to linings and coatings, and other defects prior to installation.

C. Remove all defective pipe from site and replace.

D. Examine areas for defects such as weak structural components or deviations beyond allowable tolerances for piping clearances that adversely affect execution and quality of Work.

E. Start installation only when conditions are satisfactory.

3.02 BEDDING

A. Excavate pipe trench in accordance with Division 31 for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.
   1. Dig bell or coupling holes.
   2. Do not support pipe on blocks or mounds of earth.
   3. Provide uniform and continuous bearing and support for full length of pipe between bell holes.
   4. Minor disturbance over a maximum length of 18 inches near the middle of each length of pipe will be permissible by the withdrawal of pipe slings or other lifting tackle.

B. Alignment and grade:
   1. Except as indicated on the Drawings, lay all pipe straight between changes in alignment and at a uniform grade between changes in grade.
   2. Use batter boards to determine and check pipe subgrades.
   3. Other methods of maintaining alignment and grade may be acceptable. Submit complete information describing the proposed method to the Engineer for review before pipe laying is started.

C. Place bedding material at trench bottom, level fill materials in one continuous layer per Division 31 23 23.

3.03 INSTALLATION

A. Install as specified or in accordance with the manufacturer's instructions.

B. Cutting Pipe:
   1. Cut pipe to measurements taken at the site, not from the Drawings.

C. Cut pipe neatly without damage to pipe coating or lining
   1. Cut smooth, straight, and at right angles to pipe axis.
   2. Dress and bevel end of cut pipe to remove roughness and sharp corners, recoat exposed metal with coating approved for intended service.
      a. Cut ductile iron pipe with saw or abrasive wheel.

D. Piping underground:
   1. Install ductile iron piping and fittings in accordance with AWWA C600 except as specified herein.
   2. Inspect pipe and accessories for defects before lowering into trench.
   3. Repair or replace any defective, damaged or unsound pipe.
   4. Carefully lower pipe, fittings, and accessories into the trench with derricks, ropes, and other suitable equipment to prevent damage.
   5. Do not dump or drop pipe or accessories into trench.
   6. Do not lay pipe in water, under unsuitable weather conditions or under unsuitable trench conditions.
   7. Joint to form true and smooth line.
   8. Trim pipe only for closures.
   9. Remove any pipe not making a good fit.
   10. Begin pipe laying at the lowest point unless reverse laying is accepted by Engineer.
   11. Utilize implements, tools and facilities as recommended by the manufacturer.
   12. Keep pipe clean during and after laying.
   13. Close all open ends with watertight expandable type plugs:
      a. At the end of each day's operations.
      b. Whenever pipe ends are left unattended.

c. Deposit adequate backfill on pipe to prevent flotation.
d. Do not use wood, burlap or other similar temporary plugs.

14. Remove and re-lay any pipe which has floated.
15. Provide an isolation or shutoff valve and union at the water connections to each fixture and unit of equipment, whether shown on the Drawings or not.
16. Group piping with other site piping work whenever practical. Maintain 10 feet minimum separation between potable water and sanitary or storm sewer pipes.
17. Install pipe to indicated elevation to within tolerance of 1/2 inch.
18. Route pipe in straight line.
19. Install pipe to allow for expansion and contraction without stressing pipe or joints.
20. Slope water pipe and position drain at low points.
21. Protect from lateral displacement by placing embedment evenly on both sides of pipe.
22. Lay pipe with bell ends facing the direction of laying except when Engineer authorizes reverse laying.
23. Form and place concrete for thrust blocks at each elbow or change of direction of pipe .main. Not required when using restrained joint pipe.
24. Establish elevations of buried piping to ensure not less than 5 feet of cover.
25. Backfill trench in accordance with Division 31.
26. Reference Division 31 for additional requirements.

E. Piping in buildings or structures:
1. Completed installation should present a neat, orderly appearance.
2. Do not block openings, passageways, or pipe galleries.
3. Run piping parallel to walls of building or structure.
4. Keep piping from contacting walls, structures, or installed items.

3.04 JOINTS

A. Make joints carefully and neatly.

B. Connect piping in accordance with manufacturer's instructions.

C. Mechanical Joints:
1. If an effective seal is not obtained, disassemble joint, clean thoroughly, and reassemble
2. Do not over-tighten bolts to compensate for poor installation.
3. Carefully align holes in mechanical joints with restraint devices to permit installation of the harness bolts.
4. Install flange and mechanical joint pieces so the four mechanical joint holes, as well as the flange holes, straddle the top centerline for horizontal piping, or the side centerline for vertical piping.

D. Push-on Joints:
1. Bevel spigot ends of field cut piping.
2. Groove spigot ends of field cut restrained joint piping.
3. Thoroughly clean and lubricate inside of receiving bell and outside of spigot and gasket immediately before jointing.
4. Relieve any tension in rubber gasket by inserting a dull instrument under the gasket and rake two complete revolutions around joint.
5. Place spigot end of the pipe in the bell end of the preceding pipe with care to prevent contact of the joint with the ground.
6. Complete the joint by pushing pipe home with slow steady pressure, without jerky or jolting movements.
7. Do not exceed 80 percent of the pipe manufacturer's instructions for maximum deflection.

E. Flanged Joints:
1. Take care when bolting flanges to insure that there is no restraint on the opposite end of the pipe which would prevent gasket compression or cause unnecessary stress in flanges.
2. Leave one flange free to move in any direction while tightening flange bolts.

3. Do not pack or assemble bell and spigot joints until all flanges affected thereby have been tightened.
4. Tighten bolts gradually at a uniform rate to compress gaskets uniformly
5. Take special care in connecting to pumping equipment to insure no stresses are transmitted to pump flanges by connecting piping:
    a. Permanently support piping for accurate matching of bolt holes and uniform contact over the entire face of abutting pump and pipe flanges are obtained before bolting those flanges.
    b. Allow pump connection piping to move parallel to its longitudinal centerline while bolts are tightened.
    c. Level, align, and wedge pumps into position to fit connecting piping but do not install grout until after initial pipe fitting and alignment to allow shifting the pump on its foundation.
    d. Grout pumps prior to final bolting of connecting piping.

F. Flanged Coupling Adapters:
1. Install per manufacturer installation instructions.

G. Mechanical Couplings:
1. Cut pipe ends clean and smooth.
2. Leave a space of 1/4 inch to 1 inch between pipe ends.

H. Grooved couplings: Arrange piping so the clear space between pipe ends inside each grooved coupling is not more than one times, or less than 2 times, the maximum recommended by manufacturer.

I. Reducers:
1. Provide eccentric reducers adjacent to flowmeters where installed in horizontal position.
2. Install with straight side on top to avoid forming trapped air.

J. Pipe Restraining Methods:
1. In interior locations and where subject to internal pressure, block, anchor or harness piping with mechanically coupled, push-on or similar joints to prevent separation of joints.
2. In buried piping subject to hydrostatic heads in excess of 30 feet provide concrete thrust blocking to prevent pipe movement caused by internal pressure at:
    a. Fire hydrants and gate valves.
    b. Plugs, tees, and wyes.
    c. Bends deflecting 11-1/4 degrees or more.
    d. Other locations show on Drawings.
3. Concrete thrust blocking shall provide:
    a. Bearing area as indicated on the Drawings.
    b. Provide bond break.
    c. Extend from fitting to solid undisturbed earth.
    d. Installed so joints are accessible for repair.
    e. If the lack of a solid vertical excavation face is due to improper excavation, all additional costs shall be borne by Contractor.
4. For areas where ground is unstable or unsuitable for concrete thrust blocking, as determined by the Engineer, or as indicated on the Drawings, provide joint restraint by tied pipe:
    a. Provide sufficient number of tied joints to equal or exceed restraining length as shown on the Drawings.
    b. In fills and embankments provide concrete thrust blocks and tied joints to equal or exceed restraining length as shown on the Drawings:
        1) Tie rods and Cor-ten eye bolts at mechanical joints.
        2) Tie rods and clamps at push-on joints.
        3) Restrained joint pipe.

3.05 CONCRETE ENCASEMENT

A. Concrete encase all piping below slabs on grade and where indicated on the Drawings.

B. Provide reinforcing as indicated on the Drawings.

C. Suitably support and block pipe and anchor against flotation.

3.06 CONNECTION TO EXISTING PIPE LINES

A. Make connections between new and existing piping by other contractors with suitable fittings, provide all fittings required for testing.

B. Schedule connection to minimize inconvenience to the Owner, other contractors, and as authorized by Owner.

C. Provide facilities for adequate dewatering and disposal of water from dewatered line and excavations without damage to adjacent property.

3.07 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to 1/4 inch per foot, two percent minimum but never less than 1/8 inch per foot. Maintain gradients.

B. Slope exposed water piping and arrange to drain at low points.

3.08 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 01 45 00.

B. Test each line at the Contractor's expense in the presence and to the satisfaction of the Engineer.

C. Provide all necessary pumping equipment, piping connections, pressure gauges with maximum of 5 psi increments, and other required equipment, facilities, and materials.

D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner. Hydrostatic Test Conditions: Identify lines, test pressure, and test medium according to Specification 01 60 00.

E. Procedure:

1. Disconnect all fixture devices and other accessories which may be damaged by the specified test pressure.
2. Plug or cap ends as required.
3. Bleed system to eliminate all air from system.
4. No testing before concrete thrust blocks have adequate curing time, 7 days minimum.
5. Notify Engineer 48 hours prior to testing.
6. Test for 2 hours with no more than 5 psi loss in pressure, test all line valves by pressurizing upstream to test pressure and relieving downstream pressure, valve must maintain test pressure in each pipe line reach.
7. Structure test so as to test all intermediate valves.
8. Leakage is the quantity of water added to a test section to maintain test pressure + 5 psi.
   a. L = S x D x (P)0.5 / 133,200
      L = allowable leakage, in gallons per hour.
      S = length of pipe tested, in feet.
      D = nominal diameter of the pipe, in inches.
      P = average test pressure during the test, in psi (gauge).
   b. All visible leaks shall be stopped to the satisfaction of the Engineer.
   c. Water used for pressure testing process piping may be non-potable.
   d. Water used for pressure testing potable waterlines must be potable.
9. All joints located in interior locations shall be watertight and free of leaks.
10. Length of pipe in the interior locations shall not be included in calculation of allowable leakage quantity.
11. Immediately locate and replace all pipe fittings, valves, pipe joints, and other materials found to be defective with new and acceptable material.

F. Owner will provide water for initial filling and testing of pipeline.

3.09 CLEANING AND DRAINING

A. The inside of all pipe, valves, and fittings shall be smooth, clean, and free from blisters, loose mill scale, sand, and dirt when connected.

B. Wire brush, if necessary, wipe clean and keep joint contact surfaces clean until connection is complete.

END OF SECTION

SECTION 40 05 51
PROCESS VALVES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following general-duty valves:
   1. Butterfly valves.
   2. PVC Ball Valve
   3. Ductile-iron non-slam check valve
   4. Combination Air/Vacuum Valve

1.02 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; furnished specialties; and accessories.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 PVC BALL VALVE

A. Manufacturer:
   1. American Valve
   2. Red Flag
   3. TOMEX
   4. Engineer Approved Equal.

B. Materials:
   1. Body: PVC
   2. Seal Material: EPDM
   3. Connection Type: True Union

2.03 BUTTERFLY VALVES

A. Manufacturers:
   1. Flangeless, Ferrous-Alloy Butterfly Valves:
      a. American Valve, Inc.
      b. Bray International, Inc.
      c. Cooper Cameron Corp.; Cooper Cameron Valves Div.
      d. Crane Co.; Crane Valve Group; Center Line.
      e. Crane Co.; Crane Valve Group; Stockham Div.
      f. Dover Corp.; Dover Resources Company; Norriseal Div.
      g. General Signal; DeZurik Unit.

B. Materials
   1. General:
      a. Rubber seat, tight closing discs seat at 90 degrees with pipe axis.
         1) Shaft: Keys and pins for securing disc to shaft to be 18-8 stainless steel.
      b. Valve ends suitable for specified use:
         1) Lugged

c. Materials:
    1) Body: Cast iron
    2) Shaft: Stainless steel, one piece
    3) Disc: Broze or cast iron with corrosion-resistant metal plating
    4) Seat: Synthetic rubber or elastomer with suitable temp rating
    5) Shaft beaings: Bronze or teflon
    6) Shaft seal: Suitable synthetic rubber rings

2.04 DUCTILE IRON NON-SLAM CHECK VALVE

A. Manufacturers:
    1. Val-Matic Surgebuster
    2. Engineer Approved Equal

B. Materials:
    1. Body and Cover: ASTM A536 Grade 65-45-12 ductile iron.
    2. Disc: Buna-N (NBR), ASTM D2000-BG.
    3. Disc Accelerator: Type 302 Stainless Steel.

C. Shop Coatings:
    1. Coal tar epoxy: Tnemec “Series 46H-413 Hi-Build Tneme-Tar”, or equal.
    2. Epoxy: Tnemec “Series 66 Hi-Build Epoxoline”, or equal.
    3. Rust-inhibitive primer: Tnemec “37H Chem-Prime H.S.”, or equal.
    4. Rust-preventive compound: Rust-Oleum, or equal.

2.05 COMBINATION AIR/VACUUM VALVE

A. Manufacturers:
    1. A.R.I. Model D-025
    2. Engineer Approved Equal

B. Materials:
    1. Reinforced Nylon Body
    2. NPT Threaded
    3. Stainless Steel Base

PART 3 EXECUTION

3.01 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 40 XX XX Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install check valves for proper direction of flow and as follows:
    1. Swing Check Valves: In horizontal position with hinge pin level.
    2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
    3. Lift Check Valves: With stem upright and plumb.

G. On sewage and sludge lines install with seat on upstream end with plug rotating up into open position for valves in horizontal lines.

3.02 JOINT CONSTRUCTION

A. Refer to Section 40 00 00 Section for basic piping joint construction.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION

SECTION 40 05 57
VALVE ACTUATORS

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install manual and powered actuators for proper operation of all valves required for equipment, valves, or systems as shown and indicated on the Drawings and as specified herein.

1.02 SUBMITTALS

A. Provide in accordance with Section 01 30 00.

B. Shop Drawings: Submit complete fabrication, assembly foundation, and installation drawing for all pumps, motors and accessories to illustrate construction, assembly of components and required clearances from piping, equipment, walls or other items.

C. Product Data—Provide complete data on valve accessories sufficient to verify compliance with the specifications. Product data shall include torque and pull-force requir

1.03 WARRANTY

A. Provide 2-year manufacturer’s warranty beginning from the date of Substantial Completion.

1.04 OPERATION AND MAINTENANCE DATA

A. Provide in accordance with Section 01 78 23 Operation and Maintenance Data.

B. Operation Data: Include manufacturer's instructions, description of system operation, start-up data, trouble-shooting check lists, and repair data.

C. Maintenance Data: Include installation and maintenance instructions, recommended spare parts lists and exploded assembly views of actuators and accessories.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect, and handle products in accordance with Section 01 60 00 and manufacturer’s instructions.

B. Prepare valves accessories for shipment according to AWWA C540, Section 7.2.

PART 2 PRODUCTS

2.01 MOTOR ACTUATORS – MODULATING AND OPEN/CLOSE SERVICE

A. Provide motor actuators where indicated on Drawings, for automated system operation or as specified for individual systems.

B. Each motor actuator to consist of motor, gearing, handwheel, limit, and torque switches, lubricants, heating elements, wiring, terminals, and integral reversing controller constructed as a self-contained unit.

C. Housing: Die-cast aluminum, Nema 4x Enclosure Rating, weatherproof.
   1. Motor and other internal electrical elements must be protected from igress of moisture and dust.

D. Operating time from fully open to fully closed or the reverse for modulating valves: Adjustable from 15 seconds to two minutes.

E. Motors:
   1. Totally enclosed, high torque, designed expressly for valve operator service.
   2. Capable of operating valve under full differential pressure for two complete open-close cycles without overheating.
   3. Contain a built-in UL approved automatic reset thermal overload protector set at 275°F.
   4. Designed in accordance with NEMA Standards.
   5. Insulation: Class F or better.
   6. Bearings: Permanently lubricated.

7. Voltage tolerance: ± 10 percent.
8. Voltage rating: 480 V, 60 Hz, 3 phase
9. Produce 1.5 times required torque.

F. Gearing:
1. All grease lubricated.
2. Service factor: 2.0.
3. Effectively sealed against entrance of foreign matter.
4. Designed to permit field ratio changes.
5. Designed so motor comes up to speed before stem load is encountered in opening and closing direction.

G. Handwheel mechanism:
1. Designed so handwheel doesn't operate during motor operation.
2. Designed so motor doesn't rotate when handwheel is rotated.
3. Provide declutching extensions to allow declutching of all electric actuators from floor level.
4. Actuator responsive to electrical power and control at all times, instantly disengaging handwheel.
5. Rotation: Counter clockwise to open.
6. An arrow indicating the open direction and the word "OPEN" cast on the handwheel.
7. Max force required: 100 lb.

H. Torque Switches:
1. Provide opening and closing torque and thrust limit switches.
2. Micrometer adjustment on each switch:
   a. Reference setting indicator
   b. Variability 40 percent
3. Contact rating: 6 amp inductive at 120 V AC and 2.2 amp at 115 V DC.

I. Geared limit switches:
1. Space for 4 geared limit switch assemblies.
2. Each assembly with 4 separate limit switches.
3. Each assembly geared to driving mechanism and independently adjustable to transfer at any point between fully open and fully closed valve position.
4. Contact rating: 6 amp inductive at 120 V AC and 2.2 amp at 115 V DC.
5. Set limit switches as indicated on Drawings.

J. Provide 2 limit switch assemblies.

K. Terminal facilities:
1. Provide for connection to motor leads, switches, slide-wire type position transmitter, if required, and heating elements in geared limit switch compartment.

L. Controller:
1. Integrally mounted reversing motor starter in geared limit switch compartment.
2. Motor overload protective device in each phase.
3. A nameplate of permanent type construction on the controller enclosure identifying the equipment controlled as with letters and numerals not less than 3/4 inch high.
4. Mechanically and electrically interlocked.
5. Provided with the necessary direct operated auxiliary contacts for required interlocking and control.
6. Pilot devices:
   a. In a weatherproof enclosure close coupled to actuator housing if actuator is easily accessible; if actuator is not easily accessible, locate pilot devices on nearby wall or mounting station.
   b. Local Open-Stop-Close momentary push buttons.
   c. Local-Off-Remote maintained selector switch.

d. Local Red "Open" and Green "Closed" indicating lights.

7. NEMA Size 1 minimum.
8. For modulating valves, provide manual-automatic switch and solid state modulator to receive 4-20 mA control signal and actuate valve to signaled position.

M. Manufacturers:
1. Modulating service:
a. Rotork IQ20
b. Or Engineer approved equal

PART 3 EXECUTION

3.01 INSTALLATION

A. Install actuators in accordance with the manufacturer's instructions.

B. Install actuators such that position indicators are visible by standing on operation floor or from permanent platform.

C. Valve control stations:
1. Provide power for all actuators.
2. Install where accessible by standing on operations floor or from permanent elevated platform.
3. If valve is not within reach or easily accessible by standing on operations floor or from permanent elevated platform, install remote valve control station at location acceptable to Engineer.

D. Provide minimum distances required from walls and other piping to center of valve to accommodate actuator dimensions and to facilitate maintenance of actuator. Immediately notify Engineer of all conflicts or discrepancies.

3.02 ADJUSTMENTS

A. Check and adjust valves and accessories for smooth operation in accordance with manufacturer's instructions.

B. Powered actuator:
1. Adjust limit and torque switches as indicated on drawings.
2. Adjust opening/closing speed as indicated in the schedule of this specification.

3.03 FIELD QUALITY CONTROL

A. Provide under provisions of Section 01 40 00.

B. The actuator manufacturer shall provide the services of a factory-qualified field engineer to initially check installation of the powered actuators before energizing the equipment, make electrical control panel modifications as necessary, and to place the unit in service in accordance with this section. The factory field engineer shall also be responsible for instructing operation personnel as to proper process and maintenance procedures.

C. Supervise equipment start-up during the start-up, field testing and pre-demonstration period of Section 01 75 16.

D. Complete Manufacturer's Field Report.

E. Complete Manufacturer's Installation Certificate of Section 01 75 16.

F. Coordinate inspection of all valves by manufacturer's representative and instruct plant personnel on their operation and maintenance.

G. Provide manufacturer's field service representative for a minimum of one (1) day to inspect installation and observe start-up.

H. Two, consecutive 8 hour days for installation assistance, inspection, and certification of installation of all the pumps.

I. Provide additional four (4) hours of Owner's personnel training after start-up.

END OF SECTION

SECTION 40 05 59
WEIR GATES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to install, ready for operation and field test stainless steel gates and appurtenances as shown on the Contract Drawings and as specified herein.

B. The gates and appurtenances shall be supplied in accordance with the latest edition of AWWA C561 Standard for Fabricated Stainless Steel Slide Gates as modified herein

1.02 SUBMITTALS

A. Provide the following information to confirm compliance with the specification in addition to the submittal requirements specified in Section 01 30 00.

B. Complete description of all materials including the material thickness of all structural components of the frame and slide.

C. General assembly drawings showing all details of construction, details required for installation, dimensions, and anchor bolt locations. General assembly drawings must be provided in 3D format.

D. Maximum bending stress and deflection of the slide under the maximum design head. Calculations for maximum operating load, hoist selection, and stem design.

1.03 QUALITY ASSURANCE/QUALIFICATIONS

A. All of the equipment specified under this Section shall be furnished by a single manufacturer with a minimum of 20 years experience designing and manufacturing water control gates. The manufacturer shall have manufactured water control gates for a minimum of 100 projects.

B. The manufacturer's shop welds, welding procedures, and welders shall be qualified and certified in accordance with the requirement of the latest edition of ASME, Section IX or AWS D1.6 Structural Welding Stainless Steel.

1.04 CONTAMINATION PREVENTION

A. In order to avoid contamination and maintain surface purity, the principal manufacturing facility must have a dedicated stainless-steel facility segregated and isolated from the facility where products of other materials such as carbon steel or cast iron are manufactured. The stainless - steel material must be kept separated from other materials beginning from acquisition and storage through handling, fabrication, assembly, and dispatch.

B. Mechanical removal of free iron particle, oil, dirt, paint, welding flux, slag, heat tint and scales of oxides must be supplemented with glass bead blasting followed by in house chemical bath pickling and passivation. Spray passivation or pickling and passivation performed by a third party is strictly not permitted.

1.05 CORROSION PREVENTION

A. To prevent crevice corrosion and advocate long life of stainless steel fabricated products, the principal manufacturer must only use continuous welding practices performed in house by the principal manufacturer. To verify the quality of the welds, a dye penetration test shall be conducted on all weld joints and approved by a quality control inspector.

1.06 MATERIAL PROPERTY ASSURANCE

A. Heatless cutting of stainless steel by a CNC water jet capable of 35,000 psi must be utilized to ensure there is no change in corrosion resistance properties of the stainless steel. Cutting methods utilizing heat will not be accepted.

PART 2 EQUIPMENT

2.01 GENERAL

A. Each slide gate will be manufactured as detailed here and will be supplied fully tested as per requirements. To the maximum extent possible, the gate assembly comprising of frame, guides and slide will be supplied as a factory assembled unit and shipped to site ready to install on the wall thimble or wall.

B. The slide gates will be manufactured in accordance with AWWA C561.

C. The gate manufacturer will be Rodney Hunt Inc. or prior approved equal.

D. The slide gates will be designed for water tightness for both seating and un- seating differential head per the actual site requirement as detailed in the Stainless Steel Slide Gate Table.

E. The slide gates will be shop tested to verify the leakage performance at operating head in the un-seating direction. Where sealing configuration permits, hydrostatic testing will be conducted at 1.5 times operating head, to demonstrate structural integrity. Testing for opening load at the unseating operating head to verify actuating mechanism sizing will also be conducted.

F. The slide gates will be of rising stem type unless site geometry prohibits it. Operation will be by means of an electric actuator.

G. The slide gate will be supplied complete with all accessories such as: gate assembly, gasket, studs and nuts for mounting, stem, thrust nut, stem couplings, stem guides, pedestal, operating mechanism as required, gate opening indicating arrangement and as required anchor bolts and fasteners for stem guides and pedestal.

H. The allowable leakage rate for the slide gates in this specification shall be 1/2 the allowable leakage listed in the latest revision of AWWA C561, 0.05 gpm/ft of wetted seal perimeter in seating head and unseating head conditions.

I. The gates shall utilize self-adjusting seals. Due to the difficulty of accessing gates when they are in service - gates that utilize adjustable wedges, wedging devices or pressure pads are not acceptable.

J. All structural components of the frame and slide shall be fabricated of stainless steel having a minimum thickness of 1/4-inch and shall have adequate strength to prevent distortion during normal handling, during installation and while in service.

K. All welds shall be performed by welders with AWS certification for the material grades used in fabrication.

L. The gate shall utilize self-adjusting seals. Due to the difficulty of accessing gates when they are in service - gates that utilize adjustable wedges, wedging devices or pressure pads are not acceptable.

M. All structural components of the frame and slide shall be fabricated of stainless steel having a minimum thickness of 1/4-inch and shall have adequate strength to prevent distortion during normal handling, during installation and while in service.

N. All welds shall be full and continuous performed by welders with AWS certification for the material grades used in fabrication.

O. Finish: Mill finish on stainless steel. Welds shall be sandblasted to remove weld burn and scale accompanied by passivation. All iron and steel components shall be properly prepared and shop coated with a primer.

2.02 FRAME

A. The frame assembly, including the guide members, invert member and yoke members, shall be constructed of stainless steel plate with a minimum thickness of 1/4-inch.

B. Frame design shall allow for embedded mounting, mounting directly to a wall with stainless steel anchor bolts and grout or mounting to a wall thimble with stainless steel mounting studs and a mastic gasket material. Mounting style shall be as shown on the Contract Drawings.

C. All wall mounted or wall thimble mounted gates shall have a flange frame. Flat frame gates are not acceptable.

D. Gussets shall be provided as necessary to support the guide members in an unseating head condition.

E. The frame shall extend to accommodate the entire height of the slide when the slide is in the fully opened position on upward opening slide gates or downward opening weir gates.

F. On self-contained gates, a yoke shall be provided across the top of the frame. The yoke shall be formed by a structural members affixed to the top of the side frame members to provide a one-piece rigid assembly. The yoke shall be designed to allow removal of the slide.

G. A rigid stainless-steel invert member shall be provided across the bottom of the opening. The invert member shall be of the flush bottom type on upward opening gates.

H. A rigid stainless steel top seal member shall be provided across the top of the opening on gates designed to cover submerged openings.

I. A rigid stainless-steel member shall be provided across the invert of the opening on downward opening weir gates.

2.03 SLIDE

A. The slide and reinforcing stiffeners shall be constructed of stainless steel plate. All structural components shall have a minimum thickness of 1/4-inch.

B. The slide shall not deflect more than 1/360 of the span or 1/16 inch, whichever is smaller, under the maximum design head.

C. Reinforcing stiffeners shall be continuously welded (stitch welding will not be acceptable) to the slide and mounted horizontally. Vertical stiffeners shall be continuously welded on the outside of the horizontal stiffeners for additional reinforcement.

D. The stem connector shall be constructed of two angles or plates. The stem connector shall be continuously welded to the slide. A minimum of two bolts shall connect the stem to the stem connector.

2.04 SEALS

A. All gates shall be provided with a self-adjusting seal system to restrict leakage in accordance with the requirements listed in this specification.

B. All gates shall be equipped with UHMW polyethylene seat/seals to restrict leakage and to prevent metal to metal contact between the frame and slide.

C. The seat/seals shall extend to accommodate the 1-1/2 x the height of the slide when the slide is in the fully closed or fully opened position.

D. All upward opening gates shall be provided with a resilient seal to seal the bottom portion of the gate. The seal shall be attached to the invert member or the bottom of the slide and shall be held in place with stainless steel attachment hardware.

E. All downward opening weir gates shall be provided with UHMW polyethylene seat/seals across the invert member.

F. The seal system shall be durable and shall be designed to accommodate high velocities and frequent cycling without loosening or suffering damage.

G. All seals must be bolted or otherwise mechanically fastened to the frame or slide. The seals shall be mounted so as not to obstruct the water way opening.

H. Gates that utilize rubber “J” seals or “P” seals are not acceptable.

I. The seal system shall have been factory tested to confirm negligible wear (less than 0.01”) and proper sealing. The factory testing shall consist of an accelerated wear test comprised of a minimum of 100,000 open-close cycles using a well- agitated sand/water mixture to simulate fluidized grit.

2.05 WALL THIMBLES

A. Wall thimbles shall be provided when shown on the Contract Drawings.

B. The wall thimble depth shall be equal to the thickness of the concrete wall in which the thimble is to be mounted.

C. Wall thimbles shall be fabricated stainless steel construction of adequate section to withstand all operational and reasonable installation stresses.

D. Wall thimbles shall be constructed of 1/4-inch minimum thickness stainless steel and the front face shall have a minimum thickness of 1/4–inch.

E. The fabrication process shall ensure that the wall thimble is square and plumb and the front face is sufficiently flat to provide a proper mounting surface for the gate frame.

F. The face of the wall thimble shall only be machined if recommended by the gate manufacturer. If the wall thimble is to be machined, the front face shall have a minimum thickness of 1/4-inch after machining.

G. A water stop shall be welded around the periphery of the thimble. Wall thimbles shall be designed to allow thorough and uniform concrete placement during installation.

H. Studs and nuts shall be stainless steel. Water stop may be stitch welded.

I. A suitable gasket or mastic shall be provided to seal between the gate frame and the wall thimble.

2.06 OPERATING STEM

A. The slide gates will be supplied with rising type operating stems unless non-rising stems are required by installation geometry.

B. The stem will be supplied with ACME full or stub threading. The stem will be designed to allow for elevation deviations of up to 2”.

C. The stem shall be constructed of solid stainless-steel bar for the entire length, the metal having a tensile strength of not less than 90,000 psi for stems that are 3 inches or less in diameter. Stems that are in excess of 3 inches in diameter shall have a tensile strength of 85,000 psi.

D. The threaded portion of the stem shall have a minimum outside diameter of 1-1/2 inches. Stem extension pipes are not acceptable.

E. The design of stem will be per the provision in AWWA C561.

F. The L/r ratio will not exceed 200.

G. For buckling, Euler’s formula will be used with an end condition of 2.0. For threaded sections, the radius of gyration will be based on the minor diameter. At the stem design load as follows, the yield strength of the material will not be exceeded.

H. As a minimum for manual hoists, the stem design load is the load produced with a 100 pound effort on the crank or handwheel.

I. For electric actuators, the stem design load is the greater of the load produced with a 100 pound handwheel effort and 1.50 times the load produced at a locked rotor condition.

J. For hydraulic actuation, the stem design load will be 1.25 times the thrust produced at system relief pressure

K. Stems of more than one section shall be joined by stainless steel or bronze couplings. The coupling shall be threaded and bolted to the stems.

L. Stems shall be provided with adjustable stop collars to prevent over closing of the slide.

2.07 ELECTRIC MOTOR ACTUATORS

A. See Section 40 05 07.

2.08 ANCHOR BOLTS

A. Anchor bolts shall be provided by the gate manufacturer for mounting the gates and appurtenances.

B. Quantity and location shall be determined by the gate manufacturer.

C. If epoxy type anchor bolts are provided, the gate manufacturer shall provide the studs and nuts.

D. Anchor bolts shall have a minimum diameter of 1/2-inch.

PART 3 MATERIAL OF CONSTRUCTION

3.01 WEIR GATE CONSTRUCTION

A. The gates shall be manufactured using the materials list in the table below:

Frame Assembly and Retainers	Stainless Steel, ASTM A240 Type 304L or ASTM A240 Type or 316L
Slide and Stiffeners	Stainless Steel, ASTM A240 Type 304L or ASTM A240 Type or 316L
Stem	Stainless Steel, ASTM A240 Type 304L or ASTM A240 Type or 316L
Fasteners, Nuts, and Bolts	Stainless Steel, ASTM A276 Type 304 ASTM F593 and F594 GR1 for Type 304 and GR2 for Type 316
Seat/Seals and Facing	Ultra-High Molecular Weight Polyethylene ASTM D4020
Lift Nuts	Bronze ASTM B584
Pedestals and Wall Brackets	Stainless Steel, ASTM A240 Type 304L or ASTM A240 Type or 316L
Operator House	Cast Aluminum or Ductile Iron

PART 4 EXECUTION

4.01 INSTALLATION

A. Installation of the gates and appurtenances shall be done in a workmanlike manner. Handle, store and install the equipment specified in this Section in strict accordance with the manufacturer's recommendations.

B. Review the installation drawings and installation instruction prior to installing the gates.

C. The gate assemblies shall be installed in a true vertical plane, square and plumb.

D. Fill the void in between the gate frame and the wall with non- shrink grout as shown on the installation drawing and in accordance with the manufacturer's recommendations.

E. Add a mastic gasket between the gate frame and wall thimble (when applicable) in accordance with the manufacturer's recommendations.

4.02 FIELD TESTING

A. After installation, all gates shall be field tested in the presence of the ENGINEER and OWNER to ensure that all items of equipment are in full compliance with this Section. Each gate shall be cycled to confirm that they operate without binding, scraping, or distorting. The effort to open and close manual operators shall be measured and shall not exceed the maximum operating effort specified above. Electric motor actuators shall function smoothly and without interruption. Each gate shall be water tested by the CONTRACTOR, at the discretion of the ENGINEER and OWNER, to confirm that leakage does not exceed the specified allowable leakage.

END OF SECTION

SECTION 40 05 62
PLUG VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install plug valves as shown and indicated on the Drawings and as specified herein.

1.02 SUBMITTALS

A. Submit under provisions of Sections 01 30 00.

B. Product Data – Provide complete data on valve accessories sufficient to verify compliance with the specifications:
   1. Provide manufacturer's catalog information with size, dimensions, number of turns to open, materials, and assembled weights.
   2. Indicate valve pressure/temperature rating.

C. Test Reports: AWWA C504.

1.03 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 01 78 23.

B. Maintenance data: Include installation and maintenance instructions, recommended spare parts lists and exploded assembly views of valves, operators and accessories.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect, and handle products to site in accordance with manufacturer's instructions.

B. Deliver and store valves and accessories in shipping containers with labeling in place in accordance with AWWA C504, Section 6:
   1. Seal valve ends to prevent entry of foreign materials into valve body.
   2. Box, crate, or otherwise completely enclose valves, operators and accessories to protect against damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers
   1. DeZurik.
   2. Milliken.
   3. Engineer Approved Equal.

2.02 MATERIALS

A. Valves
   1. Body: and plug: Ductile iron, ASTM A536 Grade 65-45-12 or cast iron, ASTM A126, Class B.
   2. Plug facing: Nitrile Butadiene (Buna-N or Hycar), 70 durometer hardness.
   3. Seat: Welded-in nickel overlay of pure nickel (90% minimum), machine faced.
   4. Stem seal:
      a. Buna-N multiple v-ring with adjustable gland.
      b. Buna-N Dual U-cup.
      c. EPDM self-lubricating packing ring.
   5. Thrust washers: PTFE.
   6. Upper and lower trunnion bearings: Sleeve type, type 316 stainless steel.

B. Shop coatings:
   1. Coal tar epoxy: Tnemec "Series 46H-413 Hi-Build Tneme-Tar", or equal.
   2. Epoxy: Tnemec "Series 66 Hi-Build Epoxoline", or equal.

3. Rust-inhibitive primer: Tnemec “37H Chem-Prime H.S.”, or equal.
4. Rust-preventive compound: Rust-Oleum, or equal.

2.03 FABRICATION

A. Non-lubricated eccentric plug valves:
   1. Port area: All plug valves shall allow 100% port flow through the valve.
   2. Port design: Rectangular or round.
   3. Drip tight shutoff at differential pressure equivalent to maximum rated pressure from either direction.
   4. Ends to match connecting piping:
      a. Flanged, 125 lb, ASME B16.1.
      b. Mechanical joint, AWWA C111.
   5. Maximum working pressure:
      a. 175 psig, 4 inch through 12 inch.
      b. 150 psig, 14 inch through 36 inch.
   6. Opening motion eccentric, lifting plug away from body seat.
   7. Provided with fully adjustable plug position stops.
   8. Valve bonnet stuffing box sufficiently deep for 4 packing rings on 4-inch and larger valves.
   9. Valve body plainly marked to indicate seat end.
   10. Actual length within 1/16 inch ± of specified or theoretical length.
   11. Valve packing adjustment accessible without removing actuator from valve.

B. Valve actuators:
   1. 2" valve operating nut.

2.04 SHOP FINISHING

A. Reference provisions under Section 09 90 00 for surface preparation and painting materials.

B. Shop paint all ferrous metal surfaces of valves and accessories, both interior and exterior for corrosion protection.

C. Manufacturer's standard paint will be acceptable if it is functionally equivalent to the specified paint and compatible with the specified field painting.

D. Surfaces to be painted:
   1. Unfinished surfaces:
      a. Interior of valves; Asphalt varnish (2 coats) coat tar, or epoxy for potable water applications.
      b. Exterior of other valves to be buried, submerged, or located in manholes: Asphalt varnish or coal tar.
      c. Exterior of other valves: Rust-inhibitive primer.
      d. Actuators and accessories: Rust-inhibitive primer.
      e. Flange faces and interior working parts: Rust-preventative compound.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves and accessories in accordance with the manufacturer’s instructions.

B. Check and adjust valves and accessories for smooth operation in accordance with manufacturer’s instructions.

C. Except as required for proper operation, install with shaft horizontal and plug in upper half of body.

D. In vertical pipe runs, install valve with the seat end flange up.

E. On sewage and sludge lines install with seat on upstream end and with plug rotating up into open position for valves in horizontal lines.

3.02 FIELD QUALITY CONTROL

A. Coordinate inspection of all valves by manufacturer's representative and instruct plant personnel on their operation and maintenance.

END OF SECTION

SECTION 40 70 05
METERS AND GAGES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following meters and gages for mechanical systems:
   1. Analog Pressure Gauges
   2. Radar Level Transmitters
   3. Magnetic Flowmeter

1.02 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Operation and maintenance data.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 PRESSURE GAUGES

A. Manufacturers:
   1. AMETEK, Inc.; U.S. Gauge Div.
   2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
   3. Ernst Gage Co.
   4. Eugene Ernst Products Co.

B. KOBOLD Instruments, Inc.
   1. Marsh Bellofram.
   2. Miljoco Corp.
   3. Noshok, Inc.
   4. Palmer - Wahl Instruments Inc.
   5. REO TEMP Instrument Corporation.
   6. Trerice, H. O. Co.
   7. Weiss Instruments, Inc.
   8. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
   9. WIKA Instrument Corporation.
   10. Winters Instruments.

C. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
   1. Case: Dry type, drawn steel or cast aluminum, 2-1/2-inch diameter.
   2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
   3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
   4. Movement: Mechanical, with link to pressure element and connection to pointer.
   5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
   6. Pointer: Red metal.
   7. Window: Glass.
   8. Ring: Metal.
   9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.

10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

D. Pressure-Gage Fittings:
1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.03 RADAR LEVEL TRANSMITTER

A. Radar Level Transmitter
1. Acceptable Manufacturers:
   a. Vegapuls 31
   b. Engineer approved equal
2. Design and Fabrication:
   a. Communications: 4-2mA 2-wire, HART, Bluetooth
   b. Process Connections: 1-1/2" NPT mounting, 1" conduit
   c. Protection: Non-EX ordinary location, CE, FM, CSA, RCM.
3. Accessories:
   a. Mountain Bracket: 1-1/2" mount, 80mm offset, 316L Stainless Steel.

2.04 FLOWMETERS

A. Magnetic Flowmeter:
1. Indicator/Transmitter:
   a. Remotely mounted
   b. All solid state circuitry
   c. Except for indicating scale and totalizer, interchangeable between magnetic flow meters
   d. Indicator and totalizer visible without opening enclosure
   e. Display; 4-1/2 digits
   f. Self-contained zero return which sets flow meter output to zero when flow through meter is minimal
   g. NEMA 4X enclosure
   h. Two programmable setpoint relays, Form “C” rated at 5A resistive
   i. One Analog output; 4-to-20 mA and pulse output for remote totalizer
   j. Accuracy: +/- 1.0 percent
   k. Stability: 0.5 percent of full scale
   l. Response time: 2 seconds minimum
   m. Power: 120 V AC
   n. Liner Material: Hard Rubber
2. Sensor:
   a. Magnetic flow meter
   b. No moving parts in contact with fluid
   c. Flanged
   d. Suitable for 250 psig working pressure
   e. Capable of standing empty for extended periods of flow through time without damage
   f. No constriction in or obstruction of flow through meter
   g. Weather resistant and splash-proof
   h. Encapsulated characterized field coils
   i. Range: As shown on instrument list
   j. Accuracy: ± 0.1 percent of Full Scale
   k. Repeatability: +/- 0.1 percent
   l. Temperature Range: 32-to-176 degrees F
   m. Provide spare flanged spool piece of exact laying length

3. Provided with all communication and power supply interconnecting cables for complete operating system.
4. Magmeter must have no upstream/downstream straight pipe requirements.
5. Manufacturers:
    a. Endress+Hauser; Model Promag W 400 with 0xDN trim
    b. Engineer Approved Equal.

PART 3 EXECUTION

3.01 INSTALLATIONS

A. Calibration of Instruments:
1. Notify the Project Engineer two weeks prior to calibrating instruments
2. The Project Engineer shall determine if calibration procedures will be witnessed
3. Perform calibration exactly as outlined in Manufacturer's printed instructions
4. Check calibration at several points along instrument range
5. Complete data entry on Instrument Calibration Record Sheet immediately after each step of calibration and obtain the Project Engineer's initials for each sheet
6. Completed Instrument Calibration Record Sheets must be submitted prior to substantial completion

B. Control Loop Checkout:
1. Perform control loop checkout in an organized fashion:
    a. Final elements should be first tested and verified
2. Check loop from final element back to instrument cabinet, and/or control panel.
    a. Verify loop operation at control cabinet or control panel
    b. The Contractor will demonstrate each working loop to the Project Engineer.

C. Install direct-mounting pressure gages in piping tees or tappling saddles with pressure gage located on pipe at most readable position.

D. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.

E. Install flowmeter elements in accessible positions in piping systems.

F. Install permanent indicators on walls or brackets in accessible and readable positions.

G. Install connection fittings for attachment to portable indicators in accessible locations.

H. Calibrate meters according to manufacturer's written instructions, after installation.

I. Adjust faces of meters and gages to proper angle for best visibility.

3.02 FIELD QUALITY CONTROL

A. Field testing will be performed under provisions of Section 01 45 23

B. Provide Manufacturer's field services for Work of this Section

C. Prior to start-up:
1. Advise Contractor on installation
2. Check, calibrate, and place equipment in operation
3. Visit the job as often as required and spend as much time as necessary to insure compliance with specification
4. Advise Contractor of necessary corrections for start-up

D. Start-up:
1. Check each loop and demonstrate operation to the Project Engineer

E. Provide written directions to Contractor detailing all corrections necessary for proper operation
1. Provide 8 hours preliminary instruction to plant personnel on operation of instrumentation and controls after conclusion of loop checks

F. Follow-up and Training:
1. As specified in Section 01 79 00

2. Check all corrections made since start-up and recalibrate instruments where changes have occurred
3. Inspect all instrument and control loops with plant personnel, address operation and performance concerns
4. Provide minimum of 8 hours of training encompassing all equipment described in this section

END OF SECTION

SECTION 41 22 13.13
BRIDGE CRANES

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install bridge cranes and trolley hoists as specified herein and where shown on the drawings.

B. Bridge crane, trolleys, hoists, and accessories in for removal, and maintenance of pumps, piping, and other miscellaneous equipment.

1.02 PERFORMANCE AND DESIGN REQUIREMENTS

A. Bridge crane and hoist:
   1. Location: Pump Station
      a. Type: Top running single girder, overhead bridge crane with manual bridge trucks.
      b. Hoist/trolley/monorail capacity: 2 ton
      c. Hoist lift: Electric, single speed
         1) Maximum Motor Size: 480V, 3 phase
         2) Type: Hook attachment
      d. Trolley travel:
         1) Type: Manual chain and gear
      e. Size of runway beams and columns: As shown on Drawings
      f. Length of Runway beams: As shown on Drawings
      g. Required hoist lift distance: 10'
      h. Material requirements: Standard

1.03 SUBMITTALS

A. Submit under provisions of Sections 01 30 00.

B. Shop Drawings:
   1. Outline and installation drawings
   2. Connection details
   3. Weights
   4. Electrical and control panel drawing and wiring schematics

C. Product data:
   1. Sufficient data to verify compliance with Specifications
   2. Installation methods
   3. Data describing materials used, parts, devices, and other accessories
   4. Schematic wiring diagrams for electric chain hoist/trolleys and bridge cranes
   5. Annotated manufacturer's cutsheets for all system components (trucks, raceways, festoon wiring systems, trolley hoists,

D. Certifications:
   1. Copies of all required inspections, reports, and certificates.
   2. Manufacturer’s certificate of installation.
   3. Manufacturer’s certificate of training.

E. Start-up:
   1. Manufacturer’s field report per Section 01 40 00.
   2. Manufacturer’s field test report per Section 01 40 00.

F. Closeout submittals:
   1. Warranty documents.
   2. Operation and maintenance manuals per Sections 01 30 00 and 01 78 23.

G. Qualification Statements:

1. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.

1.04 QUALITY ASSURANCE

A. All equipment supplied by a single manufacturer.

B. Verify that each system component is compatible with all other components of the system and provide all devices necessary for a properly functioning system.

C. Manufacturer Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience.

D. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and dated no more than 12 months before start of scheduled welding work.

E. Erector Qualifications: Company specializing in performing the work of this section with minimum 3 years documented experience.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 01 60 00.

B. Accept equipment and components on site in factory packing. Inspect for damage. Comply with manufacturer's installation instructions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Trolley and hoist:
   1. Columbus McKinnon Corp. (CM) Loadstar
   2. Yale
   3. Duff Norton
   4. Stahl
   5. Harrington
   6. Or Approved Equal.

B. Bridge crane
   1. Columbus McKinnon Corp. (CM) Top Running Crane Bridge Kits.
   2. Or Approved Equal

2.02 MATERIALS

A. Crane framing, masts, boom, and base plates: Steel, ASTM A36 Trolley and bridge wheels:
   1. Standard: Forged steel or cast iron with hardened tread, black oxide finished.
   2. Spark resistant: Manganese bronze.

B. Wheel gears: Alloy carbon steel precision machine cut, supported between sealed ball bearing pillow blocks:
   1. Pinions: Heat-treated alloy steel.

C. Chain:
   1. Standard: Zinc-plated, heat-treated steel.
   2. Spark resistant: Stainless steel.

D. Axles: Steel.

E. Bearings: Anti-friction, lifetime lubricated and sealed, B10 life 5,000 hours.

F. Lifting hook: Stainless steel, coated forged steel, or galvanized steel

G. Cable: 304 stainless steel.

2.03 ACCESSORIES

A. Chain Container:
   1. Steel.
   2. For storage of all excess chain.

2.04 FABRICATION

A. General:
   1. Corrosion resistant

B. Trolley:
   1. Single rigidly constructed unit
   2. Designed to support hoist
   3. Driven through a sealed worm gear drive permanently lubricated wheels:
      a. Integrally cut spur teeth or machine cut gears pressed on hubs on one set of wheels.
      b. Permanently shielded, lifetime lubricated, anti-friction bearings suitable for radial and thrust load.
   4. Rigid mount design integral with hoist for close headroom.

C. Hoist:
   1. Gearing brake, mechanical load brake, and gearing mounted or assembled in the trolley frame, cross mounted:
      a. Gearing fully enclosed lifetime lubricated.
      b. True vertical lift.
      c. Mechanical load brakes:
         1) Load raised or lowered by double revved wire rope.
         2) Load automatically sustained at any position.
      d. Integral load limiting device.
   2. Lifting tackle:
      a. Lower block and hook.
      b. Safety type.
      c. Guarded sheaves.
      d. Slow-opening, non-fracturing hook.
      e. Safety latch at throat of opening.
      f. Hook supported by ball or roller thrust bearing to permit easy turning.
      g. Sheaves: Anti-friction or sleeve bearings.

D. Bridge:
   1. Rigidly supported by end trucks.
   2. Wearing surface of lower flange constructed of specially fabricated flanges or standard flanges ground smooth.
   3. Steel design and fabrication in accordance with applicable AISC specifications.
   4. Max main girder deflection with max hoist load in any position: 1/450 of span.
   5. Impact allowance: 10 percent of max hoist load.
   6. Max allowable tensile and compressive stresses: 14,500 psi.
   7. Solid State electronic acceleration control where required.
   8. End trucks:
      a. Designed to distribute load equally to each wheel
      b. Securely attached to beam with fitted bolts in reamed holes
      c. Provided with heavy gusset plates to insure adequate rigidity and squareness
      d. Heavy end plates to engage runway beam stops
      e. End truck wheel base: 6'-3" Maximum
      f. End truck overall length (bumper to bumper): 8'-3" maximum
   9. Bridge Wheels:
      a. Permanently shielded, lifetime lubricated, anti-friction bearings suitable for radial and end thrust loads.
      b. Fixed or rotating axles.
      c. Gear driven: Provide 1 wheel with either spur gear teeth cut in the flanges or a machine cut gear pressed on the wheel hub to engage drive pinions on each truck.
   10. Hoist Motors:

a. Hoist motors shall be TEFC, continuous-duty motors which meet NEMA standards. Insulation shall be NEMA Class F. Motor design shall be NEMA design D.

11. Electrical and Control Enclosures:
    a. Electrical and control enclosures shall carry a NEMA 4 enclosure rating.

E. Bumps and end stops:
1. Field locate end stops per manufacturer instructions at each end of runway beams, bridge beam, and monorails.
2. Locate so that no part of trolley makes contact with adjacent structures.
3. Provide rubber bumps on each end of end-trucks.

PART 3 EXECUTION

3.01 ERECTION

A. Erect in accordance with manufacturer’s instructions.

3.02 FIELD QUALITY CONTROL

A. Provide under provisions of Sections of Division 01.

B. Provide manufacturer's field service representative for a minimum or eight (8) hours for installation assistance, check, and approval for each installation.

C. Provide additional two (2) hours of owner's personnel training.

END OF SECTION

SECTION 43 24 16
VERTICAL TURBINE PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Work under this Section shall include all labor, equipment, and materials necessary to furnish and install three (3) vertical turbine pumps.

1.02 SUBMITTALS

A. Submit in accordance with Section 01 30 00, copies of all materials required to establish compliance with this Section. Submittals shall include at least the following information:

B. Product data: Provide manufacturer's literature including general assembly, materials of construction, performance characteristics, coatings, power requirements, wiring diagrams, service connections, and additional information necessary to determine compliance with these Specifications:
   1. Each Pump:
      a. Name of manufacturer.
      b. Type and model.
      c. Rotational speed at all designated operating conditions.
      d. Size of suction nozzle.
      e. Size of discharge nozzle.
      f. Type of bearings.
      g. Net weight of pump only.
      h. Net weight of components and total assembly including motor.
      i. Complete performance curves showing capacity versus head, NPSH required, pump efficiency and bhp at all designated operating conditions.
      j. Type and construction of seals.
      k. Type of coupling.
      l. Data on shop painting.
   2. Each Motor:
      a. Name of manufacturer.
      b. Type and model.
      c. Type of bearings and shaft.
      d. Rated size of motor hp.
      e. Temperature rating.
      f. Insulation Rating.
      g. Full load rotative speed.
      h. Net weight.
      i. Efficiency at full, ¾, and ½ load and rated pump condition.
      j. Full load current.
      k. Power factor at no load and at full load.
      l. Locked rotor current.
      m. Overall dimensions and base details.

C. Drawings of the proposed equipment giving general dimensions sufficient to determine how the equipment is to be supported and if it will fit within the space available.
   1. Pump Assembly Drawings
   2. Motor Drawings

D. Any additional information such as descriptive literature, manufacturer's specifications, and other data to demonstrate compliance with these specifications including but not limited to:
   1. Weld Certificates for all welded components (to be furnished at project completion)
   2. Pump Performance and Testing Data
   3. Vibration Analysis

4. Motor specifications

E. ISO-9001 quality certificate and documentation from pump manufacturer.

F. Manufacturers NSF61 & 372 certificate from the pump manufacturer.

G. Manufacturer's installation instructions: Provide connection requirements and start-up instructions for pumps.

H. Test Reports: Submit certified copies of shop test reports for each pump supplier at least 10 days before shipping equipment. Reports shall include:
   1. Test log
   2. Description of test piping, equipment and setup
   3. Test procedure
   4. Certified performance curves at rated conditions, plotted against capacity:
      a. Head
      b. Brake horsepower
      c. Efficiency
      d. Actual speed
      e. Net positive suction head required
   5. Plot curve to be easily read at scales consistent with the performance requirements.

I. Manufacturer's field report: Indicate personnel present and actual tests and start-up procedures that were performed by manufacturer's representative.

J. Contractor shall coordinate pump and motor system height with the available height for picking that pump and motor and placing it as required to perform the installation.

1.03 QUALIFICATIONS

A. The pump(s) shall be designed and furnished to conform to the Hydraulic Institute and AWWA specifications for Lineshaft Turbine Pumps and shall comply with all local and state sanitary and safety regulations.

B. The pump manufactured must be ISO-9001 certified, with established quality standards and procedures in accordance with ISO-9001.

C. The Pump manufacturer must be certified to NSF61 Annex G & NSF372 conforming to the "lead free" requirements of the U.S. Safe Drinking Water Act.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
   1. SIMFLO, LLC
   2. Engineer Approved Equal

2.02 DESIGN CRITERIA

A. Pump 1
   1. Designated operating conditions:
      a. Design Point: 500 GPM @ 145 ft TDH @ 80% min eff.
   2. Overall length: per plans
   3. Maximum allowable speed: 1775 RPM
   4. Mechanical seal: (cartridge, single)
   5. Motor Horsepower: 25 hp, TEFC, Inverter Duty Rated, 3 phase, 480 V, 60 HZ
   6. Pump and motor shall be suitable for continuous duty and variable speed operation.
   7. Line Shaft/column pipe maximum segment length: 10 ft

B. Pump 2
   1. Designated operating conditions:
      a. Design Point: 750 GPM @ 147 ft TDH @ 80% min eff.
   2. Overall length: per plans

3. Maximum allowable speed: 1775 RPM
4. Mechanical seal: (cartridge, single)
5. Motor Horsepower: 40 hp, TEFC, Inverter Duty Rated, 3 phase, 480 V, 60 HZ
6. Pump and motor shall be suitable for continuous duty and variable speed operation.
7. Line Shaft/column pipe maximum segment length: 10 ft

C. Pump 3
1. Designated operating conditions:
   a. Design Point: 1000 GPM @ 145 ft TDH @ 80% min eff.
2. Overall length: per plans
3. Maximum allowable speed: 1775 RPM
4. Mechanical seal: (cartridge, single)
5. Motor Horsepower: 50 hp, TEFC, Inverter Duty Rated, 3 phase, 480 V, 60 HZ
6. Pump and motor shall be suitable for continuous duty and variable speed operation.
7. Line Shaft/column pipe maximum segment length: 10 ft

D. Pump motors shall be de-rated for project elevation of5,040' ASL

2.03 GENERAL

A. PUMP CONSTRUCTION
1. DISCHARGE HEAD:
   a. The discharge head shall be fabricated of carbon steel materials using ASTM A181 flanges, ASTM A53 Grade B body pipe and ASTM A36 HR carbon steel plate. The discharge head shall be for above ground discharge with sufficient strength and rigidity to support the attached vertical motor or driver and carry the suspended weight of the attached column and bowl assembly. All wetted pressure retaining parts shall be designed for a maximum working pressure equal to the pump shut off head. The discharge flange shall be sized to match the column diameter and have a 150# ANSI raised face with bolt holes straddling the vertical centerline. A ¼" NPT pressure gauge connection shall be supplied on the top centerline of the discharge outlet. The base of the discharge head shall be circular and fully finished machined on the bottom. The top of the discharge head shall be machined to accept a standard NEMA P base, driver and have a diameter equal to the driver base diameter (BD). The head shaft shall be coupled to the top line shaft beneath the motor to facilitate ease of assembly and maintenance. Head shall be in all respects equal to SIMFLO type "L". All couplings and other moving or rotating parts shall be covered on all sides by a fabricated OSHA approved coupling guard. Coupling guards shall include an integrated hinged door for access to coupling and mechanical seal/packing. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. The pump shall be furnished with a SS nameplate securely mounted to the discharge head. At a minimum it shall contain information providing (design flow, design TDH, HP, RPM, bowl model number, number of stages, manufacturer serial number, pump type & impeller setting dimension).
   b. A rigid flanged adjustable "spacer" type motor coupling shall be provided to couple the motor shaft to the pump shaft. The spacer shall be of sufficient length to allow the mechanical seal to be removed without disturbing the motor. The motor coupling shall be a three- piece or spacer type four-piece rigid coupling. The coupling shall be of steel, designed to transmit the required torque and horsepower of the attached pump and other rotating elements. The pump side of the coupling shall be keyed to the head shaft. The motor side shall have a radial key to support down thrust and an axial key to transmit torque. A threaded adjusting nut shall be located above the pump side coupling component to allow for the vertical adjustment of the shaft mounted impellers. The coupling shall be designed to prevent movement due to up thrust and held concentric by means of machined registers.

c. The discharge head shall be fitted with a mechanical seal. The seal housing shall be of ASTM A48 Class 30 cast iron. The seal shall be of the cartridge type, sleeve mounted, easily replaceable and have its face continuously flushed with the product being pumped.The mechanical seal shall include 316 stainless steel metal parts. The mechanical seal shall have a carbon stationary face, a tungsten carbide rotating face, and fluorocarbon o-rings. The mechanical seal shall be rated for 600 psi and 400 Deg F. A seal housing bearing of the material listed in the subsection “materials of construction” shall be installed directly below the mechanical seal for stability. A nitrile o-ring shall be used to seal the seal housing to the discharge head. The seal shall be equivalent to the Chesterton 155 or John Crane 5610.

d. The pump shall be mounted and supported by a separate foundation baseplate. The baseplate shall be of ASTM A36 HR carbon steel. The baseplate shall be drilled to match the base flange drilling of the discharge head. The baseplate shall be square with radius corners, equal to or greater than the size of the base of the discharge head. The baseplate shall be uniformly faced on one side, with four drilled holes provided, one at each corner to accommodate anchor bolts. Abutting surfaces between the baseplate and the discharge head shall be machined to provide 100% surface contact with the discharge head base. The center opening diameter shall be of sufficient size to permit installation and removal of the complete pump assembly. The baseplate shall be permanently anchored, grouted and leveled within 0.003 inches per foot by the installing contractor.

2. COLUMN PIPE:

a. The column pipe shall include flanges to be made of ASTM A36 HR steel. The flanges shall include a female register to ensure proper alignment and be machined for drop-in bearing retainers. The column pipe shall be constructed of material conforming to ASTM A53 Gr. B steel with a minimum wall thickness as listed under the subsection “service conditions”. The weight of the column pipe shall be no less than that stated in ANSI/AWWA Specification E103. The column diameter will be sized such that friction loss will not exceed 5’ per 100’, based on the rated capacity of the pump. When applicable, the column diameter shall also be sized based on the avoidance of critical speeds including a +/- 25% operational margin. Column length shall not exceed 10’ for pumps running at 1800 RPM. The top and bottom sections shall not exceed 5’. Flange bolting shall be provided in the materials as listed in the subsection “materials of construction”.

b. The column line shaft shall be turned and ground and manufactured of the materiallisted in the subsection “materials of construction”.

3. LINESHAFTS:

a. Lineshafts shall be 416 Stainless Steel, turned, ground, and polished.

b. They shall be furnished in interchangeable sections not more than maximum length specified in design criteria.

c. The shaft shall be sized in accordance with the maximum recommended horsepower for a given size of shaft, taking into account the affect of the hydraulic thrust on the pumping equipment and the weight of the shaft and suspended rotating parts.

d. To ensure accurate alignment of the shafts, they shall be straight within 0.005 in. total indicator reading for a 10 ft. section. The butting faces shall be machined with center relief and square to the axis of the shaft.

e. The lineshaft shall be coupled with 304 Stainless Steel couplings, and shall be held in place by bearing retainers with neoprene lineshaft bearings at each column joint.

f. Drop-in style bronze bearing retainers shall be used on column 12" and smaller. Column over 12" shall have a weld-in bearing retainer.

4. PUMP BOWLS:

a. The pump bowls shall be constructed of the material as listed under the subsection “materials of construction”. The bowls shall be accurately machined and flanged with machined rabbet fit connections. The water passages of pump bowls size 6” through 14” shall have vitreous porcelain enamel lining and 16” and larger shall have

ScotchKote™ Fusion Bonded Epoxy 134 both to reduce friction losses. The waterways and diffusion vanes shall be smooth and free from nodules, bumps & dips and shall be cast of high quality free of blow holes, sand holes and other detrimental defects. The bowl assembly shall be fitted with a suction bell including integral cast ribs supporting the suction bearing and sand collar to protect the suction bearing from abrasives. The suction bearing shall be permanently packed with food grade grease, and shall have a length not less than 2 times the shaft diameter. The bowl bearings are to be lubricated by the product being pumped and located above and below each impeller. All bearings shall be sleeve type of the material listed in the subsection "materials of construction". When applicable, the bowl bolting material shall be as listed in the subsection "materials of construction".

5. IMPELLERS:
   a. The impellers shall be cast in one piece of the enclosed type and constructed of the material listed in the subsection "materials of construction". The impellers shall be statically or dynamically balanced. The impeller shall be securely fastened to the shaft with taper split bushings (collets) of the material listed in the subsection "materials of construction" for bowl shafts 2-3/16" nominal diameter and smaller or with keyed connections for bowl shafts larger than 2-3/16" nominal diameter. The bowl shafting shall conform to the material listed in the subsection "materials of construction". Impellers shall have pump shaft quality dimensional tolerances of +.000" .002", and shall be straightened to within .0005" total indicated reading per foot of length or .002" TIR, whichever is greater. The bowl shaft shall be of sufficient diameter to transmit the pump horsepower with a safety factor consistent with AWWA pump shaft standards. Impellers shall be adjusted vertically by external means and shall have sufficient axial clearance for reliable service in accordance with the specified operating conditions.
   b. Balance logs shall be provided upon request.
6. SUCTION BELL:
   a. Suction bell shall be fitted with grease packed lead-free bronze bearing and protected by a lead-free bronze sand collar. The suction bell shall be fitted with a heavy gauge wire woven basket type strainer, of the material listed in the subsection "materials of construction". The strainer shall have a net inlet equal to at least four times the suction pipe area. The maximum opening shall not be more than 75% of the minimum opening of the water passage through the bowl and impeller. The strainer shall be secured to the suction bell by means of bronze clips and 300 series stainless steel cap screws.

B. PAINTING:
   1. All iron and steel parts that will be in contact with pumped liquid or submerged after installation, including the inside of the pump column, discharge Head and all exterior surfaces below the sub-base plate or mounting flange, shall be shop cleaned by blasting in accordance with the coating manufacturer's recommendations and painted with an NSF-61 Approved Coating such as TNEMIC Series N140 Pota-Pox Plus coating system.
   2. The coating shall have a dry film thickness of at least ten (10) mils and shall consist of a prime (first) coat and one or more finish coats.
   3. All other iron and steel surfaces, except stainless steel and machined surfaces, shall be protected with suitable protective coatings applied in the shop.
   4. Coatings shall be suitable for the environment where the equipment is installed.
   5. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

C. MOTOR
   1. General
   2. Motor Design Standards

a. In addition to this specification, equipment shall comply with the current applicable standards promulgated by:
    1) NEMA National Electrical Manufacturers Association (MG-1)
    2) IEEE Institute of Electrical and Electronics Engineers (Testing)
    3) AFBMA Anti-Friction Bearing Manufacturers Association
    4) ANSI American National Standards Institute
    5) ASTM American Society of Testing Materials
    6) HI Hydraulic Institute
    7) AWWA American Water Works Association
b. Motor manufacturer shall be an active member of NEMA.
c. Motor manufacturer shall have experience in the design and manufacture of similar products for a minimum of 10 years. Buy-out or private labeled motors are not acceptable.

3. Motor Service Conditions
    a. Suitable for service indoors or outdoors in a clean environment.
    b. Ambient temperature not greater than 40 degrees C.
    c. Voltage variation of+/- 10%
    d. Frequency variation of+/- 5%
    e. Combination of Voltage and Frequency Variationabove, not to exceed 10%.
4. Motor Electrical Design
    a. Unless otherwise specified, power supply shall be 3/60/460 (for nominal 480 volt system).
    b. Paralleled leads are acceptable above 200HP.
    c. Insulation system shall be rated minimum Class F (155 degrees C.)
        1) Magnet wire shall be copper and rated Class H (180 degrees C.) or better.
        2) Magnet wire shall be classified Pulse Endurance, suitable for variable frequency applications.
        3) Varnish shall be 100% solids polyester. Water-borne varnish is not acceptable.
    d. Rotor bar construction shall be cast aluminum.
    e. Maximum temperature rise at rated HP shall not exceed Class B limits (80 degrees C.)
    f. Maximum temperature rise at 1.15 Service Factor shall not exceed Class F limits (115 degrees C.)
    g. Motors shall be rated for inverter duty. Starting shall be via use of variable frequency drives.
    h. Motors shall be rated for continuous duty.
    i. Motors shall be premium efficiency in accordance with "NEMA PREMIUM"™ values for horsepower, speed and enclosure.
    j. Motors applied to variable frequency drives shall adhere to NEMA MG-1 Part 31 and shall be nameplated accordingly.
5. Motor Mechanical Design
    a. The driven machine shall not overload the motor rating at any operating point.
    b. Bearings
        1) Bearings shall be rated for a 5-year minimum L-10 life at operating condition. For vertical high thrust motors, this includes the weight of the rotating element and the hydraulic thrust developed by the pump.
        2) Vertical motors shall be capable of 30% (of normal downthrust) momentary up thrust.
        3) Bearings shall be anti friction type, ball or roller as required.
        4) High thrust vertical motor thrust bearings shall be angular contact or spherical roller as required to obtain specified life.
        5) Angular contact bearings may be stacked as required for specified life.

6) Spherical roller bearings shall be oil lubricated and shall not require water cooling. Motor manufacturer must advise minimum downthrust required to keep spherical roller bearing seated.

6. Lubrication
   a. Oil lubricated bearings shall have an externally visible sight glass to view oil level.
   b. Oil fill port shall be located so over-filling is not possible.
   c. Synthetic oil is preferred when spherical roller bearings are used.
   d. Grease lubricated bearings shall be designed for electric motor use. Grease shall be capable of higher temperatures associated with electric motors and shall be equal to Exxon Polyrex EM™.
   e. Grease fittings shall be Alemite™ type, no smaller than ¼" NPT.
   f. Grease exits shall be automatic pressure relief type, no smaller that¼" NPT.
7. Vibration shall not exceed 0.08 inches per second, peak to peak.
8. Noise level shall not exceed 85 db(A) at 1 meter.
9. Motors shall have permanent lifting eyes or lugs capable of a safety factor of 10.
10. Metric fasteners are not acceptable.
11. All airway openings on weather-protected enclosures shall be screened with zinc, galvanized or stainless steel. Mesh openings shall not exceed 1/4 inch.
12. Final paint finish shall be corrosive resistant and capable of passing ASTM-B117 250 hour salt spray test.
13. Motor Accessories (When specified)
    a. Anti condensation heaters shall be provided to keep motor windings at least 10 degrees F. above the ambient temperature. Heaters shall be 1/60/115 with leads terminating in a separate auxiliary outlet box or conduit.
    b. Winding thermostats shall be in each phase of the motor. There shall be one per phase, NC, connected in series with leads terminating in the auxiliary outlet box or conduit.
    c. Grounding provisions shall be in the main terminal box.
    d. Maximum reverse rotation shall be limited to 5 degrees of arc.
    e. Motors above 200HP shall be started on reduced voltage. (via part winding, auto transformer, wye-delta)
14. Tests (in addition to manufactures' standard tests)
    a. When specified, provide correlated performance data for that design.
    b. When specified, conduct Short Commercial Test with report.
15. When specified, conduct Complete Initial Test with report. (Per latest issue of IEEE 112A, method B)
    a. When specified, conduct Noise test with report. (Per latest issue of IEEE 85)
    b. All tests shall be conducted by a NVLAP accredited test facility.
16. Motor Submittal data required
    a. Description of product.
    b. Motor nameplate information.
    c. Motor performance data.
    d. Motor dimension prints, including coupling if hollow shaft.
    e. Reed Critical Frequency data if applied to variable frequency drive.
    f. Parts breakdown.
    g. Operation and Maintenance Manual.
    h. List of any exceptions to this specification.
17. Motor Warranty
    a. The motor(s) shall be warranted to be free from defects in material or workmanship for a period of 24 months from the date of Substantial Completion, not to exceed 30 months from shipment by the manufacturer.
    b. Contractor shall be responsible for proper storage of equipment prior to placing in service in accordance with the manufacturers' recommendations and instructions.

18. PAINTING:
    a. All iron and steel parts that will be in contact with pumped liquid or submerged after installation, including the inside of the pump column, discharge Head and all exterior surfaces below the sub-base plate or mounting flange, shall be shop cleaned by blasting in accordance with the coating manufacturer's recommendations and painted with an NSF-61 Approved Coating such as TNEMIC Series N140 Pota-Pox Plus coating system.
    b. The coating shall have a dry film thickness of at least ten (10) mils and shall consist of a prime (first) coat and one or more finish coats.
    c. All other iron and steel surfaces, except stainless steel and machined surfaces, shall be protected with suitable protective coatings applied in the shop.
    d. Coatings shall be suitable for the environment where the equipment is installed.
    e. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.
    f. Painting shall be as described in the National Pump Company Paint Procedures:

D. MATERIALS OF CONSTRUCTION:

Component	**Material**
Pump Bowls	Cast Iron (ASTM A48 C130 Enamel Lined)
Impellers	CF8m 316SS
Bowl Assembly Shaft	416 HT Stainless Steel (ASTM A582)
Bowl Bearings	Bronze (ASTM 505 C89835)
Collets	Carbon Steel (ASTM A519 Gr 1018)
Bowl Bolting	304SS (ASTM F593)
Bowl Wear Rings	NA
Impeller Wear Rings	NA
Strainer	304 Stainless Steel
Column Pipe Thickness	AWWA Standard
Column Bolting	304 SS (ASTM F593 Gr CW1)
Line Shaft	416 HT Stainless Steel (ASTM A582)
Line Shaft Couplings	304 SS (ASTM A276 Gr 304)
Line Shaft Sleeves	NA
Line Shaft Bearings	Polychloroprene Rubber (PCR)
Bearing Retainers	316 SS (ASTM A743 CF8)
Disharge Head	Fabricated Steel (A36 HR Gr 70 plt, A105 Flg, A53 Gr B pipe)
Sole Plate	Fabricated Steel (A36 Gr 70 plt)
Name Plate	Stainless Steel

PART 3 EXECUTION

3.01 DELIVERY

A. The Contractor shall have a representative on site during delivery.

B. The Contractor shall coordinate the schedule of delivery with the Owner. The Owner shall require at least 2 weeks notice to schedule the unloading of the equipment.

C. The Contractor shall be responsible for monitoring the delivery for damage and document it before and after the unloading.

D. The Contracting Officer’s Representative shall be responsible for refusing the unloading of any equipment that is damaged during delivery. Any damage occurred during delivery shall be resolved in accordance with the General Conditions.

3.02 INSTALLATION

A. The equipment shall be installed in accordance with manufacturers' recommendations including, but no limited to conduit, breakers, anchorage support, plumbing, and wiring if necessary for installation.

B. Contractor shall provide all means to mount the pumps

C. Contractor shall provide proper leveling and alignment

D. The Contractor shall provide a two-year warranty on all equipment parts that are supplied by the Contractor regardless.

E. The Contractor shall be responsible for relocating any existing facilities as needed to allow space and access for new equipment

F. Attach pump base (when applicable) as indicated on Drawings

G. Align pump and motor shafts

H. Level, plumb, align, and wedge unit into position connecting piping

I. Connect discharge piping such that no strain is transmitted to pump flange

J. Pour non-shrink grout under base (sole plate), when applicable

K. Test pump connections for piping stresses after final alignment and bolting: loosen flange bolts if any movement or opening of joints is observed, adjust piping to fit.

3.03 QUALITY CONTROL

A. Contractor shall demonstrate functionality of pumps to Engineer prior to final acceptance. Demonstration shall include leak-free piping under service conditions, pump capacity, repeatability, adjustability, controls, and suction lift.

B. On-site performance testing and adjusting:
   1. All systems shall be subjected to operating conditions. Based upon visual observations, any excessive leaks, vibrations, deflections, or stress in the piping systems shall be corrected to the satisfaction of the Engineer.
   2. Check for proper vibration isolation, high bearing temperature and temperature of mechanical seal, vibration in-line and transverse to piping
   3. Check motors for overload, coordinate overload heaters, and MCP breaker setting
   4. Measure flow (design point and other point to define curve), motor energy consumption (current), discharge pressure (shut off design point and one other), unit vibration in-line and transverse to piping.
   5. Provide data to Engineer in Field Report

3.04 TESTING

A. The column assembly shall be hydrostatically tested in accordance with the Hydraulic Institute latest edition.

B. The bowl assembly shall be performance tested in accordance with the Hydraulic Institute latest edition.

C. The test results shall be witnessed, signed and stamped by a registered professional engineer.

D. Structural Natural Frequency Analysis
   1. The manufacturer shall perform a structural natural frequency analysis of the fabricated discharge head and motor assembly utilizing solid models and performed using a commercially available finite element analysis program. This analysis shall show that there are no 1st or 2nd natural frequencies within +/-25% of the specified operating range. If no operating range is specified, the operating range will be assumed to be 70 to 100 percent of full load operating speed. The report shall be submitted to the Engineer for review prior to release for production.
   2. The analysis report shall contain the following:

a. Summary detailing the operating range, analysis range, and if the design is acceptable
b. List of assumptions used in the analysis
c. Description of the model with detailed sketch and material properties
d. Analysis results and graphic representation of each mode shape
e. Signed and stamped by a registered professional engineer

E. Lateral Rotordynamic Analysis
1. This analysis is required if all the below items are met:
a. A similar pump does not already exist
b. The pump is 50 ft or less
c. Solid line shaft bearings are being used
2. The manufacturer shall perform a lateral rotordynamic analysis of the complete rotating pump assembly utilizing a commercially available program such as DyRoBeS or similar. The analysis shall be done in accordance with API 610 10th edition Annex I. This analysis shall be performed by an individual who has completed a course specializing in rotordynamic analysis. The analysis report shall contain the following:
a. Summary detailing the operating range and if the design is acceptable
b. List of assumptions used in the analysis
c. Description of the model with figure
d. Analysis results and graphic representation of each mode shape
e. A steady-state damped unbalanced response analysis (if required)
f. Signed and stamped by a registered professional engineer

F. Torsional Rotordynamic Analysis
1. The manufacturer shall perform a torsional rotordynamic analysis of the complete rotating pump assembly utilizing a commercially available program such as DyRoBeS or similar. This analysis shall show that there are not torsional natural frequency interferences within +/- 10% of the specified operating range. If no operating range is specified, the operating range will be assumed to be 70 to 100 percent of full load operating speed. If torsional natural frequency interference is found within the range of interest, a forced response analysis and fatigue life calculations shall be performed showing the shaft has infinite life. This analysis shall be performed by an individual who has completed a course specializing in rotordynamic analysis. The analysis report shall contain the following:
a. Summary detailing the operating range, analysis range and if the design is acceptable.
b. List of assumptions used in the analysis
c. Description of the model with figure
d. Analysis results and graphic representation of each mode shape
e. A torsional interference diagram
f. A forced response analysis and fatigue life calculation (if required)
g. Signed and stamped by a registered professional engineer

END OF SECTION

APPENDIX A

GEOTECHNICAL REPORT

Huddleston-Berry
Engineering & Testing, LLC

GEOTECHNICAL AND GEOLOGIC HAZARDS INVESTIGATION
UTE WATER WTP
PALISADE, COLORADO
PROJECT #01171-0018

SCHMUESER GORDON MEYER
118 W SIXTH STREET, SUITE 200
GLENWOOD SPRINGS, COLORADO 81601

JUNE 17, 2025

Huddleston-Berry Engineering and Testing, LLC
2789 Riverside Parkway
Grand Junction, Colorado 81501

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Figure 1 – Site Location Map
Figure 2 – Site Plan

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Appendix A – UDSA NRCS Soil Survey Data
Appendix B – Typed Boring Logs
Appendix C – Laboratory Testing Results

1.0 INTRODUCTION

As part of the continued infrastructure improvements, Ute Water proposes to expand their facilities in Palisade, Colorado. As part of the design process, Huddleston-Berry Engineering and Testing, LLC (HBET) was retained by Schmueser Gordon Meyer to conduct a geologic hazards and geotechnical investigation at the site.

1.1 Scope

As discussed above, a geologic hazards and geotechnical investigation was conducted for the Ute Water Water Treatment Plant (WTP) in Palisade, Colorado. The scope of the investigation included the following components:

- Conducting a subsurface investigation to evaluate the subsurface conditions at the site.
- Collecting soil samples and conducting laboratory testing to determine the engineering properties of the soils at the site.
- Providing recommendations for foundation type and subgrade preparation.
- Providing recommendations for bearing capacity.
- Providing recommendations for lateral earth pressure.
- Providing recommendations for drainage, grading, and general earthwork.
- Evaluating potential geologic hazards at the site.

The investigation and report were completed by a Colorado registered professional engineer in accordance with generally accepted geotechnical and geological engineering practices. This report has been prepared for the exclusive use of Schmueser Gordon Meyer and the Owner.

1.2 Site Location and Description

The site is located west of the existing Ute Water Water Treatment Plant along Rapid Creek Road in Palisade, Colorado. The project location is shown on Figure 1 – Site Location Map.

At the time of the investigation, the site was vegetated with weeds, brush, and trees. The site was undulating with small drainages crossing the property, but generally sloped down to the west. A small dry pond was also present in the western portion of the site. The site was bordered to the north and west by Rapid Creek Road, to the south by open land, and to the east by the existing WTP.

1.3 Proposed Construction

The proposed construction is anticipated to include a new wet well/pump station and membrane lined storage tank. The proposed structures are anticipated to be concrete.

2.0 GEOLOGIC SETTING

2.1 Soils

Soils data was obtained from the USDA Natural Resource Conservation Service Web Soil Survey. The data indicates that the soils at the site consist of the Barx-Clapper complex, 3 to 12 percent slopes. Soil survey data, including a description of the soil unit, is included in Appendix A. The site soils are indicated to have a moderate potential for frost action, low to moderate risk of corrosion of uncoated steel, and low to moderate risk of corrosion of concrete.

2.2 Geology

According to the *Geologic Map of Colorado* by Ogden Tweto (1979), the site is underlain by the Mount Garfield formation and Sego sandstone.

2.3 Groundwater

Groundwater was not encountered in the subsurface at the time of the investigation.

3.0 FIELD INVESTIGATION

3.1 Subsurface Investigation

The subsurface investigation was conducted on May 15th, 2025 and consisted of six borings as shown on Figure 2. The borings were drilled to depths of between 2.0 and 20.0 feet below the existing ground surface. Typed boring logs are included in Appendix B. Samples of the native soils were collected during Standard Penetration Testing (SPT) and/or using bulk sampling methods at the locations shown on the logs.

As indicated on the logs, the subsurface conditions at the site were slightly variable. However, the borings generally encountered 1.0 foot of topsoil above gray to brown to tan, moist, very stiff to hard sandy lean clay with gravels and occasional boulders. The sandy lean clay soils extended to the bottoms of the borings. In B-2 through B-6, the borings terminated at auger refusal on large boulders. As discussed previously, groundwater was not encountered in the subsurface at the time of the investigation.

3.2 Field Reconnaissance

The field reconnaissance included walking the site during the subsurface investigation. In general, no evidence of landslides, debris flows, rockfalls, etc. was observed. However, as discussed previously, small drainages ran through the site and these could be subject to flash flooding.

4.0 LABORATORY TESTING

Selected native soil samples collected from the borings were tested in the Huddleston-Berry Engineering and Testing LLC geotechnical laboratory for natural moisture content determination, grain size analysis, maximum dry density and optimum moisture content (Proctor) determination, and Atterberg limits determination. The laboratory testing results are included in Appendix C.

The laboratory testing results indicate that the native clay soils are slightly plastic. Due to the presence of large particles, undisturbed samples of the clay were unable to be collected for swell/consolidation testing. However, based upon the Atterberg limits and upon our experience with similar soils in the vicinity of the subject site, the native clay soils are anticipated to be slightly collapsible.

5.0 RECOMMENDATIONS

5.1 Foundations

Based upon information provided, shallow foundations are likely for the proposed structures. Spread footings and monolithic (turndown) structural slab foundations are both appropriate alternatives. However, in order to provide a uniform bearing stratum and reduce the risk of excessive differential movements, it is recommended that the foundations be constructed above a minimum of 24-inches of structural fill.

The native clay soils, exclusive of topsoil, are suitable for reuse as structural fill; provided particles in excess of 3-inches in diameter are removed. Imported structural fill should consist of a granular, non-expansive, ***non-free draining*** material with greater than 10% passing the #200 sieve and Liquid Limit of less than 30. However, all proposed imported structural fill materials should be approved by HBET.

For spread footing foundations, the footing areas may be trenched. However, for monolithic slab foundations, the structural fill should extend across the entire building pad area to a depth of 24-inches below the turndown edges. Structural fill should extend laterally beyond the edges of the foundations a distance equal to the thickness of structural fill for both foundation types.

Prior to placement of structural fill, it is recommended that the bottoms of the foundation excavations be scarified to a depth of 6 to 9-inches, moisture conditioned, and re-compacted to a minimum of 95% of the standard Proctor maximum dry density, within ±2% of the optimum moisture content as determined in accordance with ASTM D698. Structural fill should be moisture conditioned, placed in maximum 8-inch loose lifts, and compacted to a minimum of 95% of the standard Proctor maximum dry density for fine grained soils or modified Proctor maximum dry density for coarse grained soils, within ±2% of the optimum moisture content as determined in accordance with ASTM D698 or D1557C, respectively.

For structural fill consisting of the native soils or imported granular materials, and foundation building pad preparation as recommended, a maximum net allowable bearing capacity of 2,000 psf may be used. In addition, a modulus of subgrade reaction of 150 pci may be used for structural fill consisting of the native soils and a modulus of 200 pci may be used for structural fill consisting of approved materials. Foundations subject to frost should be at least 24 inches below the finished grade.

5.2 Corrosion of Concrete and Steel

As discussed previously, the USDA Soil Survey Data indicates that the site soils have a low to moderate potential for corrosion of concrete. Therefore, at a minimum, cement adequate for Sulfate Exposure Class S1 is recommended for construction at this site.

The Soil Survey Data also indicates that the site soils have a low to moderate potential for corrosion of uncoated steel. Therefore, buried steel utilities or other buried steel structural elements should consider corrosion in their design.

5.3 Non-Structural Floor Slabs and Exterior Flatwork

To help limit the potential for excessive movement of non-structural floor slabs, it is recommended that non-structural floor slabs be constructed above a minimum of 18-inches of structural fill with subgrade preparation and fill placement in accordance with the *Foundations* section of this report. It is recommended that exterior flatwork be constructed above a minimum of 12-inches of structural fill.

5.4 Lateral Earth Pressures

Stemwalls and/or retaining walls should be designed to resist lateral earth pressures. For backfill consisting of the native soils or imported granular, non-free draining, non-expansive material, we recommend that the walls be designed for an active equivalent fluid unit weight of 45 pcf in areas where no surcharge loads are present. An at-rest equivalent fluid unit weight of 65 pcf is recommended for braced walls. Although HBET generally recommends against passive resistance based upon the magnitude of movements necessary to mobilize it, if used, a passive equivalent fluid unit weight of 150 pcf is appropriate. Lateral earth pressures should be increased as necessary to reflect any surcharge loading behind the walls.

5.5 Drainage

Due to the presence of moisture sensitive soils at the site, proper site grading is critical to the performance of the structures. In order to improve the long-term performance of the foundations and slabs-on-grade, grading around the structures should be designed to carry precipitation and runoff away from the structures. It is recommended that the finished ground surface drop at least twelve inches within the first ten feet away from the structures.

HBET recommends that downspout extensions be used which discharge a minimum of 15 feet from the structures or beyond the backfill zones, whichever is greater. However, if subsurface downspout drains are utilized, they should be carefully constructed of solid-wall PVC and should daylight a minimum of 15 feet from the structures. In addition, an impermeable membrane is recommended below subsurface downspout drains. Dry wells should not be used.

5.6 Excavations

Excavations in the native sand soils at the site may stand for short periods of time but should not be considered to be stable. Trenching and excavations should be sloped back, shored, or shielded for worker protection in accordance with applicable OSHA standards. The site soils generally classify as Type C soil with regard to OSHA's *Construction Standards for Excavations*. For Type C soils, the maximum allowable slope in temporary cuts is 1.5H:1V..

6.0 GENERAL

The recommendations included above are based upon the results of the subsurface investigation and on our local experience. These conclusions and recommendations are valid only for the proposed construction.

As discussed previously, the subsurface conditions encountered in the borings were slightly variable. However, the precise nature and extent of any subsurface variability may not become evident until construction. As a result, it is recommended that HBET provide construction materials testing and engineering oversight during the entire construction process.

It is important to note that the recommendations herein are intended to reduce the risk of structural movement and/or damage, to varying degrees, associated with volume change of the native clay soils. However, HBET cannot predict long-term changes in subsurface moisture conditions and/or the precise magnitude or extent of volume change. Where significant increases in subsurface moisture occur due to poor grading, improper stormwater management, utility line failure, excess irrigation, or other cause, either during construction or the result of actions of the property owner, several inches of movement are possible. In addition, any failure to comply with the recommendations in this report releases Huddleston-Berry Engineering & Testing, LLC of any liability with regard to the structure performance.

Huddleston-Berry Engineering and Testing, LLC is pleased to be of service to your project. Please contact us if you have any questions or comments regarding the contents of this report.

Respectfully Submitted:
Huddleston-Berry Engineering and Testing, LLC

Michael A. Berry, P.E.
Vice President of Engineering

FIGURES

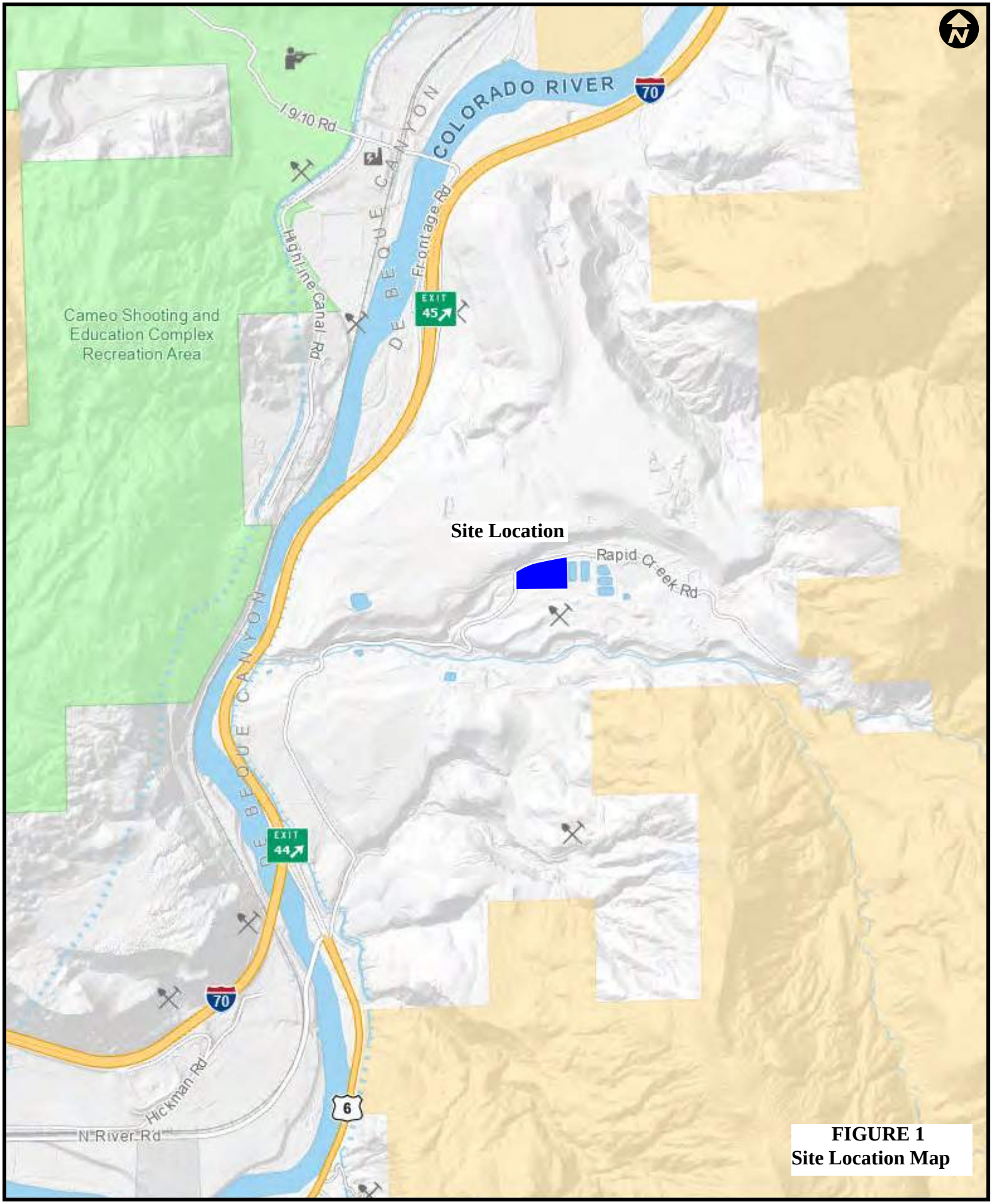


FIGURE 1
Site Location Map

Mesa County Map

6/2/2025

The Geographic Information System (GIS) and its components are designed as a source of reference for answering inquiries, for planning and for modeling. GIS is not intended or does not replace legal description information in the chain of title and other information contained in official government records such as the County Clerk and Recorders office or the courts. In addition, the representations of location in this GIS cannot be substitute for actual legal surveys.
The information contained herein is believed accurate and suitable for the limited uses, and subject to the limitations, set forth above. Mesa County makes no warranty as to the accuracy or suitability of any information contained herein. Users assume all risk and responsibility for any and all damages, including consequential damages, which may flow from the user's use of this information.

0 0.125 0.25 0.5 mi

0 0.15 0.3 0.6 km

Mesa County, Colorado
GIS/IT Department
gis.mesacounty.us

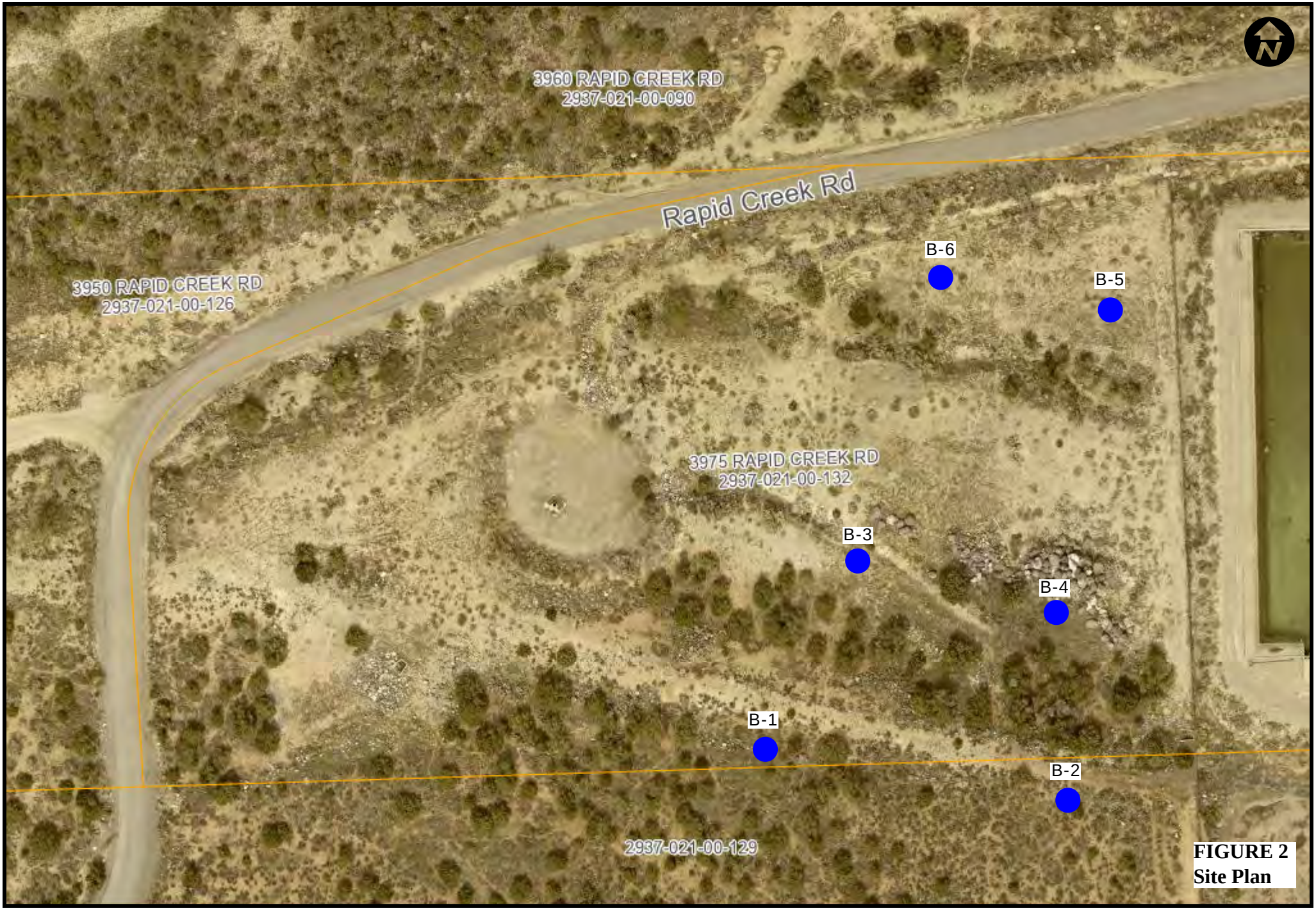


FIGURE 2
Site Plan

Mesa County Map

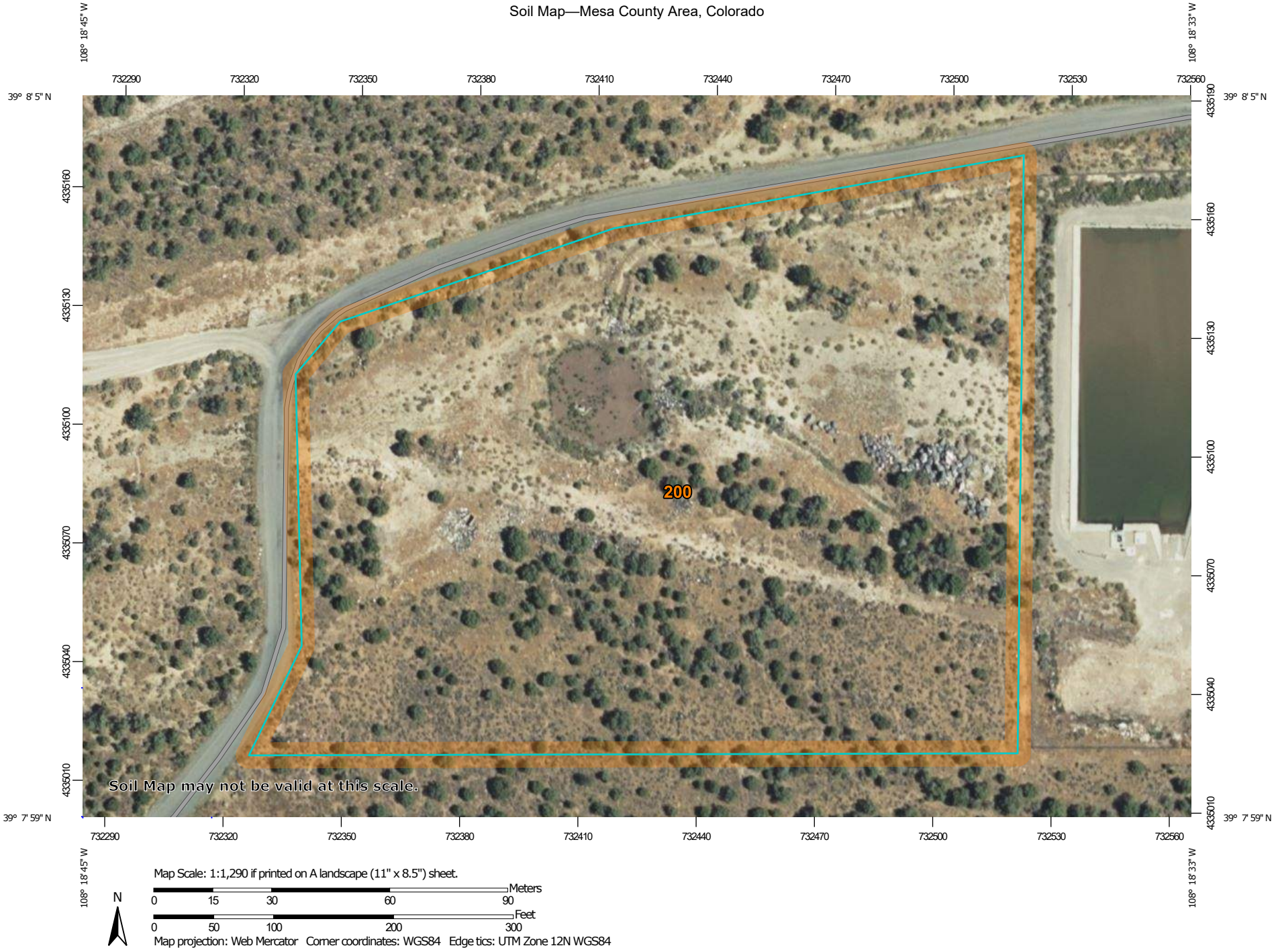
The Geographic Information System (GIS) and its components are designed as a source of reference for answering inquiries, for planning and for modeling. GIS is not intended or does not replace legal description information in the chain of title and other information contained in official government records such as the County Clerk and Recorders office or the courts. In addition, the representations of location in this GIS cannot be substitute for actual legal surveys.
The information contained herein is believed accurate and suitable for the limited uses, and subject to the limitations, set forth above. Mesa County makes no warranty as to the accuracy or suitability of any information contained herein. Users assume all risk and responsibility for any and all damages, including consequential damages, which may flow from the user's use of this information.

0 0.005 0.01 0.02 mi
0 0.0075 0.015 0.03 km

6/2/2025

Mesa County, Colorado
GIS/IT Department
gis.mesacounty.us

APPENDIX A
Soil Survey Data



Map Scale: 1:1,290 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Mesa County Area, Colorado
Survey Area Data: Version 15, Sep 6, 2024

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 24, 2020—Jul 8, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
200	Barx-Clapper complex, 3 to 12 percent slopes	6.0	100.0%
Totals for Area of Interest		**6.0**	**100.0%**

Map Unit Description

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named, soils that are similar to the named components, and some minor components that differ in use and management from the major soils.

Most of the soils similar to the major components have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Some minor components, however, have properties and behavior characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Additional information about the map units described in this report is available in other soil reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the soil reports define some of the properties included in the map unit descriptions.

Report—Map Unit Description

Mesa County Area, Colorado

200—Barx-Clapper complex, 3 to 12 percent slopes

Map Unit Setting

National map unit symbol: k08d
Elevation: 4,990 to 7,120 feet

Mean annual precipitation: 9 to 12 inches
Mean annual air temperature: 49 to 54 degrees F
Frost-free period: 120 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

Barx and similar soils: 60 percent
Clapper and similar soils: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Barx

Setting

Landform: Structural benches
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium and/or eolian deposits derived from sandstone and shale

Typical profile

A - 0 to 3 inches: loam
Bt - 3 to 14 inches: clay loam
Bk - 14 to 40 inches: loam
C - 40 to 60 inches: loam

Properties and qualities

Slope: 3 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.21 to 0.71 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Maximum salinity: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: R034BY212UT - Semidesert Loam (Wyoming Big Sagebrush)
Hydric soil rating: No

Description of Clapper

Setting

Landform: Structural benches
Down-slope shape: Linear
Across-slope shape: Linear

Parent material: Till derived from basalt

Typical profile

A - 0 to 3 inches: very stony loam
Bk1 - 3 to 12 inches: very stony loam
Bk2 - 12 to 26 inches: very cobbly loam
Bk3 - 26 to 60 inches: very cobbly loam

Properties and qualities

Slope: 3 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.71 to 2.13 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 40 percent
Available water supply, 0 to 60 inches: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: B
Ecological site: R034BY247UT - Semidesert Stony Loam (Utah Juniper-Pinyon)
Hydric soil rating: No

Data Source Information

Soil Survey Area: Mesa County Area, Colorado
Survey Area Data: Version 15, Sep 6, 2024

Soil Features

This table gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

A *restrictive layer* is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. The table indicates the hardness and thickness of the restrictive layer, both of which significantly affect the ease of excavation. *Depth to top* is the vertical distance from the soil surface to the upper boundary of the restrictive layer.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence generally results from either desiccation and shrinkage, or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. The table shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which results from a combination of factors.

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, saturated hydraulic conductivity (Ksat), content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion also is expressed as *low*, *moderate*, or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Report—Soil Features

Soil Features–Mesa County Area, Colorado									
Map symbol and soil name	Restrictive Layer				Subsidence		Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness	Initial	Total		Uncoated steel	Concrete
		Low-RV-High	*Range*		*Low-High*	*Low-High*			
		In	*In*		*In*	*In*			
200—Barx-Clapper complex, 3 to 12 percent slopes									
Barx		—	—		0	0	Moderate	Moderate	Moderate
Clapper		—	—		0	0	Moderate	Low	Low

Data Source Information

Soil Survey Area: Mesa County Area, Colorado
Survey Area Data: Version 15, Sep 6, 2024

APPENDIX B
Typed Boring Logs

Huddleston-Berry Engineering & Testing, LLC
2789 Riverside Parkway
Grand Junction, CO 81501
970-255-8005

BORING NUMBER B-1

CLIENT SGM
PROJECT NAME Ute Water WTP
PROJECT NUMBER 01171-0018
PROJECT LOCATION Palisade, CO
DATE STARTED 5/15/25 **COMPLETED** 5/15/25
GROUND ELEVATION
HOLE SIZE 3
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 3000 Truck
AT TIME OF DRILLING Dry
LOGGED BY TEC **CHECKED BY** MAB
AT END OF DRILLING Dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Sandy CLAY with Organics (TOPSOIL)										
		Sandy Lean CLAY with Gravels (cl), occasional boulders, gray, brown and tan, moist, very stiff to hard										
			SS 1	67	14-7-8 (15)							
5												
			SS 2	61	37-27-23 (50)							
10												
			SS 3	100	22-20-20 (40)							
15												
			SS 4	38	28-50							
20		Bottom of hole at 20.0 feet.										

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BORING NUMBER B-2

CLIENT SGM
PROJECT NAME Ute Water WTP
PROJECT NUMBER 01171-0018
PROJECT LOCATION Palisade, CO
DATE STARTED 5/15/25 **COMPLETED** 5/15/25
GROUND ELEVATION
HOLE SIZE 3
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 3000 Truck
AT TIME OF DRILLING Dry
LOGGED BY TEC **CHECKED BY** MAB
AT END OF DRILLING Dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		Sandy CLAY with Organics (TOPSOIL)										
		Sandy Lean CLAY with Gravels (cl), occasional boulders, reddish tan, moist, very stiff to hard										
2.5			SS 1	56	5-8-8 (16)							
5.0												
7.5		*Refusal at 8' on Large Boulder	SS 2	75	28-22							
		Bottom of hole at 8.0 feet.										

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BORING NUMBER B-3

CLIENT SGM
PROJECT NAME Ute Water WTP
PROJECT NUMBER 01171-0018
PROJECT LOCATION Palisade, CO
DATE STARTED 5/15/25 **COMPLETED** 5/15/25
GROUND ELEVATION
HOLE SIZE 3
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 3000 Truck
AT TIME OF DRILLING Dry
LOGGED BY TEC **CHECKED BY** MAB
AT END OF DRILLING Dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		Sandy CLAY with Organics (TOPOIL)										
		Sandy Lean CLAY with Gravels (cl), occasional boulders, tan to brown and gray, moist, very stiff to hard										
2.5			SS 1	39	4-33							
5.0												
7.5			SS 2	44	29-5							
10.0												
12.5			SS 3	15	30							
		*Refusal at 13.5' on Large Boulder										
		Bottom of hole at 13.5 feet.										

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BORING NUMBER B-4

CLIENT SGM
PROJECT NAME Ute Water WTP
PROJECT NUMBER 01171-0018
PROJECT LOCATION Palisade, CO
DATE STARTED 5/15/25 **COMPLETED** 5/15/25
GROUND ELEVATION
HOLE SIZE 3
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 3000 Truck
AT TIME OF DRILLING Dry
LOGGED BY TEC **CHECKED BY** MAB
AT END OF DRILLING Dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		Sandy CLAY with Organics (TOPSOIL)										
		Sandy Lean CLAY with Gravels (cl), occasional boulders, tan and gray, moist, very stiff to hard										
2.5			SS 1	56	28-21-15 (36)							
5.0		*Refusal at 6.5' on Large Boulder										
		Bottom of hole at 6.5 feet.										

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BORING NUMBER B-5

CLIENT SGM
PROJECT NAME Ute Water WTP
PROJECT NUMBER 01171-0018
PROJECT LOCATION Palisade, CO
DATE STARTED 5/15/25 **COMPLETED** 5/15/25
GROUND ELEVATION
HOLE SIZE 3
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 3000 Truck
AT TIME OF DRILLING Dry
LOGGED BY TEC **CHECKED BY** MAB
AT END OF DRILLING Dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		Sandy CLAY with Organics (TOPSOIL)										
		Sandy Lean CLAY with Gravels (cl), occasional boulders, tan, moist, very stiff to hard										
2.5			SS 1	67	12-10-14 (24)							
5.0												
7.5			SS 2	0	30							
		*Refusal at 9' on Large Boulder										
		Bottom of hole at 9.0 feet.										

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BORING NUMBER B-6

CLIENT SGM
PROJECT NAME Ute Water WTP
PROJECT NUMBER 01171-0018
PROJECT LOCATION Palisade, CO
DATE STARTED 5/15/25 **COMPLETED** 5/15/25
GROUND ELEVATION
HOLE SIZE 3
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 3000 Truck
AT TIME OF DRILLING Dry
LOGGED BY TEC **CHECKED BY** MAB
AT END OF DRILLING Dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Sandy CLAY with Organics (TOPSOIL)										
1		Sandy Lean CLAY with Gravels (cl), occasional boulders, reddish tan, moist, very stiff to hard *Refusal at 2' on Large Boulder										
2		Bottom of hole at 2.0 feet.										

APPENDIX C
Laboratory Testing Results

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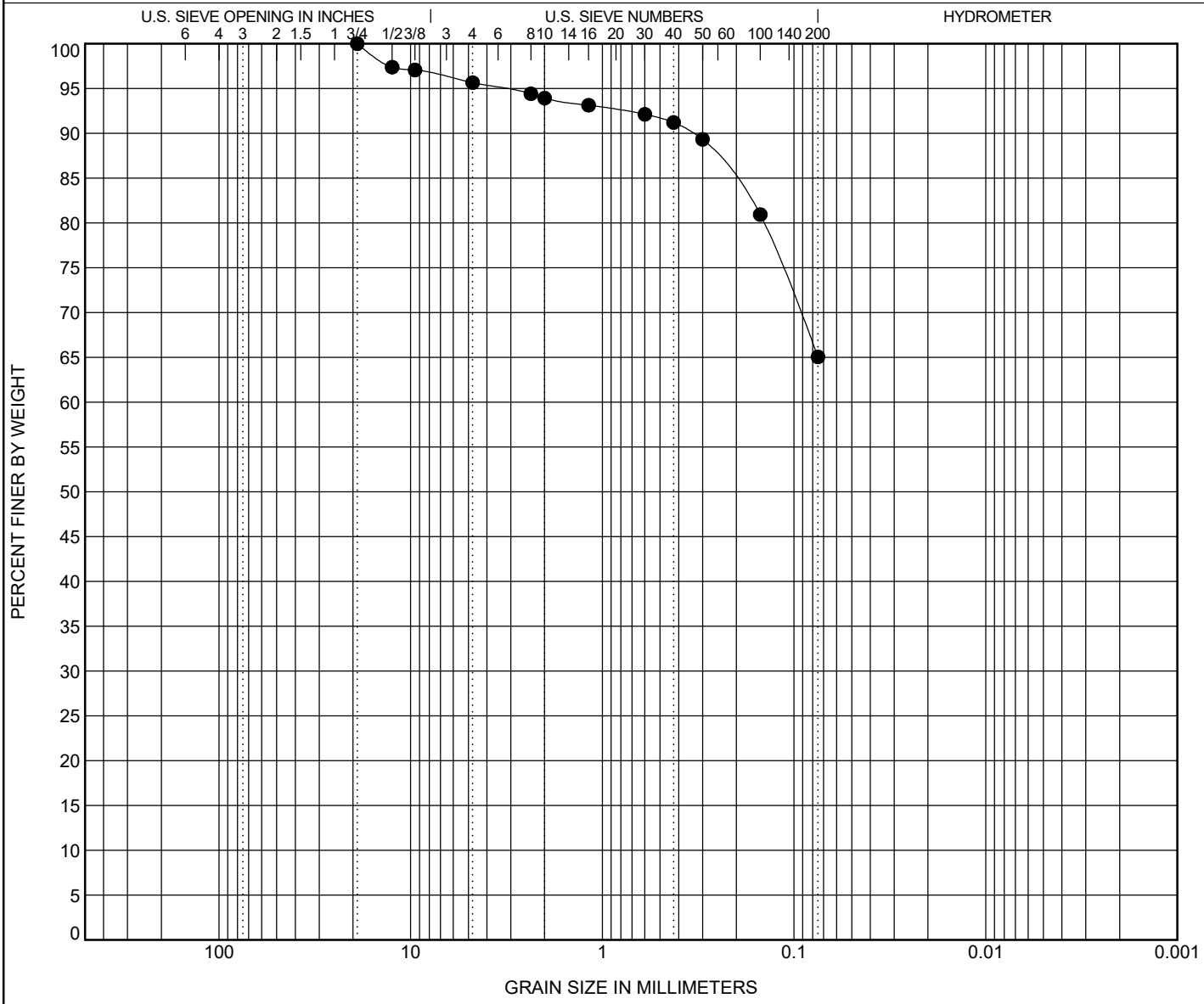
GRAIN SIZE DISTRIBUTION

CLIENT SGM **PROJECT NAME** Ute Water WTP

PROJECT NUMBER 01171-0018 **PROJECT LOCATION** Palisade, CO



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**Composite**	**5/15**	**SANDY LEAN CLAY(CL)**	**23**	**15**	**8**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**Composite**	**5/15**	**19**				**4.3**	**30.6**	**65.1**	

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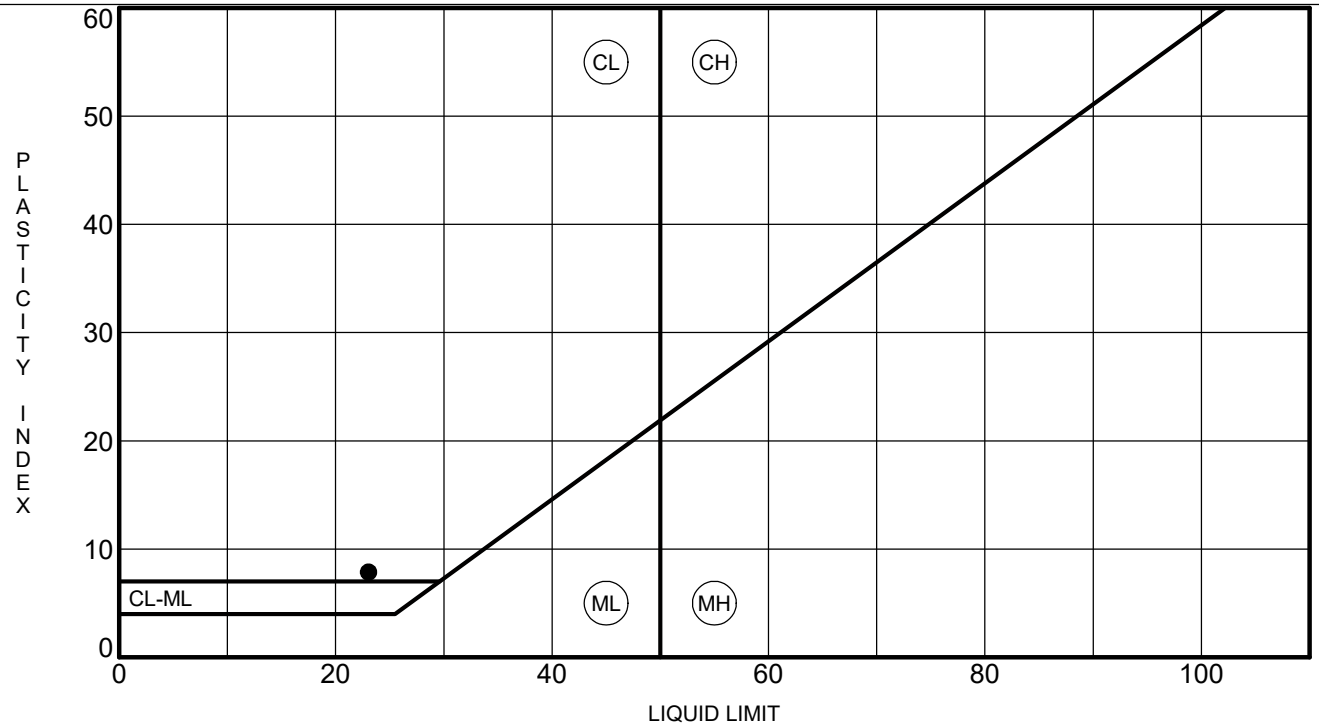
ATTERBERG LIMITS' RESULTS

CLIENT SGM **PROJECT NAME** Ute Water WTP

PROJECT NUMBER 01171-0018 **PROJECT LOCATION** Palisade, CO



	Specimen Identification		LL	PL	PI	#200	Classification
●	**Composite**	**5/15**	**23**	**15**	**8**	**65**	**SANDY LEAN CLAY(CL)**

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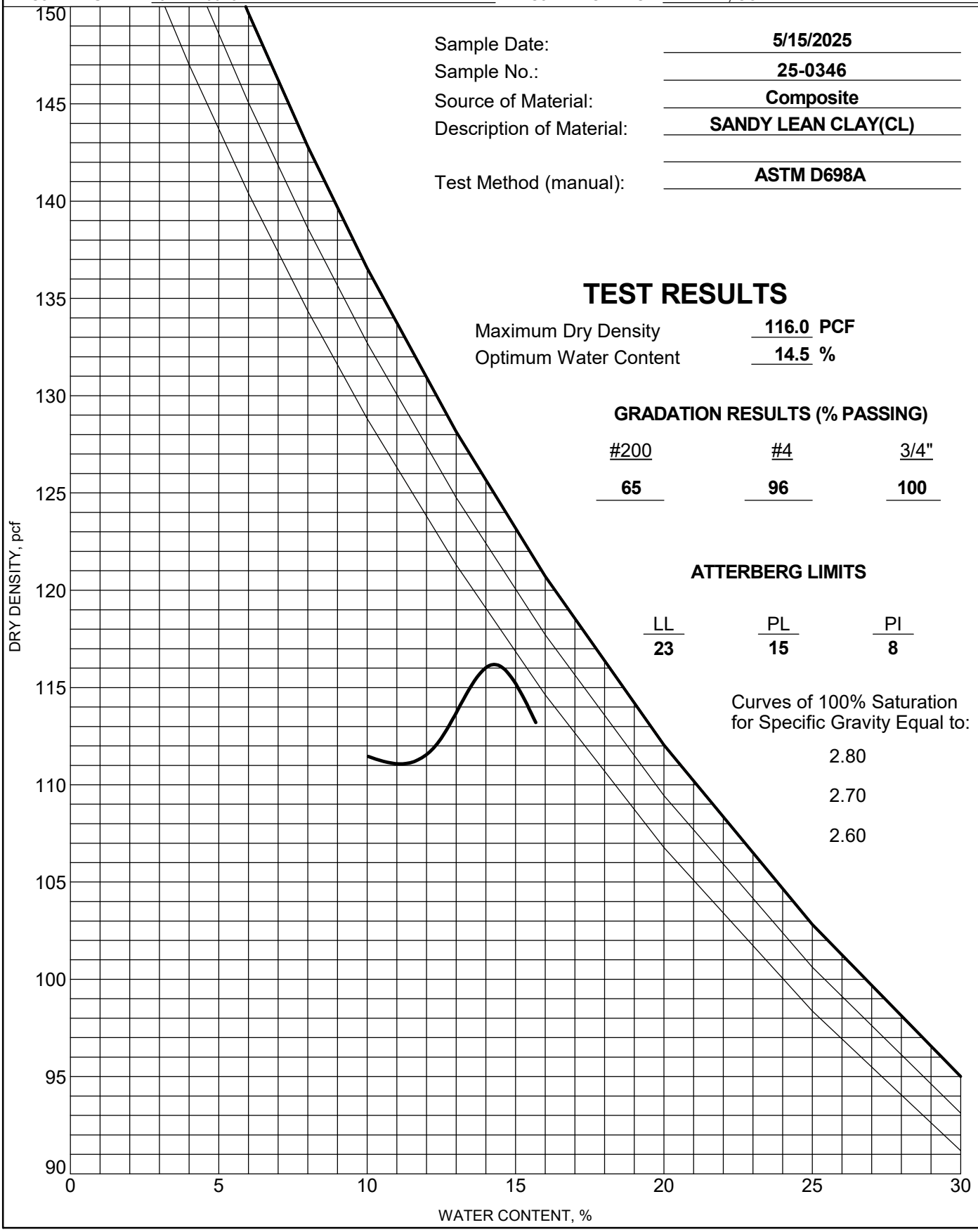
MOISTURE-DENSITY RELATIONSHIP

CLIENT SGM **PROJECT NAME** Ute Water WTP

PROJECT NUMBER 01171-0018 **PROJECT LOCATION** Palisade, CO



Sample Date: **5/15/2025**

Sample No.: **25-0346**

Source of Material: **Composite**

Description of Material: **SANDY LEAN CLAY(CL)**

Test Method (manual): **ASTM D698A**

TEST RESULTS

Maximum Dry Density **116.0** PCF

Optimum Water Content **14.5** %

GRADATION RESULTS (% PASSING)

#200	#4	3/4"
65	96	100

ATTERBERG LIMITS

LL	PL	PI
23	15	8

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60