Project Manual

Berthoud Arboretum

100% CONSTRUCTION/BID DOCUMENTS
NOT FOR CONSTRUCTION
December 12, 2025

Town of Berthoud
807 Mountain Avenue
P.O. Box 1229

THE GARDEN SPOT – Berthoud Arboretum

TECHNICAL SPECIFICATIONS

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The Drawings and Specifications have been prepared by or under the direct supervision of the following Registered Professionals.

To be completed with for the 100% CD FOR CONSTRUCTION SUBMITTAL

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END OF SECTION 00 01 07

SECTION 01 11 00 SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The Work specified in this contract consists of furnishing all management, supervision, labor, materials, tools, equipment, services, testing, and incidentals for the construction of the Work indicated in the Contract Documents including lump sum items and unit price items.

1.3 SITE CONDITIONS

A. The Contractor acknowledges satisfaction as to the nature and location of the Work, all of the general and local conditions, particularly those bearing upon availability of transportation, access to the site, disposal, handling and storage of materials, availability of labor, water, power, roads, and uncertainties of weather, or similar physical conditions at the site, the conformation and conditions of the ground, the character of equipment and facilities needed preliminary to and during work, and all other matters that can in any way affect the work or the cost thereof under this contract.

B. The Contractor further acknowledges, by submission of a bid and on each change in work proposal, satisfaction as to the character, quality and quantity of all surface and subsurface materials and all features on top of the surface or at worksites that would be encountered from his inspection of the site and from reviewing available records of exploratory work furnished by the Town. Failure by the Contractor to become acquainted with the physical conditions of the sites and all the available information will not relieve the Contractor from responsibility for properly estimating the difficulty or cost of performing the Work.

C. The Contractor warrants that as a result of examination and investigation of all the aforesaid data and the site, that the Contractor can perform the Work in a good and workmanlike manner and to the satisfaction of the Town. The Town assumes no responsibility for any representations made by any of its officers or agents during or prior to the execution of this contract unless such representation is expressly stated in the contract.

1.4 DESCRIPTION OF WORK

B. The following work items are included in these specifications: Landscape improvements including site work, concrete and masonry, metals, play equipment and surfacing, site structures and furnishings, electrical, earthwork, paving and walls, irrigation, planting and utilities as listed in the Table of Contents of these specifications and as shown per the Contract Drawings. The materials and installation methods specified herein are to be considered standard for all work ordered by and performed for the Town of Berthoud, Colorado.

PART 2 - PRODUCTS (Not used)

PART 3 - EXECUTION

3.1 CONTRACTOR'S DUTIES

A. Except as otherwise specified, furnish the following to the full extent required by the contract:
   1. Labor, superintendence, supervision and products.
   2. Construction equipment, tools, machinery and materials.
   3. Utilities required for construction and related activities.
   4. Provide or be the permittee for all project permits, unless otherwise noted or agreed upon.
   5. Other facilities and services necessary to properly execute and complete the Work, including security for worksite, testing and storage and protection of all materials awaiting incorporation into the Work, providing a safe working environment for workers, Town representatives, and the public in accordance with all local, state and federal requirements.

B. Prosecute the Work as specified and in a timely manner. Submit a schedule of Work that will be performed at times other than during the eight-hour working day of Monday through Friday, daylight hours. Submit this schedule five working days prior to the beginning of Work to the Project Manager for review and acceptance. Approval to work at night may be obtained after Contractor presents a written program outlining special precautions to be taken to control the extraordinary hazards presented by night work. That program shall include, but not limited to, supplementary lighting of work areas, availability of medical facilities, security precautions, and noise limitations.
   1. Noise Ordinance variances through The Town of Berthoud may be requested, however approval is not guaranteed.

3.2 COORDINATION

A. Coordinate prosecution of the Work with those public utilities, governmental bodies, private utilities and other contractors performing work on and adjacent to the worksites. Eliminate or minimize delays in the Work and conflicts with those utilities, bodies and contractors. Schedule governmental, private utility and public utility work that relies upon survey points, lines and grades established by the Contractor to occur immediately after those points, lines and grades have been established. Confirm coordination measures for each individual case with the Town in writing.

B. In the coordination effort of work by others, the Contractor shall obtain and refer to equipment locations and other layouts, as available, to avoid interface problems.

C. The Town reserves the right to permit access to the site of the Work for the performance of work by other contractors and persons at such times that the Town deems proper. The exercise of such reserved right shall in no way or to any extent relieve the Contractor from liability for loss and damage to the work due to or resulting from its operations or from responsibility for complete execution of the Contract. The Contractor shall cooperate with other contractors and persons in all matters requiring common effort.

3.3 CONTRACTOR USE OF WORKSITE

A. Confine worksite operations to areas permitted by law, ordinances, permits and the contract.

B. Consider the safety of the Work and that of the people and property on and adjacent to the worksite when determining amount, location, movement and use of materials and equipment on worksite.

C. Do not load worksite with equipment and products that would interfere with the Work. Only equipment, tools or materials required for this Work may be stored at the worksite.

D. Protect products, equipment and materials stored on worksite.

E. Relocate stored products, equipment and materials which interfere with operations of Town, government bodies, public and private utilities, and other contractors.

END OF SECTION 01 11 00

SECTION 01 25 00 SUBSTITUTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes submittal requirements for the approval of a different material, equipment, or process than is described in the Contract Documents.
   1. If the substitution changes the scope of work, contract cost or contract time, a Change Order is required.
   2. Contract Record Drawings and specifications must include all approved substitutions even if a Change Order is not issued.

B. Reference General Conditions Article 406 “Substitution of Materials and Equipment”.

1.3 QUALITY CONTROL

A. The substitution must provide the same quality as what it is replacing. The level of quality is defined by:
   1. Maintenance and operating cost.
   2. Reliability.
   3. Durability.
   4. Life expectancy.
   5. Ease of cleaning.
   6. Ability to be upgraded as needed.
   7. Ease of interacting with other systems or components.
   8. Ability to be repaired.
   9. Availability of replacement parts.
   10. Established history of use in similar environments.
   11. Performance equal or superior to that which it is replacing.

1.4 SUBMITTAL

A. Refer to Division 01 Sections “Submittals” and “Shop and Working Contract Drawings, Product Data, and Samples” for submittal procedures.

B. A complete Request for Substitution using the form included in Division 01 Section “Standard Forms” must be made at least sixty (60) days prior to when an order needs to be placed or a method needs to be changed.

C. The submittal shall contain, as appropriate, detailed product data sheets for the specified items and the substitution. Samples and shop Contract Drawings shall also be submitted of the substitution as applicable. The submittal shall contain all the data required to be submitted for acceptance of the originally specified item or process.

1.5 INFORMATION

A. Provide the following information as applicable with the Request for Substitution on the item or process that is being requested to be substituted:
   1. A complete description of the item or process.
   2. Utility connections including electrical, plumbing, HVAC, fire protection and controls.
   3. The physical dimensions and clearances.
   4. A parts list with prices.
   5. Samples of color and texture.
   6. Detailed cost comparisons of the substitution and the contract specified item or process.
   7. Manufacturer warranties.
   8. Energy consumption over a one-year period.
   9. The local organization that is certified to maintain the item.
   10. Performance characteristics and production rates.
   11. A list of any license fees or royalties that must be paid.
   12. A list of all variations for the item or method specified.
   13. A list of at least three other projects of similar nature to this contract where the products or methods have been in use for at least one year including telephone number and name of the person to contact at these other projects.
   14. An analysis of the effect of the substitution on the schedule and contract cost and on the overall project as it relates to adjoining work.

1.6 SUBSTITUTION REQUEST

A. The formal Request for Substitution will be evaluated by the Project Manager and the Designer of Record based on the following criteria:
   1. Compatibility with the rest of the project.
   2. Reliability, ease of use and maintenance.
   3. Both initial and long-term cost.
   4. Schedule impact.
   5. The willingness of the Contractor to share equally in any cost savings.
   6. The ability of the item or process to meet all applicable governing regulations, rules, and laws along with funding agency requirements.
   7. The cost of evaluating the substitution.

B. Based upon the above evaluation the Project Manager will make a final determination of what is in the best interest of the Town and either approve, disapprove, or approve as noted the requested substitution.

1.7 CONDITIONS

A. As a condition for submitting a Request for Substitution the Contractor waives all rights to claim for extra cost or change in contract time other than those outlined in the request and approved by the Project Manager. The Contractor, by submitting a Request for Substitution, also accepts all liability for cost and scheduling impact on other contractors or the Town due to the substitution.

B. Included with the Request for Substitution shall be the following statement:
   1. “The substitution being submitted is equal to or superior in all respects to the contract-required item or process. All differences between the substitution and the contract-

required item or process are described in this request along with all cost and scheduling data."

C. The statement shall be signed and dated by the Contractor's Superintendent.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 25 00

SECTION 01 29 00 MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes Pay Item descriptions for measurement and payment of Work completed.

1.3 DESCRIPTION

A. General:
   1. NOTE: The Pay Item descriptions listed herein are hypothetical and will vary with each project. Do not prepare pay estimates based on these descriptions.
   2. All measurements and payments will be based on work completed in strict accordance with the Drawings and specifications for the project.
   3. The method of measurement and basis of payment described are for the work itemized in the Bid Form and in the sections of the specifications. Items may include work within a single section or in more than one section.
   4. See the General Conditions for additional information pertaining to measurement and payment. This section is intended to supplement the General and Special Conditions.

B. Measurement:
   1. Measurement for the Work will be Lump Sum and all measurements are based on the Contractor's required quantities to provide the Work as shown in the Contract Drawings.
   2. Unless otherwise specified, all longitudinal measurements will be made horizontally, and computations will be based on the dimensions shown in the Contract Drawings and Details. No measurement will be made by weight tickets.
   3. Quantities shall be rounded to the nearest whole number.
   4. The Contractor shall, in the presence of the Project Manager, verify all measurements and quantities required for payment by the unit price method.
   5. The Contractor shall provide necessary equipment, workers, and survey personnel as required for measurements.

C. Units:
   1. Measurement by Volumes: Measurement by cubic dimension using mean length, width and height, or thickness. Longitudinal measurements will be made horizontally.
   2. Measurements by Area: Measured by square dimensions using mean length and width or radius, measured horizontally.
   3. Linear Measurement: Measured by linear dimension at the item centerline or mean chord.
   4. Measured by Lump Sum or Per Each: Item inclusion as specified by the bid item description.

D. Payment:
   1. Payment for Work listed as lump sum bid items completed under this contract shall be paid for on a lump sum fixed price basis.

2. Unit bid prices, as quoted in the Bid Schedule, shall constitute full compensation for labor, materials, equipment, rentals, overhead, profit and incidentals to complete all work for each pay item and for all risk, loss, damage, or expense of whatever nature arising from the nature of the work or prosecution thereof].
3. Work or materials that are essential to the Work, but for which there are no pay items, will not be measured and paid for separately, but shall be included in other items of work.
4. Final payment for Work governed by unit prices shall be made on the basis of the measurements and quantities accepted by the Project Manager multiplied by the unit price for work which is incorporated in or made necessary by the Work**.**

PART 2 - PRODUCTS (Not Used

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

SECTION 01 31 13 COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes requirements for project and construction coordination, supervision, and administration for the Work, including but not necessarily limited to:
   1. Coordination.
   2. Administrative and supervisory personnel.
   3. General installation provisions.
   4. Cleaning and protection.
   5. Utilities and site work.

B. Reference General Conditions as listed:
   1. Title 3 “Contractor Performance and Services”.
   2. Article 301 “Consideration (Contractor’s Promise of Performance)”.
   3. Article 308 “Communications”.

C. Related Sections:
   1. Division 01 Section “Layout of Work and Surveys”.
   2. Division 01 Section “Project Meetings”.

1.3 GENERAL COORDINATION

A. General:
   1. The Contractor shall ensure that each entity involved in the performance of the Work shall cooperate in the overall coordination of the Work; promptly, when requested by the Contractor, furnish information concerning the entity’s portion of the Work; and respond promptly and reasonably to the decisions and requests of persons designated with coordination, supervisory, administrative, or similar authority.
   2. The Contractor shall, where necessary, prepare memoranda for distribution to each party involved outlining special procedures required for coordination. Include such items as required notices, reports, and attendance at meetings.
   3. Prepare similar memoranda for the Owner and separate Contractors where coordination of their work is required.

B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of schedules
   2. Installation and removal of temporary facilities
   3. Delivery and processing of submittals
   4. Progress meetings
   5. Project close-out activities

C. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water and materials. Salvage materials and equipment involved in performance of, but not actually incorporated in, the Work. Refer to other sections for disposition of salvaged materials that are designated as the Town's property.

D. Site Utilization: In addition to the site utilization limitations and requirements shown on the Contract Drawings and indicated by the Contract Documents, administer the allocation of available space equitably among entities needing access and space, to produce the best overall efficiency in the performance of the Work. Schedule deliveries to minimize the space and time requirements for storage of materials and equipment on the site; but do not unduly risk delays in the Work.

E. Coordination Meetings: Include in scheduled meetings, coordination of various entities and activities as set forth in Division 01 Section "Project Meetings". Where necessary, schedule additional coordination meetings for this purpose on an as-needed basis.

F. Layout: It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships of the various elements and systems and their interfacing with other elements and systems. Establishment and coordination of these relationships is the exclusive responsibility of the Contractor. Do not scale the Contract Drawings. Layout and arrange all elements to contribute to safety, efficiency and to carry the harmony of design throughout the Work. In case of conflict or un-dimensioned locations, verify required positioning with the Project Manager. The Contractor shall provide surveying for the layout of all improvements including both horizontal and vertical control, in accordance with the requirements of Division 01 Section "Construction Surveying".

G. Substrate Examination: The Contractor shall ensure that the subcontractor of each element of the Work examines the conditions of the substrate to receive the work, dimensions and spaces adjacent, tolerances, interfacing with other elements and services, and the conditions under which the Work will be performed. The Contractor shall require each subcontractor to notify the Contractor in writing of conditions detrimental to the proper or timely completion of the Work and ensure that they do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the subcontractor.

1.4 COMPLETE SYSTEMS

A. It is the intent of the Contract Documents that the system be complete and functional to provide the intended or specified performance. The Contractor shall provide all incidental items and parts necessary to achieve this requirement.

1.5 COMPATIBILITY

A. Provide products and equipment which are compatible with other work requiring mechanical interface including connections, control devices, water, drain and other piping connections. Verify requirements and other interface requirements before ordering equipment and resolve conflicts that may arise.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION PROCEDURES

A. Require the subcontractor of each major component to inspect both the substrate and conditions under which work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.

B. The Contractor is responsible for coordination and overseeing all work performed by the subcontractors.

C. Inspect materials or equipment immediately upon delivery and again prior to installation. Reject damaged and defective items. Re-check measurements and dimensions before starting each installation.

D. Manufacturer's Instructions: Comply with manufacturer's installation instructions and recommendations, to the extent that those instructions and recommendations are more explicit or stringent than requirements contained in Contract Documents.

E. Installation:
   1. Provide attachment and connection devices and methods necessary for securing work. Secure work true to line and level. Allow for expansion and building movement.
   2. Install each component during weather conditions and the Work status that will ensure the best possible results. Isolate each part of the completed construction from incompatible materials as necessary to prevent deterioration.
   3. Coordinate work with required inspections and tests, to minimize the necessity of uncovering completed construction for that purpose.

F. Visual Effects: Provide uniform joint widths in exposed work. Arrange joints in exposed work to obtain the best visual effect. Refer questionable choices to the Project Manager for final decision.

G. Mounting Heights: Where mounting heights are not indicated, install individual components at standard mounting heights recognized within the industry for the application indicated. Refer questionable mounting height decisions to the Project Manager for final decision.

3.2 CLEANING AND PROTECTION

A. During handling and installation, clean and protect construction in progress and adjoining materials in place. Apply protective covering where required to ensure protection from damage or deterioration prior to achieving substantial completion.

B. Clean and maintain completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

END OF SECTION 01 31 13

SECTION 01 31 19 PROJECT MEETINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes requirements for the Contractor, including his field superintendent and quality control representative, to attend meetings scheduled by the Town for the collection and dissemination of information related to the subject contract.
   1. The Contractor will prepare the minutes of each meeting and distribute them to each of the participants.

1.3 OTHER MEETINGS

A. The Contractor will be advised of times, dates, and places of contract meetings.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PRECONSTRUCTION MEETING

A. A Preconstruction Meeting will be scheduled by the Town after the Contract has been signed by all parties. The purpose of this meeting is to introduce the Town's Representatives to their counterparts in the Contractor's organization and to establish lines of communication between the representatives and outline some of the contract requirements. The Contractor's superintendent**,** quality control representative(s), and all sub-contractors shall attend this meeting.
   1. The Project Manager will distribute a notice of this meeting, along with an agenda of the subjects to be addressed.
   2. The Project Manager will explain and discuss the responsibilities and authorities of the Town, the Designer, and the Project Manager's organization.
   3. The Project Manager will provide highlights of the following information at this meeting:
      a. Insurance, laws, codes, traffic regulations, and permit requirements of public agencies and their regulations.
      b. Procedures for processing change orders.
      c. Procedures for submitting shop and working drawings, product data and samples.
      d. Monthly pay estimate cutoff dates.
      e. Payment procedures, including monthly submittals for pay application approval.
         1) Project schedule and progress reports.
         2) Quality Control reports.
         3) Soil moisture and tree watering logs.
         4) Field modification redlines for Contract Record Drawings.

f. Request for information procedures.
g. Communication procedures.
h. Quality Control and Quality Assurance procedures.
i. Environmental requirements and permits.
j. Milestones for Substantial Completion and Final Acceptance.
k. Record documents, as required prior to Substantial Completion.
l. Project closeout requirements.

B. The Contractor will introduce the Contractor's representatives and briefly describe each person's responsibilities. The Contractor shall provide the following:
1. A list of all subcontractors.
2. Office, storage areas, and construction area layouts, along with temporary easements.
3. Safety, first aid, emergency and security procedures, including the name and contact information for the Contractor's insurance company.
4. 60-day preliminary schedule.
5. Sequence of Work.
6. Construction methods, general worksite layout, and haul plan.
7. Housekeeping procedures.
8. The Contractor's general erosion and sedimentation control plans, noise, hazardous material, air and water pollution control plans, and Quality Control Plan.
9. Coordination and notification requirements for utility work.
10. Deliveries and priorities of major equipment.
11. Submittal schedule.
12. Applicable project permits.

C. Explanations provided by the Town will not amend, supersede, or alter the terms or meaning of any contract document, and the Contractor shall not claim reliance on such explanations as a defense to any breach or failure by the Contractor to perform as specified in the contract.

3.2 CONSTRUCTION PROGRESS MEETINGS

A. Progress meetings will be scheduled weekly or more often as necessary by the Project Manager to promote the competent and timely execution of the contract.

B. The meetings will be held at the worksite or at a location selected by the Project Manager. Meetings will be chaired by the Contractor.

C. The Contractor's personnel, as listed in Paragraph 3.1.A, above, shall attend unless otherwise agreed by the Project Manager.

D. The Contractor's Project Manager will be responsible for publishing minutes of the meetings.

E. At a minimum, the following items will be addressed at each meeting. The items addressed in the meeting do not waive notification or submittal requirements as required elsewhere in the contract.
1. Safety: Contractor shall report any safety issues.
2. Quality Control:
a. The Contractor's Quality Control Representative shall present and discuss the Independent Testing Agency weekly test report and/or testing schedule.
b. The Contractor's Quality Control representative shall report on inspections by other agencies and any follow-up activity required.

c. The Project Manager shall present and discuss issues regarding quality control.

3. Quality Assurance: The Project Manager shall present and discuss issues regarding quality assurance.
4. Design Activities: Open discussion.
5. Shop Drawings / Submittals / Material Procurement:
   a. The Contractor shall provide and review the submittal schedule and provide any updated information and/or changes to the schedule.
   b. The Contractor shall provide information on the status of submittals requiring re-submittal.
   c. The Contractor shall review any accepted submittals that the Contractor plans to re-submit with changes.
   d. Contractor shall provide the status of material procurement for long-lead items (long-lead items are materials and equipment that have a fabrication and/or delivery duration that exceeds 15 working days).
      1) This information shall be provided by the Contractor in a format satisfactory to the Project Manager and shall include, at a minimum:
         a) Submittal/shop drawing preparation duration.
         b) Review duration.
         c) Fabrication duration.
         d) Delivery duration.

      2) All long-lead items shall be identified with a separate activity on the approved Critical Path Method (CPM) project schedule.
6. Construction Activities: Open discussion to include coordination items with other Contractors and / or agencies.
7. Schedule:
   a. The Contractor shall provide to the Project Manager the Contractor's three (3) week look-ahead schedule and review at the meeting the items on the schedule. The schedule shall be in bar chart format based on the approved CPM, and shall include dates of testing activities, items in progress, percentage of completion of items, responsible subcontractor for the items.

END OF SECTION 01 31 19

SECTION 01 32 19 SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section summarizes the requirements for the submittal of documents to the Town that are defined in these Specifications. It also describes the procedures for "supplemental" submittals.

B. Reference the General Conditions as listed:
1. Article 309 "Contractor Submittals and other Written Communications to the Town".
2. Article 405 "Shop Drawings, Product Data, and Samples".

1.3 SUBMITTALS

A. Existing Conditions: Contractor shall provide documentation of existing conditions, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
1. Use sufficiently detailed digital photographs or videos.
2. Include plans and notations to indicate specific damaged conditions of existing construction, site elements, and landscape.

PART 2 - PRODUCTS

2.1 SUBMITTAL SCHEDULE

A. The Contractor shall provide a submittal schedule within fourteen (14) days after Notice to Proceed (NTP). The Submittal Schedule shall be directly related to the Critical Path Method (CPM) schedule, shall identify all the submittals, and shall include the following information for each submittal item:
1. Specification section, contract article, or special condition.
2. Specification Subparagraph.
3. Item description.
4. Name of subcontractor or supplier.
5. Date the submittal is due.

B. The submittal schedule shall be updated every two (2) weeks by the Contractor and submitted with the progress payment request.

2.2 SUBMITTAL REQUIREMENTS

A. Each submittal document shall include a title block showing the following information:
1. Date of submittal and revision dates.
2. Contract title and number.

3. The names of Contractor, subcontractor, supplier, manufacturer and when applicable, the seal and signature of an engineer registered in the State of Colorado, for the involved discipline.
4. Identification of product by either: description, model number, style number or lot number.
5. Subject identification by contract drawing or specification reference.

B. On each submitted drawing, include a blank space on each sheet, three inches by four inches, in the lower right corner, just above the title block, in which the Project Manager may indicate the action taken.

C. Make submissions sufficiently in advance so that the Project Manager review may be completed before any material procurement or Work represented by those submittals is scheduled to be performed.

D. Allow a minimum cycle of ten (10) working days for review of each submittal by the Town.

E. The Contractor shall at the time of submission describe variations from the contract documents in writing, separate from the submittal document. If the Project Manager approves any such variations, an appropriate contract change order shall be issued except that, if the variation is minor and does not involve a change in price or in time of performance, a modification need not be issued. If a submission contains variations and the variation column is not marked on the transmittal form, it will not be considered for review and acceptance. Along with marking the transmittal as a variation, a description must be included which outlines all the differences including maintenance and utility services along with any cost savings from an item not containing the variation.

F. Changes in accepted submittal documents will not be permitted unless those changes have been accepted, in writing, by the Town.

2.3 SUBMITTALS

A. All submittals shall be delivered to the Project Manager.

B. Electronic submittals shall be submitted via email, or approved project management system. Acceptable formats include:
1. Adobe Acrobat. All files shall be fully compatible with Adobe Acrobat, shall have no security, and bookmark every applicable submittal.
2. Microsoft Office.
3. AutoDesk AutoCAD 2018 or newer.
   a. AutoCAD files shall be packaged to include related x-ref files, plot files and pen settings.
4. Other files pre-approved by the Project Manager.

C. Electronic file names: Include project name, date, and version.

2.4 SUPPLEMENTAL SUBMITTALS

A. Supplemental submittal documents initiated by the Contractor for consideration of corrective procedures shall contain sufficient data for review. Make supplemental submittals in the same manner as initial submittals with the appropriate primary transmittal referenced.

PART 3 - EXECUTION

3.1 CONTRACTOR REVIEW

A. The Contractor shall review submittal documents, stamp and sign as reviewed and approved as complying with contract documents prior to submission to the Town.

3.2 TOWN REVIEW

A. Submittal documents will be reviewed by the Project Manager for conformance to requirements of the contract drawings and specifications. Review of a separate item will not constitute review of an assembly in which the item functions. The Project Manager will withhold approval of submittals that depend on other submittals not yet submitted. Review and acceptance will not relieve the Contractor from his responsibility for accuracy of submittals, for conformity of submittal document to requirements of contract drawings and specifications, for compatibility of described product with contiguous products and the rest of the system, or for protection and completion of the contract in accordance with the contract drawings and specifications.

B. The Project Manager will review the submittal documents for general conformance with the contract documents and mark the Action Code, sign and date the transmittal.

C. The Action Codes have the following meanings:
   1. APPROVED: no corrections or resubmissions required; fabrication may proceed.
   2. APPROVED AS NOTED: If Contractor complies with noted corrections, fabrication may proceed, and resubmission is not required. If for any reason the Contractor cannot comply with the noted corrections, fabrication shall not proceed, and Contractor shall resubmit for additional review and comment.
   3. REVISE AND RESUBMIT: means that the submittal is unacceptable and must be revised and resubmitted. Fabrication shall not proceed.
   4. REJECTED: Submittal is not in compliance with the Contract Documents and is not acceptable. Resubmit Contract compliant material.

3.3 CONTRACTOR RESPONSIBILITIES

A. Coordinate each submittal document with the requirements of the Work. Ensure each submittal for a specific trade is compatible with other submittals of that trade and submittals of related trades (including producing drawings, as needed, to show the relationship of work between trades).

B. Contractor’s responsibility for errors and omissions in submittal documents and associated calculations is not relieved by the Town’s review, correction and acceptance of submittals.

C. Contractor’s liability to the Town, in case of variations in the submittal document from the requirements of the contract documents, is not relieved by the Town’s review and acceptance of submittals containing variations unless the Town expressly approves the deviation in writing, in which the Town describes the variation.

D. The Contractor shall maintain a file of all approved submittal documents at the worksite. The complete file of approved submittal documents shall be turned over to the Town with the Record Documents at the end of the job.

E. Schedule impact due to resubmittal requirements is the responsibility of the Contractor.

END OF SECTION 01 32 19

SECTION 01 33 23 SHOP AND WORKING DRAWINGS, PRODUCT DATA, AND SAMPLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes requirements for preparing and submitting shop and working drawings, product data, samples, and record documents required by other specifications sections.
   1. The Contractor shall submit all shop and working drawings, product data and samples, as defined in the General Conditions, to the Project Manager in accordance with the requirements in the specifications. The Project Manager will return one copy of the shop and working drawings, and product data to the Contractor with a written transmittal within the time periods noted in the specifications.

B. Reference the General Conditions as listed:
   1. Article 111 “Final Completion”.
   2. Article 117 “Shop Drawings”.
   3. Article 405 “Shop Drawings, Product Data, and Samples”.
   4. Division 01 Section “Submittals”.

1.3 CHANGES

A. Changes in products for which shop or working drawings, product data or samples have been submitted will not be permitted unless those changes have been accepted and approved in writing by the Town.

PART 2 - PRODUCTS

2.1 SHOP AND WORKING DRAWINGS

A. Include the following as they apply to the subject:
   1. Contract title, work order and number.
   2. Respective contract drawing numbers.
   3. Applicable specification section numbers.
   4. Relation to adjacent structure or materials.
   5. Field dimensions clearly identified as such.
   6. Applicable standards such as ASTM or Federal Specification number, and pertinent authority specifications or standards.
   7. Identification of deviations from the Contract drawings and specifications.
   8. Drawing name, number, and revision.
   9. Contractor’s stamp, initialed or signed, certifying:
      a. Verification of field measurements.
      b. Review of submittals for compliance with contract requirements.
      c. Compatibility of the Work shown thereon with that of affected trades.

10. Blank space on each sheet per Division 01 Section “Submittals”.

B. Drawings of equipment and other items that contain multiple parts shall include exploded views showing the relationship of parts and the description of the parts into the smallest units that may be purchased or serviced.

2.2 PRODUCT DATA

A. Modify manufacturer’s standard and/or schematic drawings to delete information which is not applicable to the contract. Supplement standard information with additional information applicable to this contract.

B. Modify manufacturer’s standard(s), diagrams, schedules, performance charts, illustrations, calculations and other descriptive data to delete information which is not applicable to the contract. Indicate dimensions, clearances, performance characteristics and capacities. Include with the submittal electrical, plumbing, HVAC and any other diagrams, as applicable.

C. Modify erection, application and placing instructions to delete information that is not applicable to the contract or work order.

D. Include the following:
1. Contract title, work order and number.
2. Respective contract drawing numbers.
3. Applicable contract technical specification section numbers.
4. Applicable standards such as ASTM or Federal Specification number, and pertinent authority specification or standards.
5. Identification of deviations from the Contract drawings and specifications.
6. Contractor’s stamp, initialed or signed, certifying:
    a. Dimensional compatibility of the product with the space in which it is intended to be used.
    b. Review of submittals for compliance with contract requirements.
    c. Compatibility of the product with other products with which it is to perform, or which will be next to it.
    d. The products electrical, plumbing, control and HVAC requirements conform to contract documents and the necessary utilities are provided for in the contract documents.

E. Certificates of compliance shall be submitted for all products. The certificates shall:
1. State that the product complies with the respective specification and contract drawing requirements.
2. Be accompanied by a certified copy of test results pertaining to the product
3. Show the submittals date, Contractor’s name and address, contract title and number, product represented and its location in the contract, producer’s name, product trade name and catalog number, place of product origin, test date, testing organization’s name and address, quantity of the product to be furnished and related contract drawing and specification section numbers.
4. Be signed by an officer or another authorized representative of the producer and notarized.
5. Submit one digital copy.
6. Be received by the Town not later than thirty (30) days before the acceptance is needed of the products for ordering.

2.3 SAMPLES

A. Submit samples of sizes and quantities to clearly illustrate full color range and functional characteristics of products and materials including attachment devices.

B. Erect field samples and mock-ups at the worksite as specified in the several technical specifications sections and at locations acceptable to the Project Manager. All field samples shall be erected in a location that will be readily visible throughout the life of the contract to allow comparison of the work as it progresses to the field sample.

C. The Contractor shall verify, through appropriate inspections and tests, that the samples submitted meet the specifications and shall provide inspection and test data with the samples. The review and comments on the sample shall not relieve the Contractor of his responsibility for completion of the contract.

D. Show the following information:
   1. Contract title and number.
   2. Respective contract drawing numbers.
   3. Applicable technical specification section numbers.
   4. Applicable standards such as ASTM or Federal Specification number.
   5. Identification of deviations from the Contract drawings and specifications.
   6. Contractor's stamp, initialed or signed, certifying:
      a. Dimensional compatibility of the product with the space in which it is intended to be used.
      b. Review of submittals for compliance with contract requirements.
      c. Compatibility of the product with other products with which it is to perform, or which will be next to it.
   7. If multiple samples are submitted and the Project Manager is requested to make a choice, each sample shall have a unique identification number attached to it, so the returned transmittal can state the identification number of the accepted sample and the Contractor will know which one it is.

PART 3 - EXECUTION

3.1 CONTRACTOR RESPONSIBILITIES

A. Verify field measurements, catalog numbers and similar data.

B. The Contractor shall not start work for which submittals are required until a transmittal has been received by the Contractor showing acceptance or acceptance as noted by the Project Manager.

C. Before making submittals ensure that products will be available in the quantities and at the times required by the contract.

D. Submit final, corrected, digital drawings of contract and shop and working drawings showing the Work as actually installed, placed, erected and applied. Refer to Division 01 Section "Contract Closeout".

3.2 REVIEW BY THE TOWN

A. One digital copy of the marked-up shop and working drawing and one digital copy of the product data will be returned to the Contractor by the Project Manager. Only the transmittal form, appropriately marked, and two samples will be returned on sample submittals. Contractor shall maintain one approved sample on site for the duration of the project.

B. Contractor's responsibility for errors and omissions in submittals for compatibility will not be reduced, waived, or otherwise limited by the review and acceptance of submittals by the Town.

END OF SECTION 01 33 23

SECTION 01 43 00 QUALITY ASSURANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Quality Assurance is defined as measures, tests, and/or audits that may be performed by the Town or Town Representatives to ensure the Contractors work is installed per the construction documents and the contractors Quality Control Plan.

B. This Section identifies inspection activities to be performed by inspectors and testing agencies employed by the Town and working under the direction of the Project Manager.
   1. Inspection and tests, conducted by persons or agencies other than the Contractor, shall not in any way relieve the Contractor of his responsibility and obligation to meet all specifications and the referenced standards.
   2. The inspection and approval of work by other agencies above does not constitute inspection or acceptance of work required by the Town. Technical specifications may contain requirements more stringent than Building Inspection Division or other code agency requirements.

C. Reference General Conditions as listed:
   1. Article 1701 “Construction Inspection by the Town”.
   2. Article 1702 “Authority of Inspectors”.
   3. Article 1703 “Observable Defects”.
   4. Article 1704 “Defects – Uncovering Work”.
   5. Article 1705 “Latent Defects”.
   6. Article 1706 “Removal of Defective Materials and Work”.

D. Related Sections:
   1. Division 01 Section “Contractor Quality Control”.
   2. Division 01 Section “Submittals”.
   3. Division 01 Section “Shop and Working Drawings, Product Data, and Samples”.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TOWN’S QUALITY ASSURANCE MEASURES

A. According to the judgment of the Project Manager, any portion of the work in this contract may be tested at any time for any reason.

B. Contractor shall not rely upon these tests to assure compliance with the Contract Documents.

3.2 TESTING – GENERAL

A. Tests: Shall be made by a testing laboratory approved by the Project Manager. Except as otherwise provided, sampling and testing of materials and laboratory methods and testing equipment shall be in accordance with latest standards and tentative methods of ASTM.
   1. Specific information concerning testing methods, sample sizes, etc., is included under applicable sections of Specifications.
   2. Any modification of, or elaboration on, these test procedures included for specific materials under their respective sections in Specifications shall take precedence over these procedures.

3.3 COST OF TESTING

A. All costs for testing and re-testing of non-compliant work shall be borne by the Contractor.

B. The Town reserves the right to hire a third-party testing agency or inspector to verify the Contractor's reports at the Town's expense.

3.4 TEST REPORTS

A. Test reports, whether performed for the Town or the Contractor, shall be submitted to the Project Manager and Contractor as soon as results are available. Reports shall be clear, concise, comprehensive written forms containing required test results. The reports shall be delivered to the Contractor and the Project Manager concurrently as soon as available, but no later than monthly.

B. Reports of tests made by testing laboratories shall be distributed by testing laboratory as a digitally created PDF.

3.5 MANUFACTURING AND FABRICATION INSPECTIONS

A. The Project Manager may elect to perform additional inspections and/or tests at the place of the manufacturer, the shipping point, or at the destination to verify conformance to applicable specifications. Inspections and tests performed by the Town shall not relieve the Contractor from the responsibility to meet the Specifications, nor shall such inspections/tests be considered to be a guarantee for acceptance of materials that will be delivered at a later time.

B. The Project Manager or his authorized representative may inspect at its source any material or assembly to be used in the Work. Manufacturing plants may be inspected from time to time for the purpose of determining compliance with specified manufacturing methods or materials to be used in the Work and to obtain samples for testing and further inspection.

C. Should the Project Manager conduct plant inspections the following conditions shall exist:
   1. The Project Manager shall have the cooperation and assistance of the Contractor and the producer with whom the Contractor has contracted for materials.
   2. The Project Manager shall have full access during scheduled production or warehousing working hours to parts of the plant that are concerned with the manufacture, production, storage, or shipping of materials being furnished.

3. The Contractor shall arrange for adequate office or working space that can reasonably be needed for conducting a plant inspection. Office or working space shall be conveniently located with respect to the plant and/or warehouse as required by the Project Manager.

D. It is understood and agreed that the Town shall have the right to re-test, at the Town's expense, any materials that have been tested and accepted at the source of supply after it has been delivered to the site.

END OF SECTION 01 43 00

SECTION 01 45 16 CONTRACTOR QUALITY CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section identifies the Quality Control activities to be performed during all phases of the contract by the Contractor. Quality Control is defined as the process by which the Contractor ensures the project is constructed per the construction documents.

B. The Contractor shall have a Quality Control Program in place to ensure that all materials and work are completed in compliance with contract documents. The Contractor is solely responsible for Quality Control. The Town reserves the right to conduct additional tests or audits to verify compliance per Division 1 section "Quality Assurance".

C. Test schedules and/or testing requirements for materials used on this project are included in the technical specifications. Laboratory and field testing identified in the technical specifications shall be conducted by an Independent Testing Agency (ITA) retained by the Contractor.

1.3 LEVEL OF CONTROL

A. The intent of this section is to enable the Contractor to establish a necessary level of control that will:
   1. Adequately provide for the production of acceptable quality materials.
   2. Provide sufficient information to ensure both the Contractor and the Project Manager that the specification requirements are being met.
   3. Allow the Contractor as much latitude as possible to develop his or her own standards of control.

1.4 SUBMITTALS

A. Refer to Division 01 Sections "Submittals" and "Shop and Working Drawings, Product Data, and Samples", for submittal requirements.

B. Quality Control Plan: Within ten (10) days after Notice to Proceed, the Contractor shall submit a Quality Control Plan for review and acceptance. Acceptance by the Project Manager does not relieve the Contractor of compliance with the contract requirements. The Contractor Quality Control Plan shall address the following as a minimum:
   1. Provide a general description of Quality Control monitoring to be performed until final acceptance by the Town. Include monitoring activities of Work and the worksite during times no construction activity is scheduled to take place.
   2. The Contractor shall designate an employee as the Quality Control Representative, qualified to perform quality control monitoring of the Work. The designated individual shall have the authority to direct work changes required to bring the Work into

conformance with contract requirements including stopping non-conforming work in progress.

3. The Quality Control Plan shall address each technical specification division's requirements for quality control. The Contractor shall identify each item requiring submittal and approval/acceptance prior to installation of work. Also, the Contractor shall identify each item of work requiring testing by the independent testing agency.
4. The Quality Control Plan shall address and establish controls and documentation format to ensure that items or materials that have been accepted through receiving inspection are used or installed. Identification and traceability shall be provided throughout all inspections, test activities, and records. For stored items, provisions shall be made for the control of item/material identification, consistent with the expected duration and type of storage.
5. Provide a methodology of monitoring, testing, and exercising of all equipment, valves and/or assemblies to ensure the Work installed is in proper working order.

C. List of Suppliers and Subcontractors: Submit a list of suppliers and subcontractors, including items to be supplied by each supplier and/or subcontractor. Identify work to be performed by each subcontractor. The list shall be updated and resubmitted as required.

D. Emergency Contact List: Submit a list of emergency contact information including name, company, title, work phone number, mobile phone number, and other means of contact for at least four individuals.

1. Review the Emergency Contact list on a weekly basis. In the event there is any change in any of the information, the Contractor shall forward the updated list to the Project Manager.
2. The Emergency Contact list shall include the project number, project title, and date of issue.

E. Quality Control Report:

1. The Quality Control Report shall be submitted weekly or per the discretion of the Project Manager in the format detailed in Division 01 Section "Standard Forms". The report shall address as a minimum the following: identify notifications and discussions with/by other agency inspectors, identify work placed that day and any deviations and/or corrections required to bring the Work into conformance with the contract. Reporting must be digital format and signed by the Contractors Quality Control Representative. Legible, hand written reports on the approved form shall be accepted. Scanned copies of daily reports are acceptable.
2. Submit one electronic copy of the Quality Control Report to the Project Manager the week following the work or per the discretion of the Project Manager. The report shall be signed by the Contractor's Quality Control Representative and the Contractor's Superintendent.

F. Corrective Action Report (CAR): Conditions adverse to quality will be reviewed by the Contractor and the Town Representative to determine the cause and to recommend a corrective action that will preclude recurrence.

1. The condition, its cause, and the corrective action planned shall be reported to the Project Manager prior to implementation.
2. Follow-up action shall be taken to verify implementation of the corrective action.
3. The Contractor will document the corrective action and a copy of the Corrective Action Report (CAR) will be transmitted to the Project Manager.

1.5 DOCUMENTATION

A. The Contractor shall not change or alter approved submittals, procedures, specifications, drawings, or other pertinent documentation without the Project Manager's written authorization.

B. All records and documents that are quality related shall be prepared, identified, and maintained by the Contractor and shall be made available to the Town upon request. Records shall be protected from damage, deterioration or loss. A copy of the records and documents shall be maintained at the Work site at all times unless the Project Manager has approved other locations in writing.

C. The Contractor shall maintain records at the actual worksite and at Contractor's office to show the inspection status of materials and items installed in order to ensure that the required inspections and tests have been performed in a timely and correct manner.

1.6 INSPECTIONS AND TESTS

A. Inspections, tests, and system shut down requests, conducted by persons or agencies other than the Contractor, shall not in any way relieve the Contractor of his responsibility and obligation to meet all specifications and the referenced standards. The Contractor's designated Quality Control Representative shall inspect the Work and shall ensure the Work complies with the Contract requirements prior to any requests for inspection or testing.

B. When the specifications, laws, ordinances, rules, regulations or orders of any public agency having jurisdiction require the Project Manager's surveillance of inspections or tests, the Contractor shall notify the Project Manager of the place, date and time forty-eight (48)-hours prior to the inspection and/or test. The Contractor shall be responsible for notifying and requesting inspection by other agencies including but not limited to the Denver Building Inspection Division, Denver Fire Department, Denver Wastewater Management Division and Denver Water. Prior to request for other agency inspections, the Contractor shall meet and plan inspection times with the Project Manager and or his designated representative.

C. Special inspections or tests may be required by the technical specifications, Town, State and/or Federal Agencies in addition to those tests already performed. The Contractor shall notify the Project Manager at least forty-eight (48)- hours in advance of the additional inspections or tests.

1.7 INSPECTION PLAN

A. The Contractor shall utilize the following six-point inspection plan to ensure the conformance of the Work performed by the Contractor meets the requirements of the contract drawings and specifications, the referenced codes and standards and the approved submittals:

1. Pre-work Coordination: Prior to the start of construction work, work under each separate specification section, where a change in a construction operation is contemplated by the Contractor, and a new subcontractor starting work, a coordination meeting will be held with the Contractor's superintendent, Quality Control, and Safety representative(s), and the ITA representative. Supervisory, Safety, and Quality Control representatives of all applicable subcontractors shall also attend. The Contractor's Quality Control Representative shall chair the meeting and prepare and distribute minutes of Quality Control meetings. Meeting minutes shall be electronically distributed within twenty-four (24) hours of the meeting.

2. The purpose of the meeting is to ensure that the Contractor's personnel have no misunderstandings regarding their safety and quality procedures as well as the technical requirements of the contract. The following items shall be presented and reviewed by the Contractor:
    a. Contract requirements and specifications.
    b. Shop drawings, certifications, submittals and Record Drawings.
    c. Testing and inspection program and procedures.
    d. Contractor's Quality Control program.
    e. Familiarity and proficiency of the Contractor's and subcontractor's workforce to perform the operation to required workmanship standards including certifications of installers.
    f. Safety, security, and environmental precautions to be observed.
    g. Any other preparatory steps dependent upon the particular operation.
    h. The Contractor's means and methods for performing the Work.
3. Initial Inspection: Upon completion of a representative sample of a given feature of the Work and no later than two (2) weeks after the start of a new or changed operation, the Project Manager and/or his designated representative will meet with the Contractor's Quality Control representative and applicable subcontractor's supervisor and their Quality Control representatives to check the following items, as a minimum:
    a. Workmanship to established quality standards.
    b. Conformance to Contract Drawings, Specifications and the accepted shop drawings.
    c. Adequacy of materials and articles utilized.
    d. Results of inspection and testing methods.
    e. Adequacy of Record Drawings maintained daily.
4. Once accepted, the representative sample will become the physical baseline by which ongoing work is compared for quality and acceptability. To the maximum practical extent, approved representative samples of work elements shall remain visible until all work in the appropriate category is complete. Acceptance of a sample does not waive or alter any contract requirements or show acceptance of any deviation from the contract not approved in writing by the Project Manager.
5. Follow-up Inspection: The Contractor's Quality Control representative will monitor the work to review the continuing conformance of the work to the workmanship standards established during the preparatory and initial inspections.
6. Completion Inspection: This is not a Substantial Completion Inspection. Forty-eight (48) hours prior to the completion of an item or segment of work and prior to covering up any work, the Contractor will notify the Project Manager who will verify that the results of the segment of work are acceptable, and all inspections and tests have been completed.
    a. The purpose of this inspection is to allow further corrective work upon, or integral to, the completed segment of work.
    b. If any items are determined to be deficient, need correction or are non-conforming, a Deficiency List will be prepared and issued to the respective Contractor for correction, repair or replacement of any deficient or non-conforming items.
    c. The Project Manager and Contractor's Quality Control representative will verify the correction of the deficient and/or non-conforming items prior to the start of the next operation.
7. Prior to requesting a Substantial Completion Inspection by the Town, all work and operational systems to be inspected shall be satisfactorily completed and tested by the Contractor.
8. Substantial Completion Inspection will occur when the Contractor notifies the Project Manager the work is completed to the required stage and is ready for inspection. The

work shall have progressed to the point that the Town can beneficially occupy or utilize the work. Refer to the Contract General Conditions, Title 19 – Substantial Completion of the Work.

9. After the Contractor receives Substantial Completion from the Project Manager, the Warranty period begins. Refer to the Contract General Conditions, Title 18 – Warranties, Guarantees, and Corrective Work.
10. Final Acceptance will occur when the punch list items have been completed and all site clean-up has been done. Refer to the Contract General Conditions, Title 20 – Final Completion and Acceptance of the Work.

1.8 SAMPLES

A. The Contractor shall maintain at the worksite a copy of all samples submitted and accepted by the Town. Samples shall be made available to the designer or the Project Manager's designated representatives for review and comparison in the field. The Project Manager must accept all items and materials prior to use on the project.

B. The installed work will be compared to the samples and if any of the work is not of the same quality, material, finish, color, texture or appearance as the sample, that portion that is not the same will be considered defective and in nonconformance.

C. Contractor selection of samples will only be considered if taken at random. The Contractor shall permit Town Representatives to witness the selection of samples. Inspection or tests of items or materials that fail shall be sufficient cause to terminate further inspections/tests of the same brand, make or source of that product.

D. The Contractor is obligated to correct any item deemed deficient.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. The Contractor is responsible for Quality Control of the Construction. All acquisition of materials, sequence of construction (except as otherwise indicated), and means and methods of construction shall be the responsibility of the Contractor. Establish system to perform sufficient inspection and tests of all items of work, including that of subcontractors, to ensure conformance to Contract Documents for materials, workmanship, construction, finish, functional performance and identification.

1. Control System: Establish for all construction except where Contract Documents provide for specific compliance tests by testing laboratories and engineers employed by the Town.
2. Control System: Specifically include all testing required by various sections of Specifications.
3. Quality Control System: Means by which Contractor assures himself that construction complies with requirements of Contract Documents.
    a. Controls: Adequate to cover all construction operations and keyed to proposed construction schedule.

B. All materials required for the contract shall be new except where specified otherwise. The Project Manager may elect to perform additional inspections and/or tests at the place of the manufacture, the shipping point or at the destination to verify conformance to applicable specifications. Inspections and tests performed by the Town shall not relieve the Contractor from the responsibility to meet the specifications, nor shall such inspections/tests be considered a guarantee for acceptance of materials that will be delivered at a later time.

C. The Contractor is obligated to correct or remove non-conforming materials, whether in place or not. If necessary, the Project Manager will send written notification to the Contractor to correct or remove the defective materials from the project. If the Contractor fails to respond, the Project Manager may order correction, removal and/or replacement of defective materials by others, in which case the Contractor shall bear all costs incurred by such actions.

D. Materials accepted on the basis of a Certificate of Compliance may be sampled and inspected and/or tested by the Project Manager or their Designer at any time. The fact that the materials were accepted on the basis of such certification shall not relieve the Contractor of the responsibility to use materials that conform to the specifications.

E. The Contractor shall impose upon his suppliers the same quality control requirements, including inspection and test procedures, as imposed upon him by the specifications and referenced standards. The Contractor shall apply appropriate controls, designed to ensure that all materials supplied meet the requirements and Specifications.

3.2 CONTRACTOR'S QUALITY CONTROL SYSTEM

A. The Contractor shall be responsible for assuring compliance with the quality standards as indicated in the Contract Documents. In addition, the Contractor shall be responsible for:
   1. Review of submittals prior to their being forwarded to the Project Manager for review. The Contractor shall mark submittals with comments and shall indicate the date and party conducting the Contractor's review of each submittal.
   2. Final inspection of the project prior to calling for the Project Manager to conduct a final inspection. The Contractor shall provide his inspection comments to the Project Manager prior to the scheduled final inspection.
   3. Verification of completion of punch-list items prior to calling for verification inspection by the Project Manager.

B. Records: Maintain correct records on appropriate forms for all inspections and tests performed, instructions received from the Project Manager and actions taken as result of those instructions.
   1. Records: Include evidence that required inspections or tests have been performed (including type and number of inspections or tests, nature of defects, causes for rejection, etc.) proposed or directed remedial action, and corrective action taken.
   2. Document inspections and tests as required by each section of the Specifications.

3.3 MATERIAL AND WORKMANSHIP

A. Unless otherwise specified, or indicated on the Drawings, material shall be new, of best quality, and without flaws, and delivered upon completion in an undamaged condition.

B. Workmanship shall be the best of its respective kind. Labor shall be performed in a thorough workmanlike manner by qualified, efficient, and skilled mechanics, acceptable to the Project

Manager, and other trades involved on the job requiring acceptable substrate for the performance of their work.

3.4 TESTING – GENERAL

A. Testing Laboratory and/or Engineering services are required for quality control in portions of the work identified in other sections of these specifications.

B. Tests required by these Specifications shall be performed in strict accordance with referenced testing methods, procedures, and conditions. Pertinent data shall be included in clear, comprehensive written forms according to the requirements of these Contract Documents.

C. Contractor: Provide equipment and facilities as required for testing at no additional cost, subject to Project Manager's review, for conducting field tests and for collecting and forwarding samples.
   1. Do not use materials or equipment represented by samples until tests, if required, have been made and materials or equipment found to be acceptable.
   2. Do not incorporate any product into work which becomes unfit for use after acceptance thereof.

D. Testing: Materials or equipment proposed to be used may be tested at any time during their preparation or use. Furnish required samples without charge and give sufficient notice of placing of orders to permit testing. Products may be sampled either prior to shipment or after being received at site of work.

E. Tests: Made by testing laboratory approved by the Project Manager. Except as otherwise provided, sampling and testing of materials and laboratory methods and testing equipment shall be in accordance with latest standards and tentative methods of ASTM.
   1. Specific information concerning testing methods, sample sizes, etc., is included under applicable sections of Specifications.
   2. Any modification of, or elaboration on, these test procedures included for specific materials under their respective sections in Specifications shall take precedence over these procedures.

3.5 OTHER TESTING

A. Following Testing: Performed at expense of Contractor:
   1. Any additional tests required because of any tests that fail subject to following conditions:
      a. Quantity and Nature of Tests: Determined by the Project Manager.
      b. Tests: Taken in presence of the Town and/or the Project Manager.
      c. Proof of Noncompliance: Contractor liable for corrective action which the Project Manager feels is required including complete removal and replacement of defective material.
   2. Material Substitution: Any tests of material or equipment offered as substitute for specified item on which test may be required in order to prove its compliance with the Contract Documents.

B. Contractor: May have tests performed on material and equipment for his own information and job control so long as the Town does not assume responsibility for costs or for giving them consideration when appraising quality of materials.

3.6 EQUIPMENT TESTING

A. Equipment testing shall be as determined appropriate by the Project Manager to assure proper performance according to the manufacturer's specifications for each equipment item.

B. After all utility connections to equipment have been completed, the Contractor shall conduct final tests of equipment in presence of the Town and Project Manager.

C. Unless waived in writing by the Project Manager, the requirements of this section shall apply to all installed equipment items having utility connections.

3.7 NOTIFICATION

A. The Contractor shall be responsible for notifying the Project Manager at least three (3) working days prior to commencing work which is identified as requiring testing.

B. The Contractor shall be responsible for scheduling and coordinating all required testing with the Project Manager and, when required by the Town's Agents, the Town's Independent Testing Agency.

END OF SECTION 01 45 16

SECTION 01 50 00 TEMPORARY FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes requirements for furnishing, installing, operating, maintaining, and removing temporary construction fences, barriers, enclosures and field facilities including the Contractor's construction offices, staging areas, yards, storage areas, electrical power, telephone, internet, water, fire protection, sanitary service.

B. Construction Field Office, Yards, and Storage Areas:

1. Temporary facilities which the Contractor desires to locate in staging areas adjacent to the Work or within the project limits are subject to approval by the Project Manager. The Contractor shall provide a Construction Field Office to include the following items:
   a. The Contractor shall acquire all necessary permits for installation and construction work related to the Construction Field Office and fencing.
   b. The Contractor shall provide, as part of his Construction Field Office, a conference room for weekly meetings.
   c. The Contractor shall furnish, install and maintain at least one computer with email in his main field office. This computer should be able to access all email and FTP/online construction management software as part of project submittal process. Provide wireless internet access, secured by password, for use by the Project Manager and Consultant during the work of the Contract.
   d. Jack the mobile office unit off its wheels and provide support.
   e. Install tie downs in compliance with code.
   f. Provide access to the Construction Field Office and easily accessible space for parking. Grade the Construction Field Office site, access roadway and parking area for drainage, and surface with gravel paving or crushed stone.
   g. Water and sewer lines to the Construction Field Office, if installed, shall be installed per code and must be reviewed and approved by the Project Manager.

1.3 UTILITY AND FIRE SERVICES

Electrical Service:

1. Reference General Contract Conditions Article 327 “Power, Lighting, Heating, Ventilating, Air Conditioning, and Water Services”.
2. The Contractor shall incur all costs of temporary electric service permits, fees and deposits required by the governing authorities, and connection charges and temporary easements including installation, maintenance, and removal of equipment.

B. Water Service:

1. The Contractor shall make all connections and extensions required and shall make use of water in direct support of the Work.
2. The Contractor shall install an approved water tap at the Town's water source prior to obtaining any water.
3. The Contractor shall arrange and pay for its supply/distribution system from the Town's point of connection. The location and alignment of the Contractor's temporary supply/distribution system must be approved by the Project Manager prior to its installation.
4. The Contractor shall leave in place all above ground and underground water distribution facilities unless otherwise directed by the Project Manager.
5. The Contractor shall not use in-place fire hydrants or standpipes as sources for construction water or potable water.
6. The Contractor shall incur all costs of temporary water service permits, fees and deposits required by the governing authorities, and connection charges and temporary easements including installation, maintenance, and removal of equipment.

C. Internet Service:
1. Furnish, install, and maintain temporary internet services throughout the construction period.
2. The Contractor shall incur all costs of temporary telephone service permits, fees, and deposits required by governing authorities, and connection charges and temporary easements, including installation, maintenance, and removal of equipment.

D. Fire Protection:
1. In accordance with the Site Safety Plan, Contractor shall furnish, install and maintain temporary portable fire protection equipment throughout the construction period at all buildings (including the project site), maintenance shops, and fuel storage on all large construction equipment and at the location of any flammable materials or construction materials.

1.4 SUBMITTALS

A. Refer to Division 01 Sections "Submittals" and "Shop and Working Drawings, Product Data, and Samples" for submittal procedures.

B. Submit a site plan within five (5) days of the Notice to Proceed that shows the following:
1. Temporary facilities equipment and materials (include manufacturer's literature).
2. Details and layout of temporary installations including fences, visual fence screens, roads, utilities, parking, buildings, storage areas and drainage plans.
3. Lighting plan showing temporary lighting facilities, electrical service panel location, electrical circuit diagram and anticipated light level on the working roadway, pathway or construction surface.

PART 2 - PRODUCTS

2.1 ELECTRICAL SERVICE

A. Provide temporary power and lighting equipment consisting of fixtures, transformers, panel boards, groundings, lamps, switches, poles, conduits and wiring sized and capable of continuous

service and having adequate capacity to ensure a complete operating system. Comply with NEMA.

B. Provide temporary extension cords to supply tools not longer than two-hundred feet (200'), except that additional length may be used if equipment will be grounded within two-hundred feet (200') of tool or power.

C. Portable power generators shall be grounded.

2.2 INTERNET SERVICE

A. Provide materials and equipment adequate to provide internet service.

2.3 FIRE PROTECTION

A. Fire extinguishers shall be UL rated and shall comply with the current Town fire code.

PART 3 - EXECUTION

3.1 ELECTRICAL SERVICE

A. The approximate location of primary power lines is shown on the Construction Drawings. The Contractor shall locate electrical service where it will not interfere with equipment, storage spaces, traffic, and prosecution of the Work or the work of others. Installation shall present a neat and orderly appearance and shall be structurally sound. Maintain service in a manner that will ensure continuous electrical service and safe working conditions.

3.2 WATER SERVICE

A. Install the systems in a neat and orderly manner. Make them structurally and mechanically sound. Provide continuous service. Modify, relocate and extend the systems as the work progresses.

B. Locate systems where they will be convenient to work stations, sanitary facilities and first aid station but will not interfere with traffic, work areas, materials handling equipment, storage areas or the work of other contractors.

C. Install vacuum breakers, backflow preventers and similar devices in a manner and location which will prevent temporary water from returning to the water mains.

D. Do not incorporate any part of temporary water distribution system into the permanent water distribution system.

3.3 INTERNET SERVICE

A. Install temporary internet service and make structurally and electrically sound to ensure continuous service. Modify, relocate and extend as work progress requires. Place cables and equipment where those products will not interfere with traffic, work areas, materials, handling equipment, storage areas and the work of other contractors. Service lines may be aerial.
   1. Wireless Internet:

a. Provide wireless internet connection for the use by Project Manager and Consultants. Connection is to be Digital Subscriber Line (DSL) or faster to enable users to transmit images and/or drawings at an acceptable speed.
b. Wireless internet connection is to be secured by password. Password is to be made available to the Project Manager and Consultant for their use.

3.4 FIRE PROTECTION

A. Install products in conformance with the requirements of the applicable Denver Fire Department and OSHA regulations.
1. Provide functional fire extinguishers that are clearly identified for fire and an accessible supply of water during the period of construction. These fire extinguishers shall remain in place until permanent fire protection systems are functional.
2. Furnish not less than one (1) twenty (20) pound fire extinguisher, type 2A-20ABC within ten feet of cutting and welding operations.
3. Provide twenty (20) pound fire extinguishers, type 2A-20ABC no further than one hundred feet (100') apart in buildings.
4. Provide not less than one (1) twenty (20) pound fire extinguisher, type 2A-20ABC on any equipment of seventy-five (75) horsepower or more.

B. Fire protection equipment shall be placed in easily accessible locations throughout the construction site. The Contractor shall instruct construction personnel as to location and use of temporary fire protection equipment.

C. Fire extinguishers shall be located for easy access. Their location shall be clearly marked so that they can be seen at least seventy-five feet (75') away.

3.5 TEMPORARY CONSTRUCTION FENCING

A. Contractor shall install temporary construction fencing using six (6) foot tall minimum height chain-link fence panels designed to meet minimum standards for stability. Contractor shall provide a main vehicular access gate that is stable, operable, and lockable. A combination lock code or key must be provided to the Project Manager and Operations Staff for access to the site. All fencing must be maintained and kept in good working order for the duration of the Project.

B. Contractor shall contact all utility service companies prior to finalizing fence location and post locations for certification of current utilities and confirm location of irrigation system with field staff. Prior to any soil disturbance, Contactor shall locate pothole post locations planned within five (5) feet of known utilities. Contractor shall submit fencing plan and typical details to Project Manager at least seven days before planned execution for review and acceptance.

C. Contractor is responsible for all maintenance within the temporary construction fencing area including, but not limited to, mowing, watering, and tree protection zones.

3.6 SIGNS

A. All signs must be approved by the Project Manager prior to installation.

3.7 QUALITY CONTROL

A. Provide products for, and the execution of, the Work of this Section that will satisfy the requirements of the NEC, OSHA, and local codes. Provide products that satisfy requirements of NEMA and are UL listed.

3.8 REMOVAL

A. The Contractor shall locate all temporary facilities including the underground utilities, so they can be completely removed without damaging permanent work or the worksite of other contractors. All temporary facilities shall be removed in a timely manner following Substantial Completion of the Project or per the direction of the Project Manager.

END OF SECTION 01 50 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section consists of retention and protection of trees during the construction of the project.

1.3 DEFINITIONS AND REFERENCE STANDARDS

A. Drip Line: The outermost edge of the tree's canopy or branch spread. The area within a tree's drip line is all the ground under the total branch spread.

B. Tree Protection Zone: The Tree Protection Zone shall be the area below ground and the space above ground, equal to one and one-half foot (1.5') radius from the base of the tree's trunk for each one (1") inch of the tree's diameter at four and one-half feet (4.5') above grade (referred to as diameter at breast height)
   1. With groups of trees, there may be discontinuous (non-overlapping) perimeters of Tree Protection Zones which result in difficult to maintain or ineffective tree protection fencing. In these cases, if the distance between the perimeters of such areas is less than thirty feet (30), they should be treated as one contiguous Tree Protection Zone. In effect, this will enlarge the area of tree protection but will result in a more clearly defined and manageable area.

C. Contractor shall comply with applicable requirements and recommendations of the most current versions of the following standards and guidelines. Where these conflict with other specified requirements, the more restrictive requirements shall govern.
   1. ANSI Z133.1-2006: American National Standard for Tree Care Operations.
   2. ANSI A300: Tree, Shrub, and Other Woody Plant Management – Standard Practices.
   3. Guide for Plant Appraisal – Current Edition: Authored by the Council of Tree and Landscape Appraisers; published by the International Society of Arboriculture.

1.4 QUALITY CONTROL

A. Motorized equipment and trailers, including tractors, bobcats, bulldozers, rubber-tired excavators, tracked excavators, trucks, cars, and carts shall not be allowed access within Tree Protection Zones. Should access be necessary within designated Tree Protection Zones the Town shall be notified and shall approve of the access and driving surface prior to its use.

B. Materials and supplies shall not be stockpiled or stored within the Tree Protection Zone unless otherwise approved by the Town.

C. Under no circumstances shall any objects or materials be leaned against or supported by a tree's trunk, branches, or exposed roots. The attachment or installation of any sign, cable, wire, nail, swing, or any other material to trees that is not needed to help support the natural structure of the tree is prohibited.

1.5 SUBMITTALS

A. Tree Protection Plan: Submit a tree protection plan based on the contract drawings for approval by The Town of Berthoud.

B. Proposed methods and schedule for implementing tree and other plant protection shall be submitted for approval.

C. Proposed methods, materials, and schedule for root pruning, branch pruning, and other tree maintenance shall be submitted for approval.

D. Construction Schedule: Contractor shall submit construction schedule which includes a time frame for work near existing plants.

PART 2 - PRODUCTS

2.1 TREE PROTECTION FENCE

A. Orange plastic safety fencing – minimum of forty-eight inches (48") in height, heavy duty T-posts.
1. T-post caps must be used on all posts.

B. Galvanized Chain-link – Six feet (6') in height.

2.2 ROOT BARRIER

A. Eight (8) mesh (0.028-inch or greater) copper wire screen.

B. "Typar BioBarrier" as manufactured by Fiberweb, Inc. www.biobarrier.com or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. If it appears any work may cause damage to the branches of a tree, the Contractor shall contact the Project Manager. The Project Manager will make the determination as to whether such damage is likely and pruning is necessary.

B. To prevent or minimize soil compaction, designated routes for equipment and foot traffic by work crews shall be determined prior to commencing construction activities, and shall be indicated in the tree protection plan to be submitted by the Contractor to the Project Manager for review and approval by the Town.

C. Where work is proposed or shown on Construction Documents within a tree protection zone, the Contractor shall use a compressed air excavation tool or hand dig a trench at the limit of proposed work to reveal existing tree roots. Upon inspection and approval by the Town, if no tree roots larger than 2" are discovered, the location of the tree protection fence may be relocated to the limit of proposed work.

3.2 TREE PROTECTION FENCING

A. Tree protection fence shall be installed prior to any site activity and shall remain in place and maintained in condition in which they were installed until its removal is authorized by the Town.

B. Tree protection fencing should be installed 1-foot behind the existing curb in areas where the street surface will be removed and replaced.

C. Tree protection fences shall be constructed as follows:
   1. Plastic fencing shall have the top secured to metal T-posts with twelve-gauge (12) wire woven through the top of fencing along the entire length. Heavy duty T-posts shall be placed so that wire and fence are taut.
   2. Chain link fence shall have posts installed no less than ten feet (10') on center, at a depth of thirty-six inches (36") minimum. Installation of post shall not result in injury to tree surface roots; root flares or branches.

3.3 DEMOLITION

A. Caution should be used during removal of existing street, curb, gutter, sidewalk, drain inlets, and other concrete and asphalt demolition, to minimize injury to tree root systems. The following procedures should be used when removing existing concrete.
   1. Breaking of the existing concrete and asphalt for removal shall be done in a manner that will minimize ground disturbance and vibration.
   2. Roots and root-trunk flares growing over curbs shall not be injured during breaking of curbs and removal of debris. Wood and bark tissues shall not be injured by equipment.
   3. During the removal of concrete, all exposed root systems and soil areas shall not be disturbed.
   4. Motorized equipment and trailers, including but not limited to tractors, skid steers, bulldozers, rubber-tired excavators, tracked excavators, trucks, cars, and carts are to be limited to access on the existing paved areas only. Access is not allowed behind the curb within Tree Protection Zones.
   5. If access within designated Tree Protection Zones is approved by the Town the existing grade shall be covered with twelve inches (12") of wood mulch and overlapping sheets of three-quarter inch (3/4") thick plywood placed on top of the wood mulch to help distribute the weight of equipment and to minimize soil compaction and rutting.
      a. Exposed tree roots shall not be driven over. Plywood and/or mulch are not acceptable bridging materials for driving over exposed tree roots.

3.4 CONSTRUCTION IN TREE PROTECTION ZONES

A. The following procedures shall be used when constructing sidewalks, curbs, concrete, asphalt paving, and drainage inlets.
   1. Keep all materials and equipment within the street bounded by existing curbs.
   2. Construct new sidewalks on, or above, the existing grade instead of excavating into root zones. The new grade shall not interfere with sheet-flow drainage.
   3. Protect exposed roots from contamination by stabilization materials and concrete.
   4. Locate concrete washouts away from Tree Protection Zones. Washout runoff shall be strictly contained within the washout area and shall not flow into Tree Protection Zones or proposed new planting areas.
   5. When excavating for the construction of inlets, excavated soil shall be deposited in trucks and hauled off or deposited temporarily on three quarter inch (3/4") thick plywood outside the Tree Protection Zones. Excavated and fill soil shall not be deposited, even temporarily, on unprotected natural grade.
   6. After proper root-pruning, as needed, cover exposed roots within thirty (30) minutes to minimize desiccation. Roots may be covered with soil, mulch, or moistened burlap (7 ounce or equivalent), and shall be kept moist until the final grade is established.

B. Where possible, construction should be relocated to prevent damage to existing roots. Where relocation of walks is not possible, walks should be constructed in a manner with the least amount of impact/damage to roots including but not limited to raised, narrowed, curbed, ramped, bridged, cantilevered, use of pylons, root break out zones, root channeling, structural cells to prevent cutting and removing major roots (e.g. roots greater than two inches in diameter).

C. Grading within the Tree Protection Zone shall be performed by hand or a method approved by the Town. Any fill material that needs to be placed in the Tree Protection Zone shall be limited to a maximum of one inch (1") of fill material over the area. Fill should consist of sandy loam topsoil. Clay soils shall not be used as fill. When using fill soil, the existing surface to receive fill should be scarified by hand to a maximum depth of one inch (1") from the finished grade prior to placing fill material, to ensure proper incorporation of fill material. Any filling operation should not occur during water saturated soil conditions.

D. Existing soil may be used as a form for back of curb and gutter, with or without the use of a thin masonite-type form, although a Masonite form is preferred. This will minimize excavation in the critical root zone and prevent undue injury to the roots. This method is unnecessary in areas outside the critical root zone. Place a layer of "Typar BioBarrier" between the curb and tree roots to help inhibit root growth that may exploit small cracks in the curb. Where appropriate, use curbs with discontinuous footings to maintain natural grade near the base of trees adjacent to the curbing, and to minimize injury to roots and root flares.

E. Provide for easy concrete removal and replacement where an obvious raised root may cause sidewalk cracking in the future. This can be accomplished by installing an expansion joint on either side of the root or by scoring (as shown on the Contract Documents) the concrete on either side of the root to allow that particular section to be broken out and replaced. Compaction rating for the replacement walkway should not exceed eighty percent (80%) Proctor density. Tree roots will continue to slowly add girth every year; therefore, the base material needs to be malleable (e.g. suitable subgrade aggregates, crushed granite, or compacted sand) to prevent a fulcrum or pressure point which can crack or heave the walkway.
   1. Where appropriate, and under the direction of the Town, root restricting barriers can be installed with a minimal amount of disturbance away from sidewalks, curbs, and streets.
   2. In areas where roots need to be removed for construction of drain inlets, roots shall be pruned prior to excavation to eliminate unnecessary tearing of roots by equipment.
      a. Excavate soil by hand at the construction cut limit to a depth of thirty (30) inches or to the depth of the required root cut, whichever is less.
      b. Prune roots as specified.
      c. Protect exposed roots as specified.
   3. Concrete or chemicals spilled within Tree Protection Zones should be completely removed. Contaminated soil shall be completely removed at the time of the spill and removed by hand and/or air spade tool without disturbance to root systems. Appropriate soil should be added as necessary to restore the grade.

F. Any trees deemed damaged or destroyed by the Town Arborist in connection with this work shall be replaced in kind, at the responsible party's expense.

3.5 IRRIGATION OR UTILITY INSTALLATION

A. Contractor shall protect all trees and high-value shrubs from injury due to irrigation related work.

B. All irrigation lines in Tree Protection Zones indicated on construction plans shall be approved by the Town prior to installation. No irrigation lines shall be located within ten feet (10') of any existing tree trunk without prior approval.

C. Wherever trenching exposes roots extending through the trench wall, those roots shall be hand pruned immediately, refer to Root Pruning. All trenches within shall be closed within twelve hours (12); if this is not possible, the trench walls shall be covered with burlap and kept moistened.

3.6 PROJECT SITE MONITORING

A. The Tree Protection Zones should be monitored a minimum of two (2) times weekly (more frequently at the start of the project) until all procedures and specifications are understood and properly executed by the Contractor.

B. Specific monitoring schedules shall be reviewed at the construction meetings and modified as deemed necessary by the appropriate parties.

3.7 TREE MAINTENANCE DURING CONSTRUCTION

A. Tree Maintenance: Proper maintenance shall include, but not be limited to, structural and remedial pruning, watering, mulching, remediating soil compaction, fertilization, insect and disease control, soil and tissue analysis, aeration, and wound treatment.
   1. Minimum watering requirements shall be twenty-five (25) gallons per diameter inch every two (2) weeks March – October; thirty-five (35) gallons per diameter inch every month November – February; depending on weather conditions the Town may approve less frequent watering.

B. The timing, duration, and frequency of necessary maintenance practices should be determined and approved by the Town based on factors associated with the site and affected plants. A tree watering log may be required to be completed weekly and submitted to Project Manager or Owner's Representative.

3.8 MULCH RINGS

A. New wood mulch rings shall be installed at the base of all existing trees to remain in proposed native seed, turf, and planting bed areas as shown in contract drawings. Reference section 32 93 00 for mulch information.
   1. Mulch rings shall be 4' minimum diameter from base of the tree trunk or as designated on drawings.

B. New decorative rock mulch rings shall be installed at the base of all existing trees to remain in the existing parking lot medians as shown in the contract drawings. Reference section 32 93 00 for mulch information.
   1. Mulch rings shall be 4' minimum diameter from base of the tree trunk.

END OF SECTION 01 56 39

SECTION 01 58 00 PROJECT IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INLCUDED

A. Contractor shall prepare, erect and maintain one painted project sign at two separate locations (one sign at the main entrance to Waggener Farm Park and the Berthoud Arboretum and the second sign along Mountain Ave near the intersection at Berthoud Parkway).

B. No other signs or advertisement will be allowed without the Owner's approval.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide shop drawings of proposed project identification sign in accordance with Section 01330 Submittal Procedures.

B. Sign Material: 3/4" thick plywood, A/C, exterior APA, conforming to PS1 standards.
1. Size: Sign shall be cut from nominal 4'-0" x 8'-0" plywood sheet.

C. Posts: 4"x4" Hem-Fir or Douglas Fir, S4S, conforming to PS 20 standards.

D. Paint/Lettering: Provide submittal of shop drawings.

PART 3 - EXECUTION

3.1 GENERAL

A. A. Owner shall review signage copy for correctness and completeness prior to beginning work.
1. Special graphics or logo requirements will be furnished to the sign fabricator by the Owner and/or Architect.

2. Contact information shall include name, address, and phone number for the following:
a. Town Project Manager
b. General Contractor

B. Project sign shall be erected within two (2) weeks of Notice to Proceed and shall remain on the project site until completion of the project.

C. Location of the sign shall be as arranged at the Pre-Construction Conference.

END OF SECTION 01 58 00

SECTION 01 71 23 LAYOUT OF WORK AND SURVEYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the procedures and accuracy requirements for survey services for layout of work and field measurement of work quantities to be determined by surveys.
   1. The Work is to be verified and coordinated with Contract Drawings. Variations between Contract Drawings and actual field conditions are to be immediately brought to the attention of the Project Manager.
   2. Reference Standard Specifications for Construction General Contract Conditions, Article 318 “Construction Surveys” and Article 319 “Preservation of Permanent Land Survey Control Markers”.

1.3 SUBMITTALS

A. Refer to Division 01 Sections “Submittals” and “Shop and Working Drawings, Product Data, and Samples” for the submittal process.

B. Field Notes: Submit Copies of original pages of field notes.

C. Closeout Submittals:
   1. Original field notebooks when filled and at end of contract.
   2. Measurements for Record Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CONSTRUCTION LINES AND GRADES

A. The Contractor shall make surveys and layouts as necessary to delineate the work. The Contractor shall make the surveys for the proper performance of the Work. As a part of such surveys, the Contractor shall furnish, establish, and maintain in good order survey control points that may be required for the completion of the Work subject to the approval of the Project Manager as to their location, sufficiency, and adequacy. However, such approval by the Project Manager shall not relieve the Contractor of their responsibility for the accuracy of his survey work.

B. The Contractor shall furnish skilled labor, instrument platforms, ladders, and such other temporary structures as may be necessary for making and maintaining points and lines regarding the surveys required.

C. The City may draw the Contractor's attention to errors or omissions in lines or grades, but the failure to point out such errors or omissions shall not give the Contractor any right or claim nor shall in any way relieve the Contractor of his obligations according to the terms of this contract.

D. The Contractor's instruments and other survey equipment shall be accurate, suitable for the surveys required in accordance with recognized professional standards and in proper condition and adjustment always. Surveys shall be performed under the direct supervision of a Colorado licensed surveyor.

3.2 DIGITAL FILES

A. If approved by the Project Manager, the Contractor may elect to utilize the Design Consultant's digital CAD files as guidance for layout and location of site elements.

B. Layout and location of site elements, grades and features from digital CAD files does not relieve the Contractor of requirements, locations and grades shown on the Contract Drawings.

C. Contractor is responsible to verify locations of elements staked with digital data to assure conformance with the Contract Drawings at a level of accuracy as stated in Section 3.3 below.

3.3 SURVEYING ACCURACY AND TOLERANCES IN SETTING SURVEY, LAYOUT, AND QUANTITY CALCULATION STAKES

A. The tolerances generally applicable in setting survey stakes shall be as set forth in the CDOT's Survey Manual, latest edition. Such tolerances shall not supersede stricter tolerances required by the drawings or specifications and shall not otherwise relieve the Contractor of responsibility for measurements in compliance therewith.

3.4 RECORD MEASUREMENTS

A. Provide record measurement for items that will be hidden or visible including all civil, mechanical, and electrical, control work, and all utilities that are placed in concrete, earth, or behind walls shall be made.

B. Items located within or five feet (5') beyond a building shall be referenced to building column lines and finish floor elevations.

C. Special attention shall be paid to items requiring service, sensors, items with moving parts, access points and locations of junctions, elevation changes, and directional changes.

END OF SECTION 01 71 23

SECTION 01 74 23 CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the requirements for maintaining a clean, orderly, hazard free worksite during construction, and final cleaning for the Town's Final Acceptance. Failure to maintain the worksite will be grounds for withholding monthly payments until corrected to the satisfaction of the Project Manager.

B. Reference General Contract Conditions as listed:
   1. Article 325 "Cleanup During Construction".
   2. Article 803 "Protection of Property and Work in Progress".
   3. Article 2001 "Cleanup Upon Completion".

1.3 JOB CONDITIONS

A. Safety Requirements: Maintain the worksite in a neat, orderly and hazard-free manner in conformance with all federal, state and local rules, codes, regulations and orders, including all OSHA requirements, until Final Acceptance of the Work. Keep catwalks, underground structures, worksite walks, sidewalks, roadways and streets, along with public and private walkways adjacent to the worksite, free from hazards caused by construction activities.
   1. Inspect those facilities regularly for hazardous conditions caused by construction activities.

B. Hazards Control:
   1. Store volatile wastes in covered metal containers and remove those wastes from worksite daily.
   2. Do not accumulate wastes which create hazardous conditions.
   3. If volatile and noxious substances are being used in spaces that are not naturally ventilated, provide artificial ventilation.
   4. Hazard controls shall conform to the applicable federal, state, and local rules and regulations.
   5. Provide appropriate waste receptacles in all areas in which employees are working. Waste receptacles shall be kept covered at all times. All materials on site shall be anchored and covered to prevent any objects from becoming wind-borne.

C. Access: Maintain the worksite to permit access by other Town contractors as required and to allow access by emergency personnel.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

A. Utilize the type of cleaning materials recommended by the manufacturer for the surfaces to be cleaned.

B. Maintain current Safety Data Sheets (SDS) on site for all chemicals. Refer to following link for associated OSHA requirements. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10103

C. Ensure proper disposal of all wastes generated from the use of these materials. Must ensure compliance with all environmental regulations.

PART 3 - EXECUTION

3.1 INTERIM CLEANING

A. Clean the worksite every shift/workday for the duration of the construction contract. Maintain structures, grounds, storage areas, and other areas of worksite, including public and private properties immediately adjacent to worksite, free from accumulations of waste materials caused by construction operations. Place waste materials in covered metal containers. All hard concrete, steel, wood, and finished walking surfaces shall be swept clean daily.

B. Remove or secure loose material on open decks and on other exposed surfaces at the end of each workday or more often in a manner that will maintain the worksite hazard free. Secure material in a manner that will prevent dislodgment by wind and other forces.

C. Sprinkle waste materials with water or acceptable chemical palliative to prevent blowing of dust.

D. Promptly empty waste containers when they become full and legally dispose of the contents at dumping areas off the Town's property.

E. Control the handling of waste materials. Do not permit materials to be dropped or thrown from structures.

F. Immediately remove spillage of construction related materials from haul routes, work site, private property, or public rights of way.

G. Clean only when dust and other contaminants will not precipitate upon newly painted surfaces.

H. Cleaning shall be done in accordance with manufacturer's recommendation.

I. Cleaning shall be done in a manner and using such materials as to not damage the Work.

J. Clean areas prior to painting or applying adhesive.

K. Clean all heating and cooling systems prior to operations. If the Contractor was allowed to use the heating and cooling system, it shall be cleaned prior to testing.

L. Clean all areas that will be concealed prior to concealment.

3.2 FINAL CLEANING

A. Inspect interior and exterior surfaces, including concealed spaces, in preparation for completion and acceptance.

B. Remove dirt, dust, litter, corrosion, solvents, paint, stains, and extraneous markings.

C. Remove surplus materials, except those materials intended for maintenance.

D. Remove all tools, appliances, equipment, and temporary facilities used in the construction.

E. Remove detachable labels and tags. File them with the manufacturer's specifications for that specific material for the Town's records.

F. Repair damaged materials to the specified finish or remove and replace.

G. Clean all catch basins, manholes, drains, strainers, and filters after all trades have completed their work and just before Final Acceptance

H. Sweep roadway, driveways, floors, steps, and walks.

I. Interior areas of buildings shall be vacuumed clean and mopped.

J. Final cleanup applies to all areas within and adjacent to the site.

END OF SECTION 01 74 23

SECTION 01 77 00 **CONTRACT CLOSEOUT**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes procedures required for Substantial Completion under Title 19 and Final Completion and Acceptance of the Work under Title 20 of the General Contract Conditions and Division 01 Section "Contract Record Documents".

B. Reference General Contract Conditions as listed:
1. Article 906 "Applications for Payment".
2. Article 909 "Additional Withholding of Progress Payments".
3. Article 2003 "Final Settlement".

1.3 PREPARATION FOR FINAL INSPECTION

A. Before requesting inspection for Final Acceptance of the Work by the Town, inspect, clean, and repair the Work as required.

1.4 FINAL INSPECTION

A. When the work is complete the Contractor shall submit written notification that:
1. All punch list items have been completed.
2. All clean up at the project site has been accomplished.
3. Work has been inspected by the Contractor for compliance with contract documents.
4. Work has been completed in accordance with contract documents.
5. Work is ready for final inspection by the Town.
6. All required Record Documents have been submitted and accepted.
7. All damaged or destroyed real, personal, public or private property has been repaired or replaced.
8. All operation and maintenance manuals have been submitted and accepted and all training has been completed.

B. The Project Manager will inspect to verify the status of completion with reasonable promptness after receipt of such notification. The inspection of the work will be done in accordance with the General Contract Conditions.

C. If the Project Manager finds incomplete or defective work:
1. The Project Manager may, at their sole discretion, terminate the inspection and/or deduct all costs associated with premature inspection from final billing.
2. The Contractor shall take immediate steps to complete work and send a second written notification to the Project Manager that Work is complete.
3. The Project Manager will then re-inspect the Work.

1.5 REINSPECTION FEES

A. Should the Project Manager perform re-inspection due to failure of the Work to comply with the claims of status of completion made by the Contractor:
   1. The Contractor shall compensate the Town for such additional services at the rate of seventy-five dollars ($100.00) per man-hour.
   2. The Town shall deduct the amount of such compensation from the final payment to the Contractor.

1.6 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit a Final Statement of Accounting to the Project Manager.

B. The Final Statement of Accounting shall reflect all adjustments to the contract amount and shall include the following:
   1. The original contract amount.
   2. Additions and deductions resulting from:
      a. Previous change orders.
      b. Allowances.
      c. Final quantities for unit price items. Along with this statement shall be detailed backup for the quantities.
      d. Deductions or corrected work.
      e. Penalties.
      f. Deductions for liquidated damages.
      g. Deductions for re-inspection payments.
      h. Town resurveys required due to the Contractor.
      i. Other adjustments
   3. Total contract amount, as adjusted.
   4. Previous payments.
   5. Sum remaining due.

C. If required, the Project Manager will prepare a final change order, reflecting approved adjustments to the Contract sum which were not previously made by change orders.

1.7 FINAL APPLICATION FOR PAYMENT

A. The Contractor shall submit the final application for payment in accordance with the procedures and requirements stated in the General Contract Conditions Title 20 “Final Completion and Acceptance of the Work”.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 77 00

SECTION 01 78 23 OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section consists of requirements for preparing and submitting operation and maintenance data for mechanical, electrical, plumbing, fixtures, structures, shelters, pavement markings, playground protective surfacing, play equipment, chain link fencing, site stone, specialized irrigation (including pump stations and booster pumps), site furnishings, storm sewerage, subsurface drainage, any additional products/equipment, and other specified equipment as directed by the Project Manager.

B. Related Sections:
1. Division 32 Section “Pavement Markings”.
2. Division 32 Section “Playground Protective Surfacing”.
3. Division 32 Section “Irrigation Systems”.
4. Division 33 Section “Storm Sewerage”.
5. Division 33 Subdrainage Systems”.

1.3 SUBMITTALS

A. Refer to Division 01 Sections “Submittals” and “Shop and Working Drawings, Product Data, and Samples” for submittal procedures.

B. Submit one (1) digital copy of the Operation and Maintenance Data Manual prior to Substantial Completion for review and comment. Substantial Completion will not be issued until the final Operations and Maintenance Data Manual is received and comments are addressed and accepted. Format is indicated below in Part 3 – Execution.

PART 2 - PRODUCTS

A. The following are the requirements of digital copies:
1. Paper Size: 8-1/2-inches x 11-inches, as applicable.
2. Text: Typewritten.
3. Cover Page: Provide a cover sheet for each manual. The cover shall contain the information as required below in Part 3 – Execution.
4. Digital Data: Manufacturer’s catalog cuts, brochures, operation and maintenance data. Clear reproductions will be acceptable. If this data is in color, all final manuals shall be in color.
5. Digital Drawings: Original drawing size with legible text.
6. Digital Scans of Drawings: Black ink on white paper, sharp in detail, and suitable for making reproductions.

PART 3 - EXECUTION

3.1 GENERAL

A. Assemble each operation and maintenance manual using the manufacturer's latest standard commercial data.

3.2 COVER

A. Include the following information on the front cover and on the inside cover sheet:
   1. Title: "Operation and Maintenance Instructions".
   2. Title of the project and contract number including park or location.
   3. Title of the facility, structure, or system.
   4. Contractor's name, address, and contact information.
   5. General subject of the manual.
   6. Leave spaces for signatures of the Town representatives and Substantial Completion date.

3.3 CONTENTS OF THE MANUAL

A. An index of each manual section included in the Operations and Maintenance Manual.

B. A table of contents in front of each manual section. List and combine the information for each system in the sequence of operation.

C. Names, addresses, email addresses, and telephone numbers of the following:
   1. Contractor/Sub-contractor.
   2. Suppliers.
   3. Installers.
   4. Manufacturer's nearest service representatives.
   5. Manufacturer's nearest parts vendor and service agency.
   6. Include the manufacturer's order number and description of the order.

D. Copy of warranties and guarantees in accordance with the WARRANTY/GUARANTEE section, issued to and executed in the name of the Town.

E. Substantial Completion date of the project. If a Landscape Maintenance contract exists, include the anticipated date the Town assumes responsibility for site maintenance.

F. Include the following information within each manual section, if applicable:
   1. Description of system and component parts, including theory of operation.
   2. Pre-operation check or inspection list.
   3. Procedures for starting, operating, and stopping equipment.
   4. Post operation check or shut down list.
   5. Inspection and adjustment procedures.
   6. Troubleshooting and fault isolation procedures for on-site level of repair.
   7. Emergency operating instructions.
   8. Accepted test data.
   9. Maintenance schedules and procedures.
   10. Installers.
   11. Manufacturer's nearest service representatives.
   12. Manufacturer's nearest parts vendor and service agency.

13. Include the manufacturer's order number and description of the order.
14. Test procedures to verify the adequacy of repairs.
15. Each wiring diagram.
16. Each piping diagram.
17. Each duct diagram.
18. Each control diagram.
19. Each accepted shop drawing.
20. Location where all measurements are to be made
21. Each software program imputable or changeable on site.
22. Manufacturer's parts list with catalog names, numbers and illustrations.
23. A list of components which are replaceable by the Town.
24. An exploded view of each piece of the equipment with part designations.
25. A list of the Manufacturer's recommended spare parts, current prices, and recommended quantities for two (2) years of operation.
26. A list of special tools and test equipment required for the operation, maintenance, adjustment, testing and repair of the equipment, instruments and components.
27. Scale and corrosion control procedures.
28. Disassembly and re-assembly instructions.
29. Troubleshooting and repair instructions.
30. Calibration procedures.
31. Ordering information.
32. Training course material used to train Town staff, including slides and other presentation material.
33. Winterization and spring start-up procedures.
34. Manufacturer's maintenance and operation instructions for pump station.
35. Manufacturer's maintenance and operations instructions for booster pumps.
36. Hardware, including gate hardware.
37. Finishes, including polymer finishes.

END OF SECTION 01 78 23

SECTION 01 78 35 WARRANTIES AND BONDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the requirements for preparing and submitting warranties and bonds required by these specifications.

A. Reference the General Contract Conditions as listed:
1. Article 111 “Final Completion”.
2. Article 1501 “Surety Bonds”.
3. Article 1502 “Performance Bond”.
4. Article 1503 “Payment Bond”.
5. Article 1801 “Contractor’s Warranties, Guarantees, and Correction of Work”.
6. Article 1802 “Performance During Warranty Period”.

1.3 SUBMITTALS

A. Refer to Division 01 Section “Submittals” for submittal procedures.

B. Submit executed warranties and bonds.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 WARRANTIES AND BONDS

A. Execute the warranties and bonds required by the Contract Documents. Prepare and submit a list of all warranties and bonds on the form provided by the Town. Reference Division 01 Section “Standard Forms”.

B. Provide warranties or bonds for the materials, labor, and time-period set forth in the sections of these specifications requiring such documents. All warranties shall be in accordance with the General Contract Conditions. Refer to the individual specifications sections for all specific items requiring longer warranty periods.

C. Provide all warranties and bonds that the manufacturer or supplier furnishes at no additional cost in regular commercial trade. All warranties shall be in accordance with the General Contract Conditions. Refer to the individual specifications sections for all specific items requiring longer warranty periods.

D. The Contractor's warranty for the Work completed during the Project shall be effective for a one-year period from the date of Substantial Completion of the Work.

END OF SECTION 01 78 35

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Related Sections:
1. Division 01 Section “Temporary Facilities and Controls”.
2. Division 31 Section “Earth Moving”.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

C. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

D. Recyclable Material: Material generated during demolition operations that can be reconditioned and reclaimed for the same or different use. Such materials include asphalt, concrete, metals (steel, iron, aluminum, copper, etc), rubber, glass and paper.

1.4 PROJECT CONDITIONS

A. Keep dust to a minimum at removal areas. Use water trucks as necessary.

B. Ensure safety of persons in demolition area. Provide temporary barricades as required.

1.5 PRE-CONSTRUCTION MEETINGS

A. Preconstruction: Inspect and discuss condition of construction to be selectively demolished.

B. Review structural load limitations of existing structure.

C. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.

D. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.

E. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

A. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property. Indicate proposed locations and construction of barriers.

B. Schedule of Demolition Activities: Indicate the following:
   1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure the Town's on-site operations are uninterrupted.
   2. Interruption of utility services. Indicate how long utility services will be interrupted.
   3. Coordination for shutoff, capping, and continuation of utility services.

C. Inventory: Submit a list of items to be removed and salvaged and deliver to the Town prior to start of demolition.

D. Preconstruction Photographs or Video: Submit digital photographs or videos prior to Work commencing.

1.7 CLOSEOUT SUBMITTALS

A. Inventory:
   1. Submit a list of items that have been removed and salvaged.
   2. Include documentation of the type and volume/weight of materials hauled to the nearest recycling center.

B. Landfill Records: Provide records of receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

A. Soils as indicated on documents, free of debris, frozen materials, roots, and other organic matter. See Division 01 Section "Earth Moving".

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, pavement, trails, utilities, and vegetation to remain.

B. Set up all barriers, including those for tree protection, in accordance with Division 01 Section "Temporary Facilities and Controls" and Division 01 Section "Tree Protection and Retention", prior to proceeding with any demolition.

C. Protection and Repair of Underground lines:
   1. Existing Public Utilities: Locate existing underground utilities within the limits of work per General Contract Conditions. Request utility locates seventy-two (72) hours in advance of any excavations by calling the Utility Notification Center of Colorado at 811. The Contractor is responsible for providing written and graphical documentation from the utility owner. Take whatever precautions are necessary including potholing to verify location and depth to protect these underground lines from damage. Should unmarked or incorrectly marked utilities or other piping be encountered during excavation, notify the

Project Manager immediately for direction. If damage does occur, all damage shall be repaired by the utility owner and all costs of such repair shall be paid by the Contractor. Only written all clears will be acceptable from utility providers or utility locate services, verbal all clears will not be accepted.

2. Existing Private Utilities: Locate existing underground utilities within the limits of work per General Contract Conditions. The Contractor is required to contact all private utility companies including the Town of Berthoud to locate all private utilities. The Contractor is responsible for providing written and graphical documentation from the private utility owner. The request for locates shall be a minimum of seventy-two (72) prior to proceeding with any excavation. If, after such requests, private utilities are encountered and damaged by the Contractor these shall be repaired at no cost to the Town. If the Contractor damages staked or located private utilities, they shall be repaired by the utility owner and all costs of such repair shall be paid by the Contractor. Only written all clears will be acceptable from utility providers or utility locate services, verbal all clears will not be accepted.

3.2 DEMOLITION

A. Pavement, Slabs, and Miscellaneous Concrete Items:
   1. Remove concrete slabs-on-grade, curbs, and miscellaneous concrete items as directed. Where concrete to be removed abuts concrete to remain, pavement shall be uniformly saw-cut along an existing joint. Jagged or crooked edges will not be acceptable. Concrete shall be broken up, hauled and disposed offsite, except for areas shown for remove and reinstall for recycled concrete paving. Dust caused by saw cutting must be mitigated with water or other adequate safety measures. All recyclable materials shall be hauled to nearest recycling center.

3.3 RESTORATION

A. Backfilling: Ensure that areas to be filled are free of standing water, frost, frozen material, vegetation, including roots and debris. Place fill materials in accordance with Division 31 Section “Earth Work”.

B. Grading:
   1. Restored Areas: Grade surface to blend with original contours and provide free drainage flow. All ruts and depressions where any amount of standing water collets shall be re-graded to a smooth natural appearance to ensure positive drainage.
   2. New Construction Areas: Grade as indicated in Division 31 Section “Earth Work”.

3.4 DISPOSAL

A. Remove trash, debris and waste materials, haul and legally dispose of it off the property. All recyclable materials shall be hauled to nearest recycling center.

B. Salvaged Material: All salvaged material remains the property of the Town. Store or deliver as directed by the Project Manager.

3.5 QUALITY CONTROL

A. Comply with safety requirements for demolition, ANSI A10.6-83.

END OF SECTION 02 41 00

THE GARDEN SPOT – Berthoud Arboretum

TECHNICAL SPECIFICATIONS

SECTION 03 3053 – MISCELLANEOUS CAST-IN-PLACE CONCRETE (OTHER THAN PAVEMENT)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes for the following:

1. Drainage Structures.
2. Retaining Walls.
3. Box Base Manholes.
4. As indicated on the plans.

B. Related sections include the following:

1. Division 31 Section “Earth Moving” for excavation and backfill.
2. Division 32 Section “Concrete Paving Joint Sealants.”
3. Division 33 Section “Storm Utility Drainage Piping.”

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 SUBMITTALS

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

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

D. Samples:

1. Waterstops
2. Sealants

E. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

F. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Fiber reinforcement.
6. Waterstops.
7. Curing compounds.
8. Floor and slab treatments.
9. Bonding agents.
10. Adhesives.
11. Vapor retarders.
12. Semirigid joint filler.
13. Joint-filler strips.
14. Repair materials.

G. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

C. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
2. ACI 308, “Standard Practice for Curing Concrete”.
3. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
4. ACI 306, “Standard Specification for Cold Weather Concreting.”
5. ACI 318, “Building Code Requirements for Structural Concrete.”

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

    a. Contractor's superintendent.
    b. Independent testing agency responsible for concrete design mixtures.
    c. Ready-mix concrete manufacturer.
    d. Concrete subcontractor.

2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, concrete repair procedures, and concrete protection.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending, oxidation, and damage.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

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

    a. High-density overlay, Class 1 or better.
    b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
    c. Structural 1, B-B or better; mill oiled and edge sealed.
    d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

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

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

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

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

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

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

2.3 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project

1. Portland Cement: ASTM C 150, Type I/II. Type I Portland cement will not be permitted where sulfate resistant cement is required.

   The following materials may be used to supplement the portland cement in accordance with ACI 301, Section 4.

   a. Fly Ash: ASTM C 618, Class C or F. Class C fly ash will not be permitted where Type II or I/II Portland cement is required.
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, graded, 3/4-inch nominal maximum coarse-aggregate size.

1. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94 and potable.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494, Type A.
2. Retarding Admixture: ASTM C 494, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.

2.5 WATERSTOPS

A. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Manufacturer and Type:

a. As indicated on plans.

2.6 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating.

2.7 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, ½" thick unless indicated otherwise on the plans.

2.8 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 25 percent.

C. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

D. Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4,500 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: 6 ½ Percent, plus or minus 1.5 percent at point of delivery.

2.9 FABRICATING REINFORCEMENT

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

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and ASTM C 1116, and furnish batch ticket information to Owner’s Representative.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork according to ACI 301 to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Provide ¾-inch chamfer at exterior corners and edges of permanently exposed concrete, unless indicated otherwise on the plans.

D. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:

1. Class A, 1/8 inch (3.2 mm) for smooth-formed finished surfaces.

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

F. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

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

J. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

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

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

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

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 80 percent of its 28-day design compressive strength.

2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Owner’s Representative.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire. Vertical bars shall be coated with epoxy at exposed surface.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by the Owner’s Representative.

1. Place joints perpendicular to main reinforcement, continue reinforcement across construction joints, unless otherwise indicted.

3.6 WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

3.7 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Owner's Representative.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

G. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent

of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.8 FINISHING FORMED SURFACES

A. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to all formed concrete surfaces.

B. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated on the drawings.

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.9 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to all horizontal top slab surfaces unless indicated otherwise.

C. Broom Finish: Apply a broom finish to all surfaces exposed to pedestrian use unless otherwise indicated.

3.10 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

    a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

3.11 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Owner's Representative. Remove and replace concrete that cannot be repaired and patched to Owner's Representative's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve (1.18 mm), using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Owner's Representative.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen

concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Owner’s Representative's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Owner’s Representative's approval.

3.12 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each type of concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each compressive strength test, but not less than one test for each day's pour of each type of concrete mix.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each set of compressive strength specimens.
5. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.
6. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd.. One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required.
7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, current operations shall be evaluated and corrective procedures shall be provided for protecting and curing in-place concrete.

C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Owner's Representative, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, concrete type and class, location of concrete batch in pour, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Owner's Representative, but will not be used as the sole basis for approval or rejection.

F. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Owner's Representative. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

G. Remove and replace concrete where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 03 3053

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The General Contract Conditions, Drawings, and other Division-1 Specifications apply to Work of this Section.
B. Technical Document 9A.

1.2 DESCRIPTION

A. Furnish all labor, materials and equipment and perform all operations necessary to install mortar and grout as required by stone walls and stone veneer columns, as shown in the construction plans and as specified herein.

1. 3 RELATED SECTIONS

A. Division 310000 – Earthwork

B. Section 033000 – Cast-in-Place Concrete

C. Section 324000 – Site Stone

1.4 SUBMITTALS / SHOP DRAWINGS

A. Submit catalog data on grout proposed for use, including color.

B. Submit mix design for Masonry mortar.

C. Submit certificates signed by manufacturer and contractor, including manufacturer's name, brand and type certifying that each different cement product required for mortar and grout complies with the requirements specified on the drawings and herein.

1.5 QUALITY ASSURANCE

A. Contractor shall obtain mortar ingredients of uniform quality, from one manufacturer for each cementitious component and from one source and producer for each aggregate for the entire project.

B. Contractor shall comply with the following standards, except where more stringent requirements are stated on the drawings or herein:

1. American National Standards Institute, ANSI/NSB 211 (A41.1), "Building Code Requirements for Masonry"
2. American Society for Testing Materials, ASTM.
3. National Concrete Masonry Association, NCMA, "A Manual of Facts on Concrete Masonry."
4. Uniform Building Code, UBC, Chapter 24 – Masonry.

1.6 PRODUCT HANDLING AND STORAGE

A. Deliver and store mortar materials to prevent inclusion of foreign material and damage by water. Deliver packaged material in original manufacturer's containers.

B. Material showing evidence of water or other damage is subject to rejection.

1.7 JOB CONDITIONS

A. Masonry work shall not be performed when the temperature is below 40 degrees F. except when approved by the Project Manager, in which case there shall be provided a satisfactory method of heating materials before laying. A satisfactory method shall be provided for maintaining the air temperature around the finished masonry at 40 degrees F. minimum for a period of at least 48 hours after being placed.

B. In cold weather masonry, reinforcing steel and concrete upon which masonry is to be placed shall be kept free of frost, ice or other foreign substances.

C. Hot Weather Protection During Installation: When air temperature exceeds 99 degrees F in the shade, protect freshly laid masonry from direct exposure to wind and sun.

D. Moisture Protection During Installation: Where exposed to weather, the top of masonry walls shall be covered at the end of each days work using a waterproof material weighed down to insure its retaining in place. Maintain such protection until final capping of the wall.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Non – Shrink, Non-Metallic Grout or Dry-pack.

1. Grout shall conform to ASTM C1107 Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink) and CRD-C-621-80, Corps of Engineers Specification for Non-Shrink Grout. Provide grout specifically recommended by manufacturer for exterior applications of the types specified herein or indicated on the drawings.

2. Provide grout which shows zero percent (0%) shrinkage and not more than 0.02% expansion after 28 days, as determined by CRD C-621.

B. Masonry Mortar Mix and Reinforced Masonry Grout

1. Portland Cement: Conform to ASTM C150, Type 1, except use Type III for cold weather construction.
2. Hydrated Lime: Conform to ASTM C207, Type S.
3. Aggregates for Mortar: Conform to ASTM C144.
4. Water: clean, potable, and free from deleterious amounts of acids, alkalis or organic material.
5. Aggregates for Grout: Conform to ASTM C404.
6. Additives: None permitted, except as specified herein. Specifically, do not lower freezing point of mortar or grout by use of calcium chloride or other anti-freeze agents.
7. Fly Ash and Masonry Cement not allowed.
8. Comply with ASTM C270, Property Specifications, for mortar types required. Type S – average compressive strength at 28 days = 1800 psi.

9. Reinforced Masonry Grout: Proportioned by volume. One part Portland Cement with not more than one-tenth part hydrated lime or lime putty added, and two to three parts sand, and not more than two parts gravel.

PART 3 - EXECUTION

3.1 NON-SHRINK GROUT

A. Completely fill with grout in pockets and elsewhere as required and as shown on the drawings. Mix, install and cure grout according to manufacturer's recommendations.

3.2 MASONRY MORTAR AND GROUT

A. Grout to be used in low-lift grouted elements may be job mixed. Conform to requirements listed below.

B. Method of measuring materials shall be by either volume or weight and such that specified proportions can be controlled and accurately maintained. Measurement of sand by shovel is not allowable.

C. Mix cementitious materials and aggregate for at least 3 minutes for mortar and five minutes for grout in a mechanical batch mixer, with the maximum amount of water to produce a workable consistency.

D. Mortars that have stiffened because of evaporation of water from the mortar may be retempered by adding water as frequently as needed to restore required consistency, except that mortar not used within 2-1/2 hours after initial mixing shall be discarded.

3.3 REPAIR/ PROTECTION

A. During the construction and guarantee period, the contractor shall be responsible for the repair of any stone and wall deterioration or failure and any adjacent public or private property damages related to the malfunction of the walls. The Contractor shall repair such damages to the Project Manager's satisfaction at no additional cost to the Town.

B. All stone work in progress shall be protected at all times during construction by use of a suitable strong, impervious film fabric securely held in place.

3.4 CLEANUP

A. Concrete scum and grout stains on the pavers and walls shall be removed immediately. After the wall is constructed, it should not be saturated with water for curing or any other purposes. Where the atmosphere is dry, the wall shall have its surface dampened with a very light fog spray during a curing period for the mortar of three days. If cleaning and condition of surfaces is not satisfactory to the Project Manager, sandblasting may be required at the Contractor's expense. All joints shall be checked for tightness and uniformity of spacing.

B. Upon completion of the work under this section, the Contractor shall remove all rubbish, waste and debris resulting from his operations off-site. Remove all equipment and implements of service and leave the entire work area in a neat, clean and acceptable condition.

C. The contractor shall at all times keep the premises free from accumulation of waste materials and rubbish caused by his employees.

D. At the conclusion of the masonry work; clean all masonry, remove scaffolding and equipment used in the work, and remove all debris, refuse and surplus masonry material, and remove them from the premises. Leave the area acceptably clean.

END OF SECTION 04 05 13

THE BRICK INDUSTRY ASSOCIATION
TECHNICAL NOTES on Brick Construction
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Specifications for and Classification of Brick

Abstract: This *Technical Note* describes the predominant-consensus standard specifications for brick and the various classifications used in each. Specific requirements — including physical properties, appearance features and coring — are described. Additional requirements for each brick specification also are covered.

Key Words: appearance, ASTM standards, brick, chippage, classification, CSA standard, dimensions, distortion, durability, exposure, grade, physical properties, specification, tolerances, type, use.

SUMMARY OF RECOMMENDATIONS:

- Identify the appropriate brick specification for the intended use
- Specify each classification in the specification or verify that the default classification is valid
- Specify each required action of the purchaser and specifier
- Evaluate and specify any optional requirement
- Use requirements in consensus-based specifications; deviate from them only with consideration of effect on performance and cost

INTRODUCTION

Brick selection is made according to the specific application in which the brick will be used. Standards for brick cover specific uses of brick and classify the brick by performance characteristics. The performance criteria include strength, durability and aesthetic requirements. Selection of the proper specification and classification within that specification, along with proper design and construction, should result in expected performance.

ASTM International (ASTM) publishes the most widely accepted standards on brick. These standards are voluntary consensus standards that are reviewed and updated periodically to contain the most recent information. All have been through a thorough review process by a balanced committee of interested ASTM members classified as producers, users and general interest. All of the model building codes in the United States reference ASTM standards for brick.

Standards used in Canadian building codes are prepared by the Canadian Standards Association (CSA). The process used to prepare and revise CSA standards is similar to ASTM's. The sole CSA standard for brick, A82 *Fired Masonry Brick Made from Clay or Shale*, is similar in content to the ASTM standards for face brick and hollow brick. It also includes test methods.

This *Technical Note* identifies the standards for brick and the specific requirements for its various classifications. Other *Technical Notes* in this series address the fundamentals of brick manufacturing and the proper selection of brick.

Brick Paver Product
Manufacturer: Pacific Clay
Model: Bear Path
Size: 4" X 2-5/8" X 8" (with chamfered edges and spacer lugs)
Texture: Wire Cut
Color: Bergundy

BRICK SPECIFICATIONS

Depending on its use, brick is covered by one of several specifications. See Table 1. Because firebox brick, chemical resistant brick, sewer and manhole brick, and industrial floor brick are special uses, they will not be addressed in this *Technical Note*.

TABLE 1
Specifications for Brick

Title of Specification	ASTM Designation[1]	CSA Designation[2]
Building Brick	C 62	—
Facing Brick	C 216	A82
Hollow Brick	C 652	A82
Thin Veneer Brick Units Made from Clay or Shale	C 1088	—
Pedestrian and Light Traffic Paving Brick	C 902	—
Heavy Vehicular Paving Brick	C 1272	—
Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units	C 126	—
Glazed Brick, Single Fired	C 1405	—
Firebox Brick, Residential Fireplaces	C 1261	—
Chemical-Resistant Masonry Units	C 279	—
Sewer and Manhole Brick	C 32	—
Industrial Floor Brick	C 410	—

1. ASTM International, 100 Bar Harbor Drive, West Conshohocken, PA 19428.
2. Canadian Standards Association, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, L4W 5N6 Canada.

Beginning with the 2007a edition of ASTM C 216, an appendix has been added. The appendix is designed to explain the specification, noting subtleties and relationships that might not otherwise be clear. In many instances the use of brick is similar to the title of its ASTM specification.

Facing Brick

Facing brick are intended for use in both structural and nonstructural masonry, including veneer, where appearance is a requirement.

Hollow Brick

Hollow brick are used as either building or facing brick but have a greater void area. Most hollow brick are used as facing brick in anchored veneer. Hollow brick with very large cores are used in reinforced brickwork and contain steel reinforcement and grout.

Building Brick

Building brick are intended for use in both structural and nonstructural brickwork where appearance is not a requirement. Building brick are typically used as a backing material.

Thin Brick

Thin veneer brick have normal face dimensions but a reduced thickness. They are used in adhered veneer applications.

Paving Brick

Paving brick are intended for use as the wearing surface on clay paving systems. As such they are subject to pedestrian and light or heavy vehicular traffic.

Glazed Brick

Glazed brick have a ceramic glaze finish fused to the brick body. The glaze can be applied before or after the firing of the brick body. These brick may be used as structural or facing components in masonry.

CLASSIFICATIONS

There are several classifications used in each standard. Classifications include grade, class, type, application and use. The criteria for these classifications may include exposure or use conditions; appearance items; physical properties needed for performance; tolerances on dimensions and distortion; chippage; and void area.

Brick qualify for a particular classification based on their properties after manufacturing. While most brick can be manufactured to attain all the attributes desired by a user, certain attributes may be dictated by the production method, durability classification or appearance classification designated by the user. For example, a molded brick cannot be made to meet the classification for the tightest dimensional tolerances since the production method uses a higher percentage of water that may result in greater shrinkage. Brick manufactured by the extrusion process can be made to meet the classification for tight or loose dimensional tolerances.

When specifying brick each classification should be designated. Some ASTM brick specifications default to a certain classification if it is not designated. The default classification may not be suitable for the intended use. Table 2 contains a listing of the classifications in ASTM and CSA brick specifications.

TABLE 2
Classifications in Specifications for Brick

	Classification			
	Durability	**Appearance**	**Void Area**	**Use**
ASTM Specification				
C 62 Building Brick	Grade	None	None	None
C 216 Facing Brick	Grade	Type	None	None
C 652 Hollow Brick	Grade	Type	Class	None
C 1088 Thin Veneer Brick	Grade	Type	None	None
C 902 Pedestrian and Light Traffic Paving Brick	Class and Type	Application	None	Type
C 1272 Heavy Vehicular Paving Brick	Type	Application	None	Type
C 126 Ceramic Glazed Facing Brick	None	Grade and Type	None	None
C 1405 Single Fired Glazed Brick	Class	Grade and Type	Division	None
CSA Specification				
A82 Fired Masonry Brick Made from Clay or Shale	Grade	Type	None[1]	None

1. No classification given, but solid, cored and hollow brick are defined. See Void Area.

Durability and Exposure

Since the environmental and service conditions that brick are subjected to vary, each brick specification classifies brick for its specific durability. The classification is based on the severity of weather and the exposure of the brick. The classification assigned to the brick is typically based on physical properties of the brick. See *Technical Note* 9B for selection of the appropriate level of durability. The durability classifications for each specification are listed in Table 3.

TABLE 3
Durability Classifications

	Durability Classification	More Severe Exposure		Less Severe Exposure
ASTM Specification				
C 62 Building Brick	Grade	SW	MW	NW
C 216 Facing Brick	Grade	SW		MW
C 652 Hollow Brick	Grade	SW		MW
C 1088 Thin Veneer Brick	Grade	Exterior		Interior
C 902 Pedestrian and Light Traffic Paving Brick	Class	SX	MX	NX
	Type	I	II	III
C 1272 Heavy Vehicular Paving Brick	Type	F		R
C 126 Ceramic Glazed Facing Brick	None		—	
C 1405 Single Fired Glazed Brick	Class	Exterior		Interior
CSA Specification				
A82 Fired Masonry Brick Made from Clay or Shale	Grade	Exterior (EG)		Interior (IG)

For durability classifications the letters S, M and N in C 62, C 216, C 652 and C 902 indicate the following exposure conditions:

S indicates severe weathering.
M indicates moderate weathering.
N indicates negligible or no weathering.

Physical Property Requirements. The physical property requirements in most specifications are compressive strength, water absorption and saturation coefficient. These properties must be determined in accordance with ASTM C 67, *Standard Methods of Sampling and Testing Brick and Structural Clay Tile* [Ref. 1] or CSA A82 [Ref. 3]. The minimum compressive strength, maximum water absorption and maximum saturation coefficient are used in combination to predict the durability of the bricks in use. The saturation coefficient, also referred to as the C/B ratio, is the ratio of 24-hour cold water absorption to the five-hour boiling absorption. The physical property requirements for each standard are listed in Table 4.

Some brick are durable but cannot be classified under the physical requirements shown in Table 4. Using alternates and alternatives in the specifications allows brick that are known to perform well to meet the durability requirement. A brick qualifying for a classification by an alternate or alternative does not signify that it is of a lower quality.

The Absorption Alternate is found in ASTM C 62, C 216, C 652, C 1088, C 902 and C 1405. The Freezing and Thawing Alternative is found in ASTM C 62, C 216, C 652, C 1088, C 902, C 1272 and C 1405. The Low Weathering Index Alternative is found in ASTM C 62, C 216 and C 1088. CSA A82 includes a freeze-thaw test as an alternative if the brick does not meet the physical property requirements. Other unit specifications include alternates as well. These are discussed in the Additional Requirements section.

Absorption Alternate- The saturation coefficient requirement does not apply, provided the cold water absorption of any single brick of a random sample of five brick does not exceed 8 percent.

TABLE 4
Physical Properties in Brick Specifications

		Minimum Compressive Strength, Gross Area[1] psi (MPa)		Maximum Cold Water Absorption, %		Maximum Five-Hour Boiling Absorption, %		Maximum Saturation Coefficient		Minimum Breaking Load, lb/in. (kN/mm)	
		Average of 5 brick	Individual	Average of 5 brick	Individual	Average of 5 brick	Individual	Average of 5 brick	Individual	Average of 5 brick	Individual
ASTM Specification and Classification											
C 62 Grade	SW	3000 (20.7)	2500 (17.2)	—	—	17.0	20.0	0.78	0.80	—	—
	MW	2500 (17.2)	2200 (15.2)	—	—	22.0	25.0	0.88	0.90	—	—
	NW	1500 (10.3)	1250 (8.6)	—	—	No limit	No limit	No limit	No limit	—	—
C 216 Grade	SW	3000 (20.7)	2500 (17.2)	—	—	17.0	20.0	0.78	0.80	—	—
	MW	2500 (17.2)	2200 (15.2)	—	—	22.0	25.0	0.88	0.90	—	—
C 652 Grade	SW	3000 (20.7)	2500 (17.2)	—	—	17.0	20.0	0.78	0.80	—	—
	MW	2500 (17.2)	2200 (15.2)	—	—	22.0	25.0	0.88	0.90	—	—
C 1088 Grade	Ext.	—	—	—	—	17.0	20.0	0.78	0.80	—	—
	Int.	—	—	—	—	22.0	25.0	0.88	0.90	—	—
C 902 Class	SX	8000 [4000][2] (55.2) [(27.6)][2]	7000 [3500][2] (48.3) [(24.1)][2]	8.0 [16.0][2]	11.0 [18.0][2]	—	—	0.78	0.80	—	—
	MX	3000 (20.7)	2500 (17.2)	14.0	17.0	—	—	No limit	No limit	—	—
	NX	3000 (20.7)	2500 (17.2)	No limit	No limit	—	—	No limit	No limit	—	—
C 1272 Type	F	10,000 (69.0)	8800 (60.7)	6.0	7.0	—	—	—	—	475 (83)	333 (58)
	R	8000 (55.2)	7000 (48.3)	6.0	7.0	—	—	—	—	—	—
C 126 Coring	Vert.	3000 (20.7)	2500 (17.2)	—	—	—	—	—	—	—	—
	Horiz.	2000 (13.8)	1500 (10.3)	—	—	—	—	—	—	—	—
C 1405 Class	Ext.	6000 (41.4)	5600 (34.8)	—	7.0	—	—	0.78	0.80	—	—
	Int.	3000 (20.7)	2500 (17.2)	—	—	—	—	—	—	—	—
CSA Specification and Classification											
A82	Ext.	3000 (20.7)	2500 (17.2)	—	8.0[3]	—	17.0	—	0.78[3]	—	—
	Int.	2500 (17.2)	2200 (15.2)	—	—	22.0	25.0	0.88	0.90	—	—

1. Brick in bearing position or loaded in the same direction as in service.
2. Numbers in brackets are for molded brick and apply provided the requirements for saturation coefficient are met.
3. Either of these requirements must be met, not both.

Freezing and Thawing Alternative- The requirements for five-hour boiling water absorption and saturation coefficient do not apply, provided a sample of five brick, meeting the strength requirements, passes the freezing and thawing test as described in the Rating section of the Freezing and Thawing test procedures of ASTM C 67 with a weight loss not greater than 0.5 percent in dry weight of any individual brick (for Grade SW). Unlike ASTM C 67, CSA A 82 stipulates that brick must be kept in a frozen state during any interruption of the freeze-thaw test.

Low Weathering Index Alternative- If the brick are intended for use where the weathering index is less than 50 and have a minimum average compressive strength of 2500 psi (17.2 MPa), the requirements given for five-hour boiling water absorption and for saturation coefficient shall not apply.

Consult the appropriate ASTM specification for specific alternates.

Appearance

Classification related to the appearance may include limits tolerances on dimensions, distortion, out-of-square and chippage. The appearance classification is established on the size and precision attained in manufacturing. The classifications for appearance of brick for each specification are listed in Table 5, and requirements for size variation, distortion and chippage are listed in Table 6, Table 7 and Table 8, respectively. There are no color-related tolerances in the ASTM standards for brick. Those are dictated by the sample panel or project specification.

TABLE 5
Appearance Classifications

	Appearance Classifications	More Stringent Requirements		Less Stringent Requirements
ASTM Specification				
C 62 Building Brick	None	—		
C 216 Facing Brick	Type	FBX	FBS	FBA
C 652 Hollow Brick	Type	HBX	HBS HBA	HBB
C 1088 Thin Veneer Brick	Type	TBX	TBS	TBA
C 902 Pedestrian and Light Traffic Paving Brick	Application	PX	PS	PA
C 1272 Heavy Vehicular Paving Brick	Application	PX	PS	PA
C 126 Ceramic Glazed Facing Brick	Grade	SS		S
	Type	II		I
C 1405 Single Fired Glazed Brick	Grade	SS		S
	Type	II		I
CSA Specification				
A82 Fired Masonry Brick Made from Clay or Shale	Type	X	S	A

For appearance classifications the letters X, S and A have the following meanings:

X indicates extreme or extra control in the criteria.
S indicates standard production.
A indicates architectural or aesthetic criteria that must be specified and in many specifications must be less stringent than the S designation.

Dimensional Tolerances. Variations in raw materials and the manufacturing process will result in brick that vary in size. Permitted size variation is based on the brick classification and the relative dimensional range measured. These permitted variations in size are listed in Table 6A, Table 6B and Table 6C. The variation is plus or minus from the specified dimension. Size variation becomes important when vertical alignment of brick (stack bond) is used, when bands of brick from different production runs are combined, or when a short horizontal extent of brickwork is constructed, such as between closely spaced window openings.

TABLE 6A
Dimensional Tolerances for ASTM C 216 and CSA A82[1]

Specified Dimension or Average Brick Size in Job Lot Sample, in. (mm)	Maximum Permissible Variation, in. (mm), plus or minus from:				
	Column A (for Specified Dimension)		Column B (for Average Brick Size in Job Lot Sample)[2]		
	Type FBX	Type FBS	Type FBX	Type FBS Smooth[3]	Type FBS Rough[4]
3 (76) and under	1/16 (1.6)	3/32 (2.4)	1/16 (1.6)	1/16 (1.6)	3/32 (2.4)
Over 3 to 4 (76 to 102), inclusive	3/32 (2.4)	1/8 (3.2)	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)
Over 4 to 6 (102 to 152), inclusive	1/8 (3.2)	3/16 (4.8)	3/32 (2.4)	3/32 (2.4)	3/16 (4.8)
Over 6 to 8 (152 to 203), inclusive	5/32 (4.0)	1/4 (6.4)	3/32 (2.4)	1/8 (3.2)	1/4 (6.4)
Over 8 to 12 (203 to 305), inclusive	7/32 (5.6)	5/16 (7.9)	1/8 (3.2)	3/16 (4.8)	5/16 (7.9)
Over 12 to 16 (305 to 406), inclusive	9/32 (7.1)	3/8 (9.5)	3/16 (4.8)	1/4 (6.4)	3/8 (9.5)

1. Dimensional tolerances for Type FBA and A in C 216 and A82, respectively, shall be as specified by the purchaser, but not more restrictive than Type FBS and S (Rough), respectively.
2. Lot size shall be determined by agreement between purchaser and seller. If not specified, lot size shall be understood to include all brick of one size and color in the job order.
3. Type FBS Smooth brick have relatively fine texture and smooth edges, including wire cut surfaces. These definitions relate to dimensional tolerances only.
4. Type FBS Rough bricks are molded brick or extruded brick with textured, rounded or tumbled edges or faces. These definitions apply to dimensional tolerances only.

TABLE 6B
Dimensional Tolerances

ASTM Specification and Classification		Maximum Permissible Variation, in. (mm), plus or minus					
		3 (76) and under	Over 3 to 4 (102) inclusive	Over 4 to 6 (152) inclusive	Over 6 to 8 (204) inclusive	Over 8 to 12 (306) inclusive	Over 12 to 16 (408) inclusive
C 62		3/32 (2.4)	1/8 (3.2)	3/16 (4.8)	1/4 (6.4)	5/16 (8.0)	3/8 (9.5)
C 652	HBX	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)	5/32 (4.0)	7/32 (5.6)	9/32 (7.1)
	HBS and HBB	3/32 (2.4)	1/8 (3.2)	3/16 (4.8)	1/4 (6.4)	5/16 (7.9)	3/8 (9.5)
	HBA	As specified by the purchaser, but not more restrictive than HBS and HBB					
C 1088	TBX	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)	5/32 (4.0)	7/32 (5.6)	9/32 (7.2)
	TBS	3/32 (2.4)	1/8 (3.3)	3/16 (4.8)	1/4 (6.4)	5/16 (8.0)	3/8 (9.5)
	TBA	As specified by the purchaser					
C 126		See ASTM C 126					
C 902 and C 1272	PX	1/16 (1.6)	3/32 (2.4)	—	1/8 (3.2)	7/32 (5.6)	—
	PS	1/8 (3.2)	3/16 (4.8)	—	1/4 (6.4)	5/16 (8.0)	—
	PA	No limit	No limit	—	No limit	No limit	—

TABLE 6C
Dimensional Tolerances for ASTM C 1405

Specified Dimension or Average Brick Size in Job Lot Sample, in. (mm)	Maximum Permissible Variation in Dimensions, in. (mm) plus or minus from:			
	Column A (for Specified Dimension)		Column B (for Average Brick Size in Job Lot Sample)[1]	
	Grade S	Grade SS	Grade S	Grade SS
3 (76) and under	1/16 (1.6)	1/16 (1.6)	1/16 (1.6)	1/16 (1.6)
Over 3 to 4 (76-102), inclusive	3/32 (2.4)	1/16 (1.6)	1/16 (1.6)	1/16 (1.6)
Over 4 to 6 (102-152), inclusive	1/8 (3.2)	1/16 (1.6)	3/32 (2.4)	1/16 (1.6)
Over 6 to 8 (152-203), inclusive	5/32 (4.0)	1/16 (1.6)	3/32 (2.4)	1/16 (1.6)
Over 8 to 12 (203-305), inclusive	7/32 (5.6)	1/16 (1.6)	1/8 (3.2)	1/16 (1.6)
Over 12 to 16 (305-406), inclusive	9/32 (7.1)	1/16 (1.6)	3/16 (4.8)	1/16 (1.6)

1. Lot size shall be determined by agreement between purchaser and seller. If not specified, lot size shall be understood to include all brick of one size and color in the job order.

TABLE 7
Distortion Tolerances

		Maximum Permissible Distortion, in. (mm)		
		8 (204) and under	Over 8 to 12 (306), inclusive	Over 12 to 16 (408), inclusive
ASTM Specification and Classification				
C 62		No limit	No limit	No limit
C 216	FBX	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)
	FBS	3/32 (2.4)	1/8 (3.2)	5/32 (4.0)
	FBA	As specified by the purchaser		
C 652	HBX	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)
	HBS	3/32 (2.4)	1/8 (3.2)	5/32 (4.0)
	HBA	As specified by the purchaser		
C 1088	TBX	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)
	TBS	3/32 (2.4)	1/8 (3.2)	5/32 (4.0)
	TBA	As specified by the purchaser		
C 902 and C1272	PX	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)
	PS	3/32 (2.4)	1/8 (3.3)	5/32 (4.0)
	PA	No limit.		
C 126		Special requirements – see ASTM C 126		
C 1405	SS	1/16 (1.6)	3/32 (2.4)	3/32 (2.4)
	S	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)
CSA Specification and Classification				
A82	X	(1.5)	(2.5)	(3.0)
	S	(2.5)	(3.0)	(4.0)
	A	As specified by purchaser, but not more restrictive than Type S (Rough)		

Distortion. Permitted distortion, or warpage, of brick is listed in Table 7. The amount of distortion is based on the brick specification and face dimension. Distortion may be convex or concave and may be in the plane of the wall or perpendicular to it, as illustrated in Figure 1. Other terms for distortion are “bowed” or “banana” brick. A brick that is over the distortion limitations is difficult to lay and is easily noticeable in the brickwork.

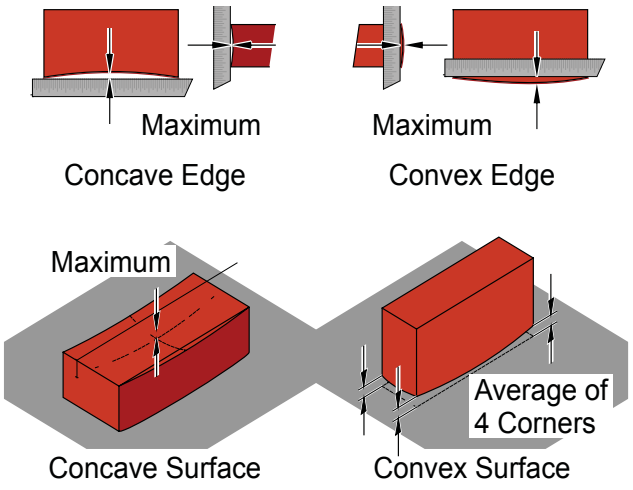


Figure 1
Distortion Measurements

Chippage. Brick may be damaged or chipped during packaging, shipping or on the job site. Limitations to the size and number of chips on individual brick are listed in Table 8. The amount of chippage is based upon the brick specification and classification.

A delivery of brick may contain up to 5 percent broken brick or brick chipped beyond the limits in Table 8. The chippage requirements in Table 8 are based on the remaining 95 percent of the shipment. The chips are measured from an edge or a corner, and the total length of these chips may not be greater than 10 percent of the perimeter of the face of the brick. Chips are more noticeable on brick that have a surface color different from the body of the brick. Chips on "through-body" color brick are less noticeable.

TABLE 8

Maximum Permissible Range of Chippage[1]

Specification and Type or Application						Percent Allowed	Chippage in From		Percent Allowed	Chippage in From	
ASTM C 216	ASTM C 652	ASTM C 1088	ASTM C 902	ASTM C 1272	CSA A82		Edge, in. (mm)	Corner, in. (mm)		Edge, in. (mm)	Corner, in. (mm)
FBX	HBX	TBX	—	—	X	95 to 100%	0 to 1/8 (0 to 3.2)	0 to 1/4 (0 to 6.4)	5% or less	1/8 to 1/4 (3.2 to 6.4)	1/4 to 3/8 (6.4 to 9.5)
FBS[2]	HBS[2]	TBS[2]	—	—	S[2]	90 to 100%	0 to 1/4 (0 to 6.4)	0 to 3/8 (0 to 9.5)	10% or less	1/4 to 5/16 (6.4 to 7.9)	3/8 to 1/2 (9.5 to 12.7)
FBS[3]	HBS[3]	TBS[3]	—	—	S[3]	85 to 100%	0 to 5/16 (0 to 7.9)	0 to 1/2 (0 to 12.7)	15% or less	5/16 to 7/16 (7.9 to 11.1)	1/2 to 3/4 (12.7 to 9.1)
FBA	HBA HBB	TBA	PA	PA[4]	A	As specified by the purchaser[5]					
—	—	—	PS	PS PX	—	100%	5/16 (7.9)	1/2 (12.7)	—	—	—
—	—	—	PX	—	—	100%	1/4 (6.4)	3/8 (9.5)	—	—	—

1. There are no chippage requirements for C 62, C 126 or C 1405.
2. Extruded brick with unbroken natural die finish face and dry-pressed brick.
3. Extruded brick with finished face sanded, combed, scratched, scarified, or broken by mechanical means such as wire cutting or wire brushing, and molded brick.
4. No limit.
5. Not more restrictive than FBS (Textured) in C 216 or HBS (altered).

ADDITIONAL REQUIREMENTS

Void Area

In ASTM standards brick are generally classified as solid or hollow. A solid brick is defined as a unit whose net cross-sectional area in every plane parallel to the bearing surface is 75 percent or more of its gross cross-sectional area measured in the same plane. Thus, a solid brick has a maximum coring or void area of 25 percent. A hollow brick is defined as a unit whose net cross-sectional area in every plane parallel to the bearing surface is less than 75 percent of its gross cross-sectional area measured in the same plane. A hollow brick has a minimum coring or void area greater than 25 percent, and a maximum of 60 percent. Brick are cored or frogged at the option of the manufacturer.

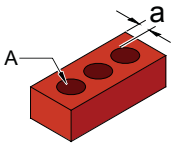
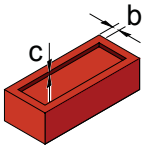
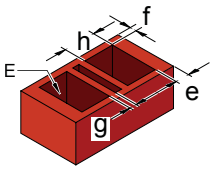
Cores. Holes in brick less than or equal to 1½ square inches (9.68 cm^2) in cross-sectional area, referred to as cores, are used to aid in the manufacturing process and shipping of brick. The cores permit better utilization of raw materials, create more uniform drying and firing of the brick, reduce the amount of fuel necessary to fire the brick and reduce shipping costs by reducing weight. Additional advantages, such as aiding in mechanical bond in a wall, easier laying of the brick, etc., also may result from brick manufactured with cores. Cores are found only in brick manufactured by the extrusion or dry-press process. Limits to the amount of coring allowed in brick, the distance from a core to a face, and web thickness where applicable are listed in Table 9.

Cells. Cells are similar to cores except that a cell is larger in minimum dimension and has a cross-sectional area greater than 1½ square inches (9.68 cm2). Some requirements for cells are shown in Table 9. Additional requirements for cells can be found in ASTM C 652, C 126 and C 1405 and CSA A82.

Frogs. Frogs are depressions in brick, usually located on one bed surface, and are included for the same reasons as cores and cells. Frogs are found in brick manufactured by the molded process. Panel frogs are limited to a specified depth and a specified distance from a face. Requirements for panel frogs are listed in Table 9. Deep frogs are depressions deeper than 3/8 in. (10 mm), and must conform to the requirements for coring, hollow spaces and void area of the applicable standard.

The Canadian Standards Association takes a different approach. CSA A82 defines a solid brick as one without cores, cells or frogs deeper than 3/8 in. (10 mm); cored brick as those of which the net cross-sectional area in any plane parallel to the bed face shall be at least 75 percent of the gross cross-sectional area measured in the same plane; and hollow brick as brick whose net cross-sectional area in a plane parallel to the bed face is not less than 40 percent and not more than 75 percent of its gross cross-sectional area measured in the same plane. Further, there is a required minimum dimension of 1/2 in. (6 mm) between cores; 1 in. (13 mm) between cells; and 3/4 in. (19 mm) to an edge from a core, cell or frog.

TABLE 9
Requirements for Void Areas[1]

ASTM Specification		Void Area, %	 Cores		 Frogs		 Cells				
			a	A	b	c	E	e	f	g	h
			in. (mm), min.	in.² (cm²), max.	in. (mm), min.	in. (mm), min.	in.² (cm²), max.	in. (mm), min.	in. (mm), min.	in. (mm), min.	in. (mm), min.
C 62		< 25	3/4 (19.1)	—	3/4 (19.1)	3/8 (9.5)	No Requirements for Cells				
C 216		< 25	3/4 (19.1)	—	3/4 (19.1)	3/8 (9.5)	No Requirements for Cells				
C 652[2]	H40V	> 25, ≤ 40	5/8 (16)	≤ 1½ (9.68)	5/8 (16)	3/8 (9.5)	< 1½ (9.68)	3/4 (19.1)	3/4 (19.1)	1/2 (13)	—
	H60V[3]	> 40, ≤ 60	5/8 (16)	≤ 1½ (9.68)	5/8 (16)	3/8 (9.5)	> 1½ (9.68)	3/4 (19.1)	3/4 (19.1)	1/2 (13)	—
C 1088		—	No Requirements for Cores, Frogs or Cells								
C 902		—	No Requirements for Cores, Frogs or Cells								
C 1272		—	Cores and Cells Not Permitted								
C 126[4]		—	No Requirements for Cores or Frogs				> 1½ (9.68)	3/4 (19.1)	3/4 (19.1)	1/2 (13)[5]	1/2 (13)
C 1405[2]	Solid	≤ 25	3/4 (19.1)	—	3/4 (19.1)	3/8 (9.5)	No Requirements for Cells				
	H40V	> 25, ≤ 40	5/8 (16)	1½ (9.68)	5/8 (16)	3/8 (9.5)	> 1½ (9.68)	3/4 (19.1)	3/4 (19.1)	1/2 (13)	—
	H60V[3]	> 40, ≤ 60	—	5/8 (16)	1½ (9.68)	5/8 (16)	3/8 (9.5)	1½ (9.68)	3/4 (19.1)	3/4 (19.1)	1/2 (13)

1. Deep frogs shall meet coring requirements of the applicable specification (see ASTM C 62, C216, C 652 and C 1405).
2. Cored-shell and double-shell hollow brick shall meet additional coring requirements of applicable specification in ASTM C 652 and C 1405.
3. Based on 3 in. (76 mm) and 4 in. (102 mm) nominal width (for larger dimensions see C 652 and C 1405).
4. Cells shall meet additional requirements of ASTM C 126.
5. Web thickness in cored brick shall meet additional requirements of ASTM C 126.

Efflorescence

Efflorescence is a crystalline deposit of water-soluble salts that can form on the surface of some brickwork. The principal objection is an unsightly appearance, though it typically is not harmful to brick. The test for efflorescence is described in ASTM C 67 and CSA A82. Brick tested under C 67 are given a rating of “effloresced” or “not effloresced.” The specifier must invoke this part of the standard for the requirement of “not effloresced” to apply. CSA A82 also includes a rating of “slightly effloresced,” and it is this rating that must be met if efflorescence testing is invoked. Requirements on efflorescence are not included in C 62 and C 126.

Strength

Brickwork may be used as a structural material, so there may be instances when it is important to specify a minimum compressive strength of the brick. This possibility is noted in ASTM C 62, C 216, C 652 and C 1405. Most brick have compressive strengths considerably higher than the minimum compressive strengths required for durability and abrasion resistance.

Initial Rate of Absorption

The initial rate of absorption (IRA) is a measure of how quickly the brick will remove water from mortar spread on it. IRA is not a qualifying property or condition of brick in the ASTM or CSA specifications. IRA values may be of interest when selecting mortar and in use of the brick on the jobsite. If the purchaser wishes to learn the IRA of the brick, the IRA test must be requested. Initial rate of absorption information is included in ASTM C 62, C 216, C 652 and C 1405.

Sampling and Testing

All brick under ASTM specifications are sampled and tested in accordance with ASTM C 67. The purchaser designates the place of selection of the brick for testing when the order is placed. Brick for efflorescence testing must be sampled at the point of manufacturer. This is because the brick may be contaminated by efflorescing materials after leaving the brick plant. Brick are sampled and tested for compliance to their specification prior to use. ASTM C 126 and C 1405 include additional tests for properties of the glaze. These are described in the following section on Glazed Brick.

CSA A82 includes sampling and test methods as part of the standard.

Facing Brick, ASTM C 216 and CSA A82

An additional tolerance is found in the ASTM standard for solid facing brick specification and in CSA A82. The amount that the exposed face of a brick can be “out-of-square” is limited. This is more critical as brick height increases. The maximum permitted dimension for out-of-square of the exposed face of the brick in C 216 is 1/8 in. (3.2 mm) for Type FBS brick and 3/32 in. (2.4 mm) for Type FBX brick. Tolerances on out-of-square for Type FBA brick shall be specified by the purchaser.

CSA A82 contains similar requirements: Type S of 3.0 mm and Type X of 2.5 mm. Tolerances on out-of-square for Type A brick shall be specified be specified but shall not be more restrictive than for Type S (Rough) brick.

Paving Brick, ASTM C 902 and C 1272

Not only must paving brick conform to the physical properties required in Table 4, but they also must have additional alternatives for durability and must meet requirements for abrasion resistance.

Alternative Performance Requirements. If information on the performance of brick in a pavement subject to similar exposure and traffic conditions is documented, then the physical property requirements in Table 4 may be waived. This is identified as the Performance Alternative.

An optional test for the freeze and thaw test is ASTM C 88 *Test Method for Soundness of Aggregates by Use of Sodium Sulfate*. The sulfate soundness test, like the freeze and thaw test, is not required unless the paving brick do not meet the saturation coefficient and absorption requirements.

Abrasion Resistance. Since paving brick are used in a horizontal application and are exposed to traffic, they must meet a specified abrasion limit. Pedestrian and light traffic paving brick (C 902) are assigned a Type by the traffic or abrasion expected. Type I pavers are exposed to extensive abrasion, such as driveways or public entries. Type II pavers are exposed to high levels of pedestrian traffic, such as in stores, restaurant floors or exterior walkways. Type III pavers are exposed to light pedestrian traffic, such as floors or patios in homes.

Heavy vehicular paving brick (C 1272) are assigned a Type depending on their intended installation. Type R pavers are intended to be set in a mortar or asphalt setting bed supported by an adequate base. Type R pavers must be at least 2¼ in. (57.2 mm) thick. Type F pavers are intended to be set in a sand setting bed, with sand joints, and supported by an adequate base. Type F pavers must be at least 2⅝ in. (66.7 mm) thick. The abrasion requirements are the same for Type F and Type R pavers.

The abrasion resistance index can be determined in either of two ways: 1) by dividing the absorption by the compressive strength and multiplying by 100, or 2) by determining the volume abrasion loss in accordance with ASTM C 418 *Test Method for Abrasion Resistance of Concrete by Sandblasting*. The abrasion requirements are listed in Table 10.

TABLE 10
Abrasion Resistance Requirements for Pavers

ASTM Specification	Traffic Type	Abrasion Index, Max.	Volume Abrasion Loss, Max. (cm^3/cm^2)
C 902 Pedestrian and Light Traffic Paving Brick	Type I	0.11	1.7
	Type II	0.25	2.7
	Type III	0.50	4.0
C 1272 Heavy Vehicular Paving Brick	Types F and R	0.11	1.7

Glazed Brick, ASTM C 126 and C 1405

ASTM C 126 and C 1405 are specifications for glazed brick and contain requirements for properties of the glaze. These properties include imperviousness, opacity, resistance to fading, resistance to crazing, flame spread, fuel contribution and smoke density, toxic fumes, hardness, and abrasion resistance.

SUMMARY

This *Technical Note* identifies brick specifications used in the United States and Canada. Classification designations for each brick specification and the criteria used to qualify for them are explained. Potential performance issues can be minimized by designating the proper brick specification and applicable classifications based on the environmental and service conditions of the project.

> *The information and suggestions contained in this* Technical Note *are based on the available data and the experience of engineering staff and members of the Brick Industry Association. The information contained herein should be used in conjunction with good technical judgment and a basic understanding of the properties of brick masonry. Final decisions on the use of the information discussed in this* Technical Note *are not within the purview of the Brick Industry Association and must rest with the project architect, engineer and owner.*

REFERENCES

1. *Annual Book of ASTM Standards*, ASTM International, West Conshohocken, PA 2006:

Volume 04.02 – Concrete and Aggregate
- ASTM C 88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate
- ASTM C 418 Test Method for Abrasion Resistance of Concrete by Sandblasting

Volume 4.05 – Chemical Resistant Nonmetallic Materials; Vitrified Clay Pipe; Concrete Pipe; Fiber-Reinforced Cement Products; Mortars and Grouts; Masonry; Precast Concrete
- C 32, Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale)
- C 62, Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale)
- C 67, Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
- C 126, Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units
- C 216, Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)
- C 279, Standard Specification for Chemical-Resistant Masonry Units
- C 410, Standard Specification for Industrial Floor Brick
- C 652, Standard Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale)
- C 902, Standard Specification for Pedestrian and Light Traffic Paving Brick
- C 1088, Standard Specification for Thin Veneer Brick Units Made from Clay or Shale
- C 1261, Standard Specification for Firebox Brick for Residential Fireplaces
- C 1272, Standard Specification for Heavy Vehicular Paving Brick
- C 1405, Standard Specification for Glazed Brick (Single Fired, Brick Units)

2. Borchelt, J. G., Danforth, L.. Jr., and Hunsicker, R., “Specifying Brick: Getting what you want for appearance and function,” *The Construction Specifier*, Construction Specifications Institute, Alexandria, VA, January 2006, pp. 20-28.
3. CSA A82, Fired Masonry Brick Made from Clay or Shale, Canadian Standards Association, Mississauga, Ontario, Canada, 2006.

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The General Contract Conditions, Drawings and other Division - 1 Specification sections apply to Work of this section.

1.2 DESCRIPTION

A. Work Included: Work consists of furnishing all labor, material and equipment necessary for completion of the following work.

1. Guardrails, guardrail mesh, handrails, welds, washers, bolts, nuts, shims, and anchor bolts and anchor plates.

2. Erecting, connecting, field welding, and adjusting for plumb and level.

3. All other work normally related to the above or specified under this section.

B. All other miscellaneous angles, channels, pipes/tubes and plates as indicated.

C. Definitions:

1. Metal Fabrications: Synonymous with miscellaneous metals

1.3 SUMMARY

A. This section includes both standard and custom handrails as shown in the contract drawings.

B. These include stainless steel pipe railing

1.4 REFERENCES

A. ASTM A167-Standard Specification for stainless and heat resisting chromium nickel steel plate, sheet and strip

B. ASTM A269-Standard Specification for seamless and welded austenitic stainless steel tubing

C. ASTM A276-Standard Specification for stainless and heat resisting bars and shapes

D. ASTM A312-Standard Specification for seamless and welded austenitic stainless steel pipe IAWS D1.1-Structural Welding Code Steel; 2008

E. AWS D1.6-Structural Welding Code Stainless Steel; 2007

F. AWS B2.1-84-Welding procedure and performance calculations

G. ASTM E894-Standard Test Methods for anchorage of permanent metal railing systems and rails for buildings

H. ASTM E935-Standard Test Methods for performance of permanent metal railing systems and rails for buildings

I. ASTM E985-Specifications for permanent metal railing systems and rails for buildings

J. NOMMA-Metal finishes manual

K. 2021 IBC Sections 1014 and 1015

1.5 PERFORMANCE REQUIREMENTS

A. Handrail shall be designed to withstand without permanent deflection the following loads:

a. Top Rail

1. Concentrated load of 200 lb/ft applied at any point and any direction.

2. Uniform load of 50 lb/ft applied horizontally and concurrently with uniform load of 100 lb/ft applied vertically downward.

3. Concentrated and uniform loads above need not be assumed to act concurrently.

b. Hand Rail other than top Rail

1. Concentrated load of 200 lb/ft applied at any point and any direction.

2. Uniform load of 50 lb/ft applied in any direction.

3. Concentrated and uniform loads above need not be assumed to act concurrently

c. Infill areas

4. Concentrated horizontal load 50 lb/ft applied to 1 sq. ft. at any point is system, including intermediate rails, panels, pickets, cables or other elements making up infill area. Loads need not be assumed to act concurrently with loads on top rails in determining stress on infill.

1.6 SUBMITTALS

A. Shop drawings:

1. Drawings shall specify material sizes, shapes, plans, sections, install details and finishes per requirements

2. Drawings shall be of reproducible quality and prepared at an approved scale.

3. Indicate plans, elevations, detail sections, and profile. Show jointing, anchorage and accessory items, and specify finishes. Furnish setting diagrams and templates for items set in other work. Especially, show details for tubular steel junction at walls and all tubular steel connections.

4. Include erection drawings, elevations, and details where applicable.

5. Indicate welded connections using standard AWS welding symbols. Indicate net weld lengths.

6. Take field measurements prior to preparation of shop drawings and fabrication, where possible, to ensure proper fitting of the work. However, do not delay job progress; allow for adjustments and fittings wherever the taking of field measurements before fabrication might delay the work.

B. Product data for rail systems and finishes.

C. Welder certifications.

D. Samples of rail materials and finish: Samples: Submit samples of all materials to be furnished under this section in size and form.

7. Steel for handrail post and rail (2 each).

8. One section of handrail in place for review by Owner's Representative. Show typical welds, fasteners and screws for compatible finish.

E. Structural calculations and testing.

F. One-year manufacturer's warranty for materials and installation at project completion.

G. Forward warranty on finish; when applicable; to owner at project completion.

1.7 QUALITY ASSURANCE

A. Obtain railing through one source from a single manufacturer.

B. Check dimensions of other construction by accurate field measurements before fabrication to insure proper rail fit up. Incorporate final dimensions into field use shop drawings. Coordinate fabrication lead times with construction progress to avoid delaying the work.

C. Shop assembled mechanical joints shall fit to within 1/16".

D. Expansion joints shall fit within 1/8" to allow for thermal expansion within the handrail.

E. Railing posts shall be plumb to within 1/8" over 3'-0'.

F. Welder Qualifications: Currently qualified according to AWS D1.1. AISC Specifications for Architecturally exposed Structural Steel.

G. Hand Rail Fabrication: Demonstrated experience with at least five projects of comparable scope.

H. Architectural metals shall be of the best commercial quality and their various forms shall be straight and true. All steel to be FY 36KSI, ASTM A36, all reinforced steel to be FY 60 KSI, and all tubes to be ASTM A500, (grade b). There shall be no scratches, scars or creases, buckles, ripples or chatter marks. Finished surfaces must be smooth and true.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver anchor bolts and other anchorage devices that are embedded in cast-in-place concrete or masonry construction to the project site in time to be installed before the start of cast-in-place concrete operations or masonry work.

B. Provide setting drawings, templates, and directions for the installation of anchor bolts and other similar devices.

C. Metals that are stored at the project site shall be above ground on platforms, skids, or other supports. Protect steel from corrosion. Store other materials in a weather tight and dry place until ready for use.

D. Handle in such a manner so as to protect surfaces and to prevent damage to fabricated pieces, during storage, erection and during construction.

E. Store packaged materials in their original, unbroken package or container. Materials shall be carefully handled and stored under cover in a manner to prevent deformation and damage to the materials and to shop finishes, and prevent rusting and the accumulation of foreign matter on the metal work.

F. All such work shall be repaired and cleaned before erection.

PART 2 PRODUCTS

2.1 MATERIALS

A. Provide metal free from pitting, seam marks, roller marks, grinding marks and stains at areas exposed to view on completed rail units.

B. Steel
1. Pipe and tubing: ASTM A 269 Type 304 or Type 316.
2. Bar: ASTM A 276 Type 304 or Type 316.
3. Fittings: ASTM A 276/ A 479 Type 304 or Type 316.

2.2 FINISHES

A. Steel

1. Stainless Steel

2.3 FABRICATION

A. Fabricate handrails and guardrails in accordance to approved shop drawing and field dimensions using mitered and welded joints with bends where indicated on shop drawings.

B. Shop fabricate in greatest possible lengths to eliminate field splicing, but not to exceed 20’-0” in length.

C. Form bends to uniform radius, free of distortion, twists, cracks and grain separation.

D. Top rails shall be continuous over posts for strength with splices for expansion located within 6 to 12 inches of post.

E. Splices and expansion joints shall utilize internal splice connectors with set screws to allow for rail expansion over ambient temperature change.

F. Weld all shop assembled connections continuous without undercut and or distortion of rail materials.

G. Grind and or dress exposed welds smooth and flush to corner or fillet without weakening rail connection.

H. Remove all burrs and sharp edges from exposed ends of final rail assemblies.

I. Lightly sand and blend with fine grit paper all light scratches prior to rail finishing.

J. Provide drainage and weep holes within rail assemblies to prevent entrapment of water within rail assemblies. Note that caution should be used when pressure washing rails assemblies to prevent water entry to non-vented areas under pressure.

K. Provide post inserts where required due to loading within long post spans.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable and ready to receive work.

3.2 PREPARATION

A. Field measurements: Take measurements on site as required for correct fabrication and installation. Fabricator shall be responsible for errors in fabrication and for correct fit of structural steel.

B. The contractor assures that all components, specified or required to satisfactorily complete the installation are compatible with each other, with adjoining substrates, materials and work by other trades, and with the conditions of installation and expected use.

C. Pre-assemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.

3.3 INSTALLATION

A. Install in accordance with shop drawings utilizing established working points.

B. Set railings within sleeves, use anchor bolts or core drill for mounting holes. Maintain slab edge distances and rail locations per shop drawings.

C. Assemble rails fitting splices together to form tight hairline joints while allowing for thermal expansion as required.

D. Make all adjustments to alignment for satisfactory rail appearance and to plumb posts prior to final tightening of fasteners or pouring of holes.

E. Set railings within sleeves or cored holes using a high quality anchoring grout such as Quickrete. Slope grout 1/8” up on posts for drainage.

F. Locate wall brackets per shop drawings and set anchors within concrete.

G. Install wall rail onto brackets using fasteners supplied per the drawings.

H. After installation is complete clean product using non-abrasive mild soap and water. Do not utilize any cleaners containing any type of acid. I) Use touch up paint and touch up kit to repair any areas damaged during installation.

END OF SECTION 05 52 13

PART 1 GENERAL

1.01 RELATED DOCUMENTS: Drawings and general provisions of the Construction Contract, Division - 1 Specification sections, apply to work of this section.

1.02 RELATED WORK:

A. Earthwork – Section 312000 Earth Moving

B. Playground Protective Surfacing – Section 321816

1.03 DESCRIPTION

A. The work in this section consists of furnishing and installing playground equipment.

1.04 QUALITY ASSURANCE

A. Material, craftsmanship and installation for all play equipment shall conform to recognized association standards including ASTM and Consumer Product Safety Commission (CPSC) standards.

B. Contractor to submit color samples, technical data, and installation methods prior to any ordering and/or installing of these items.

C. Contractor to field locate each proposed item and associated paving prior to any installation and/or construction and shall have Owner's Representative's review.

1.05 SUBMITTALS

A. Submit manufacturer's technical data and installation information for approval by the Owner and Landscape Architect.

PART 2 PRODUCTS

A. Playground Equipment, Center Pivot Swing Set:
Manufacturer: Miracle Play Systems, Denver, Colorado, Amber Hildebrand-Singleton, 303.530.4414, amber@miracleplaysystems.com :
1. Model: Custom Center Pivot Irrigation Swing Set
2. Color: Galvanized Steel
3. Materials: Galvanized Steel and Plastic Wood Cedar for the seats
4. Height: 11'-0 ¾"
5. Length: 67'-6¾"
6. Swings to have limited movement

B. Playground Equipment, "Beaver Log Jam" Log Climbing Frame No. 2 Robina:
Manufacturer: Duncan & Grove, Hebron, Illinois, Sean Procyk, 888 571 9470, sp@duncanandgrove.com:
1. Model: Log Climbing Frame NO. 2
2. Materials: Robinia

C. Playground Equipment, Turtle Log Climber:
   1. Model: Custom Climbing Feature
   2. Contractor to engage with local chainsaw artist. Artist and their work to be approved by the project manager and the Town of Berthoud.

D. Playground Equipment, Mushroom Ensemble Musical Instruments:
Manufacturer: Willy Goat, 1-888-920-4628, willygoat.com
   1. Model: Mushroom Ensemble Musical Park Instruments
   2. Color: Red, White, & Tan
   3. Materials: Powder coated steel frame, anodized aluminum head, stainless steel hardware

E. Playground Equipment, Musical Chimes NO.1 Robinia:
Manufacturer: Duncan & Grove, Hebron, Illinois, Sean Procyk, 888-571-9470, sp@duncanandgrove.com:
   1. Model: Musical Chimes NO.1 Robinia
   2. Materials: FSC Robinia, 304 Stainless Steel
   3. Height: 59”

F. Playground Equipment, A-Frame
Manufacturer: Duncan & Grove, Hebron, Illinois, Sean Procyk, 888-571-9470, sp@duncanandgrove.com
   1. Model: Stilted Playhut No.1
   2. Materials: FSC Robinia
   3. Height: 8’

G. Playground Equipment, Musical Chimes No. 2 Robinia:
Manufacturer: Duncan & Grove, Hebron, Illinois, Sean Procyk, 888-571-9470, sp@duncanandgrove.com
   1. Model: Musical Chimes No. 2 Robinia
   2. Materials: FSC Robinia

H. Playground Equipment, Embankment Slide:
Churchich Recreation, Denver, CO, Marc Paynter, 720-899-1238, marc@churchichrecreation.net
   1. Manufacturer: UPC Parks
   2. Model: 8’ Tall with 1’H ADA transfer platform Double Wide Winged Embankment Slide
   3. Materials: Soft Gray Concrete Slide
   4. Finish: Smooth Texture
   5. Color: Silver Top Rail

PART 3 EXECUTION

3.01 INSTALLATION

A. All playground equipment shall be installed at locations shown on drawings and per manufacturer’s instructions.

B. Playground equipment installation shall be performed by a certified installer, certified by the equipment manufacturer. Contractor shall provide certification, prior to final acceptance, that playground equipment was installed in accordance with CPSC and ASTM guidelines and standards.

END OF SECTION

SECTION 12 83 00 SITE FURNIISHINGS

PART 1 GENERAL

1.1 SUMMARY

A. DESCRIPTION

1. The work in this section consists of furnishing and installing benches, tables, bicycle racks, trash and recycling receptacles, bollards, and planter pots.

B. QUALITY ASSURANCE

1. Material and craftsmanship for site furnishings shall conform to recognized association standards.
2. Contractor to submit color samples, technical data, and installation methods prior to any ordering and or installing of these items.
3. Contractor to field locate each item and associated paving prior to any installation and/or construction and shall have Owner's Representative's review.

C. SUBMITTALS

1. Submit manufacturer's technical data and installation information for approval by the Owner and Landscape Architect.

PART 2 PRODUCTS

2.1 LITTER AND RECYCLING RECEPTACLES

A. Litter and Recycling Receptacle: Dispatch Litter & Recycling Receptacle by Forms + Surfaces. Contact Nathan Erickson (T) 800-451-0410, or Landscape Architect approved alternate.
1. Model: 45 Gallon
2. Lid: Litter Opening Lid for trash and Recycling Opening Lid for recycling
3. Finish/Color: Powder coated, Silver
4. Surface Mounted for concrete applications and Concrete Base for crusher fines locations
5. Coordinate final locations with Owner's Representative prior to mounting
6. Install per manufacturers detail and recommendations
7. Quantity: Per plans, one trash and one recycling at each location

2.2 BICYLE RACKS

A. Bola Bike Rack by Landscape Forms. Contact Vivian Kovacs (T) 800-430-6206 X 1323, or Landscape Architect approved alternate.
1. Model: Bola Bike Rack
2. Finish: Stainless Steel
3. Mounting Method: Embedded. Include extension for racks located in crusher fines for embed.
4. Install per manufacturers detail and recommendations
5. Quantity: Per plans

2.3 BENCH TYPE A

A. Backed Bench by Janus Et Cie. Contact Amber Conner (T) 720-810-0822, or Landscape Architect approved alternate.
   1. Model: Koko II Bench with Arms
   2. Finish/Material: Aluminum
   3. Color: Silver
   4. Mounting: Surface Mounted
   5. Install per manufacturers detail and recommendations
   6. Quantity: Per plans

2.4 PICNIC TABLE TYPE & BACKLESS BENCH

A. Dining Table by Janus Et Cie. Contact Amber Conner (T) 720-810-0822, or Landscape Architect approved alternate.
   1. Model: Koko II Dining Table Rectangle 184
   2. Finish/Material: Aluminum
   3. Color: Silver
   4. Length: 72.5”
   5. Mounting: Surface Mounted
   6. Install per manufacturers detail and recommendations
   7. Quantity: Per plans

B. Backless Bench by Janus Et Cie. Contact Amber Conner (T) 720-810-0822, or Landscape Architect approved alternate.
   1. Model: Koko II Backless Bench 155
   2. Finish/Material: Aluminum
   3. Color: Silver
   4. Mounting: Surface Mounted
   5. Install per manufacturers detail and recommendations
   6. Quantity: Per plans

2.5 REMOVABLE BOLLARD

A. Calpipe Security Bollards. (T) 877-283-8518, or Landscape Architect approved alternate.
   1. Model: 6” SSP06040 SCH 40 Stainless Steel - Removable
   2. Bollard Cap Style: Standard Flat
   3. Color/Finish: Stainless Steel
   4. Install per details, manufacturers details and recommendations
   5. Quantity: Per plans

2.6 DOG WASTE STATION

A. DOGIPOT. (T) 800-364-7681, or Landscape Architect approved alternate.
   1. Model: #1011-Mini
   2. Color/Finish: Black #1003-BLK-L
   3. Install per details, manufacturers details and recommendations
   4. Quantity: Per plans

2.7 CAFÉ TABLES AND CHAIRS

A. Landscape Forms. Landscape Forms, Inc, 7800 E. Michigan Ave. Kalamazoo, Michigan 49048 (T) 800-430-6209, www.landscapeforms.com, or Landscape Architect approved alternate.
   1. Model: Bravo Bistro

2. Color/Finish: Powdercoated Carbon
3. Table Size: 23.5” Dia. Table Top, 28” Tall
4. Chair Size: 17.25” Deep X 16” Wide X 32.5” Tall, seat height 17.5”
5. Install per details, manufacturers details and recommendations
6. Quantity: Per plans

2.8 METAL PICKET FENCE & GATE

A. Ameristar.1555 N. Mingo, Tulsa, OK 74116, (T) 888-333-3422, www.ameristarfence.com, or Landscape Architect approved alternate.
1. Model: Montage Plus – 4’H
2. Color/Finish: Powdercoated Black
3. Install per details, manufacturers details and recommendations
4. Quantity: Per plans

PART 3 EXECUTION

2.1 INSTALLATION

A. All site furniture shall be installed per Drawings and manufacturer’s instructions.

END OF SECTION 12 83 00

WAGGENER FARM PARK PHASE 2

SECTION 13 34 23 - PRE-ENGINEERED RESTROOM BUILDING

Specification Date: 11/13/2025

SECTION 1: BUILDING SUPPLIER SCOPE

1.1 SUMMARY

A. The work shall include furnishing the sealed architectural, structural, mechanical, and electrical plan sets and furnishing the structural, mechanical, and electrical building components as a complete, pre-designed restroom building package as shown on drawings and as specified herein.

1.2 GENERAL REQUIREMENTS

A. Packaged building design and engineering and furnishing all specified building package components shall be supplied by Romtec, Inc., or pre-approved alternate, hereafter designated as the ***building supplier***.
B. The ***building supplier*** shall be a single source design, engineering, and manufacturing firm who shall meet all the following requirements.
C. The packaged building shall be a current standard product of ***building supplier***.
D. ***Building supplier*** shall be regularly engaged in and have at least ten (10) years of experience in packaged building engineering, design, supply, and construction.
E. The ***building supplier*** must meet or exceed the product specifications. The Romtec, Inc. building package is an approved guide and example.
F. Alternate ***building suppliers*** shall demonstrate that they have designed, engineered, produced, delivered, and constructed at minimum ten (10) functioning site-built buildings of similar type. Project completion dates and a reference contact from the owner of each project must be provided.
G. Alternate ***building suppliers*** must disclose all instances of any prior municipal reviewer or landscape architect's rejection of the same or similar product as an "or equal" to the specified basis of design building package.
H. Bidders who propose and alternate ***building supplier*** other than Romtec, Inc. are required to provide a complete submittal package minimum of ten (10) calendar days prior to the bid opening date with full sealed plan sets, calculations, and all pre-engineered structural items.
I. Any products proposed as "or equal" that are not as specified must be specifically listed in the alternate ***building supplier*** submittal package and accompanied by manufacturers data sheets for review. These products will be approved or denied prior to the bid opening. Incomplete submittals will be rejected and returned to the bidder.
J. The building and its concrete footings, foundation, and slab are to be engineered by the ***building supplier*** to meet site-specific conditions, including wind and snow loading, local frost depth, and ground conditions.
K. Fasteners that are normally included with individual components, as we all any atypical fasteners, shall be supplied by ***building supplier***.
L. Building is to be designed and constructed to meet local codes and approvals for permanent structures. Any building that is temporary, permanently relocatable, prefabricated modular, an offsite constructed product, or constructed of precast material is not an accepted equal to permanent, onsite, conventional construction.
M. No approval by any external entity will override the local building authority's codes and inspections. Seals meant for modular homes and production plant certifications will not be allowed in lieu of sealed plans from a licensed engineer and conventional inspection during construction.
N. Building sidings, treatments, and roofing are to be as specified. Precast buildings with painted textures are not considered architecturally equivalent.
O. The ***building supplier*** shall provide complete, code-compliant building plans including plans, elevations, sections, and details, under seal of a National Kitchen and Bathroom Association (NKBA) certified technical designer.
P. The ***building supplier*** shall provide complete structural calculations meeting code for design loads and seismic design under seal of a professional Engineer with current license in the state where the project is located.
Q. The reviewing authority reserves the right to review or reject all submittals at its sole discretion.
R. All work and materials shall comply with current industry building codes and regulations for the state where the project is located.
S. Americans with Disabilities Act Accessibility Guidelines (ADAAG) will be followed in design, manufacture, and construction.

1.3 DESIGN & SUBMITTAL DOCUMENTATION

A. The ***building supplier*** work shall include the design of the architectural, mechanical, structural, and electrical components that will be required for this building.
B. The building will be designed as a complete building package to be delivered to the job site for construction on-site by the contractor.

C. Within one (1) week of contract award, the ***building supplier*** shall submit the packaged building preliminary Scope of Supply and Design Submittal (SSDS), including the building plan view and elevation drawings.
D. The ***building supplier*** will provide complete submittal documentation in the ***building supplier's*** standard electronic submittal format for review.
E. The preliminary SSDS will be reviewed by relevant parties and returned to the ***building supplier*** with any required revisions to the terms, product data sheets, and/or building plan view and elevation drawings noted as comments.
F. The ***building supplier*** shall make any required corrections or revisions and resubmit the preliminary SSDS until the preliminary SSDS is approved by the relevant parties.
G. Once the preliminary SSDS has been approved, the ***building supplier*** will provide full sealed plan sets stamped by an engineer licensed in the state that the building is located for review by the permitting authority.
H. Up to three (3) wet stamped sets of the plans and structural calculations shall be provided by ***building supplier*** before any additional fees apply. Standard plan set size is 11" x 17".
I. Permitting authority will review the full sealed plan set and return with any required revisions or corrections noted as comments.
J. ***Building supplier*** shall provide one full round of sealed plan revisions in response to permitting authority comments before any additional fees are allowed.
K. The following sections shall be included in the ***building supplier***'s preliminary Scope of Supply and Design Submittal. Incomplete submittals will be rejected and returned to the bidder.
    1. INTRODUCTION
    2. BUILDING DESIGN,
        (a) SUPPLIED ITEMS
        (b) EXCLUDED ITEMS
        (c) PLAN VIEW AND ELEVATION DRAWINGS
    3. PRODUCT DATA
    4. WARRANTY & LIMITATIONS

Note: Overall site plan is not part of ***building supplier's*** *scope.*

1.4 WARRANTY

A. The building package and all associated components provided by ***building supplier*** shall be warranted against defects in materials and workmanship for a period of not less than one (1) year from the date of acceptance. Acceptance is the date of delivery of the building package, or, if delivery is delayed for any reason beyond ***building supplier's*** control, the date that the building and all its associated components were ready to deliver.

B. ***Building supplier*** shall pass through to owner all relevant manufacturers' warranties for individual products and components of the building package.

SECTION 2: BUILDING PACKAGE PRODUCTS

2.1 APPROVED BUILDING SUPPLIERS

A. Romtec, Inc.
18240 North Bank Road, Roseburg, OR 97470
Tel: 541-496-3541; Fax: 541-496-0803;
Email: RIsales@romtec.com
Web: www.Romtec.com

B. Requests for use of an alternate ***building supplier*** will be considered in accordance with provisions of Section 1.

2.2 BUILDING DESCRIPTION

A. Refer to drawings for quantities, dimensions, locations, and installation methods for the materials and items described in this section.

B. Building dimensions shall match what is indicated on drawings.=

2.3 PLUMBING FIXTURES & ACCESSORIES

A. The following plumbing fixtures and accessories shall be supplied by ***building supplier***.
B. Toilet shall be floor mount, top supply, white vitreous china.
    1. Flush valve shall be a chrome, manual lever with ADA compliant metal oscillating non-hold-open handle.
C. Urinal shall be wall mount, top supply, back discharge, white vitreous china.
    1. Flush valve shall be a chrome, manual lever with ADA compliant metal oscillating non-hold-open handle.
D. Lavatory shall be 19 in. x 17 in. white vitreous china and wall hung with anti-splash rim and concealed front overflow.
    1. Faucets shall be a 2.2gpm, pivot action lever style faucet.

E. Grab bars shall be stainless steel.
F. Toilet paper dispenser shall be stainless steel, wall mount with two-roll capacity.
G. Surface-mounted towel dispenser shall be fabricated of heavy duty, 22-gauge stainless steel with exposed surfaces in satin finish. Refill indicator on face of cabinet. Tumbler lock to secure hinged front panel. Towel dispenser capacity 525 multi-fold or 400 C-fold towels.
H. Soap/Sanitizer Dispenser shall be Bradley Corp. Diplomat Series Model 6A01, surface-mounted automatic foam soap/sanitizer dispenser, with face formed with contemporary contours, radii, and finish matching related accessories in manufacturer's designer series. Capacity 27 oz (800 ml). Equipped with hinged cover and completely concealed mounting plate. Vandal resistant filler hole cover and sight gauge. Corrosion-resistant foam soap/sanitizer valve.
I. Haws ADA vandal-resistant dual drinking fountain and bottle filler, model 1119P.
    1. Surface mount, stainless steel drinking fountain guard rails.
J. Bradley phenolic restroom partitions shall be supplied by ***building supplier***.
    1. Solid Phenolic core is composed of compressed cellulose fibers impregnated with resins. The surface laminate is fused to the resin-impregnated core. All edges are machined and finished smooth with a 15-degree beveled edge. Materials shall be non-absorbent, impact and graffiti resistant. Materials shall be impervious to steam, soaps/detergents, and mildew.

2.4 ELECTRICAL

A. The following electrical fixtures shall be supplied by ***building supplier***.
B. Light fixtures shall be supplied by ***building supplier***.
    1. Exterior lights to be LED downlights with cast-aluminum housing with corrosion-resistant paint in dark bronze. Polycarbonate lens.
    2. Exterior lights controlled by photocell.
    3. Interior surface mount, 48” LED light fixtures.
    4. Restroom lights controlled by motion sensor.
    5. Mech room lights controlled by switch (switches by installer).
C. Main breaker panel shall be supplied by ***building supplier***.
    1. Breaker Panel shall be 100 Amp, single-phase, rain tight.

*Note: Breaker panel shall be sized to accept only the loads of the **building supplier** electrical fixture package. The **building supplier** should modify the main breaker panel as needed to be most efficient based on any design changes.*

2.5 STRUCTURE

A. Concrete Masonry Units (CMU) shall be supplied by ***building supplier***.
    1. Walls shall be constructed of 8"W x 16"L x 8"H smooth-face mortar joint concrete masonry units (concrete blocks).
    2. Blocks shall be manufactured to ASTM C90 designation for load bearing concrete masonry units.
    3. Block color to be ***Gray***.
B. Exterior wall finish shall be fiber cement board and batten siding.
    1. Siding shall be mounted over OSB sheathing supplied by ***building supplier***.
C. Sanitary tile cove base on interior restroom walls to be supplied by ***building supplier***.
D. Wire weave gable vents for natural ventilation shall be supplied by ***building supplier***.
    1. Pre-assembled steel frame with 10-gauge, 1” square lock joint wire weave mesh integral insect screen.
    2. Steel frame shall be powder coated ***black***.
E. Door system components shall be supplied by ***building supplier***.
    1. Doors shall be Steelcraft® SL18 standard laminated honeycomb core and 18-gauge galvanized steel.
    2. Door frame shall be pre-welded Steelcraft® 3-Sided flush frame, 16-gauge galvannealed A-60 steel.
    3. Doors and frames shall be powder coated ***black***.
    4. Masonry door clips (3/16” dia.) for door frame shall be fitted between the doorframe and concrete blocks to bond frame to wall. Door clips shall allow full internal grouting of the frame during installation.
    5. Hinges shall meet ANSI A5112 with non-removable pin and two ball bearings.
    6. Hager 5100 Series Grade 1 door closer shall be constructed of cast iron.
    7. Door shall have 0.038” gauge, stainless steel protection plates.
    8. Doors shall have pull handles with stainless steel plates and deadbolt locks.

2.6 ROOFING

A. The following roof components shall be supplied by ***building supplier***.
    1. Glulam beam shall be 24F-V4 and architectural grade.
    2. Tongue & groove decking shall be 2x6 V-edge deck boards, select deck Douglas fir.
B. Timber truss with steel post, 6’ roof extension.

1. All exposed steel truss plates/brackets and posts are powder coated ***black***.

C. Roofing shall be Fabral, 26-gauge, Horizon 16, standing seam panels, with 16 in. coverage width.
   1. Roofing package shall include inside and outside foam closures, matching trim (eaves, gables, and ridge) and fasteners, sheet metal flashing (all sides), and 30# felt (under metal).
   2. Roofing color to be selected by the ***owner*** from the manufacturers' standard color chart.

2.7 DELIVERY, STORAGE, AND HANDLING

A. The ***building supplier*** freight shall be based on delivering the product on a 48' to 53' flatbed or van truck and trailers, or as close to those dimensions as can legally access the site. Overall dimensions of the truck and trailers allowed to access the site are: 70' overall length, 102" wide and 168" high.

B. ***Building supplier*** shall deliver organized building package components in stages as shrink-wrapped pallets that correspond to a typical sequence of construction. A bill of material stating the stages of palletized components shall be included with every delivery.
   1. Stage 1 pallets shall include structural components such as block, frames, vents, beams, connectors, trusses, etc.
   2. Stage 2 pallets shall include second stage structural components such as filler wall material, windows, skylights, roofing, etc.
   3. Stage 3 pallets shall include structural finish components such as siding material, tile, doors etc.
   4. Stage 4 pallets shall include plumbing and electrical fixtures and other finish materials such as toilets, sinks, drinking fountains, electrical fixtures, accessories, etc.

SECTION 3: BUILDING INSTALLER SCOPE

The installing contractor or subcontractor, hereafter designated as the ***building installer,*** is responsible for building package installation. ***Building installer*** work will generally include foundation/pad construction and building package assembly/construction.

> Note: ***Building supplier's*** *scope is separate from the* ***building installer's*** *scope. Romtec, Inc., is the approved* ***building supplier****, not a designated* ***building installer.***

3.1 CONSTRUCTION SUBMITTALS

A. If required by ***owner*** and/or reviewing authority, ***building installer*** shall submit product data sheets and relevant information about the specified ***building installer*** supplied products below for review and approval.

3.2 WARRANTY

A. ***Building installer's*** work shall be warranted against defects in materials and workmanship for a period of not less than one (1) year from the date of acceptance. Acceptance is the date that installation work for the building package is completed, including any relevant final punch list. In the event that final acceptance of the completed building is delayed for reasons beyond ***building installer's*** control, the warranty shall be one (1) year from the completion of ***building installer's*** installation work and demobilization.

B. ***Building installer*** shall pass through to owner all relevant manufacturers warranties for individual products and components supplied by ***building installer***.

3.3 STRUCTURE

A. Masonry (concrete) grout shall be supplied and installed by ***building installer***.
   1. Grout shall have a minimum compressive strength of 2,500 psi at 28 days, 9+/-1" slump, with max ½" aggregate.
   2. Fine or coarse grout may be used in accordance with 2009 UBC.
   3. All CMU block must be fully grouted and may not be wetted.

   Note: *If required for installation,* ***building installer*** *will be responsible for providing appropriate equipment and labor for notching CMU block for bond beams, cutting CMU block to make any required shapes, and/or grinding CMU block for fixture mounting.*

B. Rebar for walls shall be supplied and installed by ***building installer***.
   1. All walls shall have # 4 and # 5 rebar. See final approved plans for spacing.
   2. All rebar used in the building must meet ASTM A615 manufacturing standards and is to be placed per the final approved plans.

C. Interior block wall finish shall be latex epoxy paint supplied and installed by ***building installer***.

D. Interior floors to be sealed concrete finish supplied by ***building installer***.

E. Sealant for all exposed wood shall be supplied and installed by ***building installer***.

F. Sealant for all exterior CMU block is required, to be supplied and installed by ***building installer***.

G. Fiber cement siding is primed to be painted on-site by ***building installer***.
   1. Siding shall be mounted over OSB sheathing (sheathing supplied by ***building supplier***).

3.4 ELECTRICAL

A. Electrical rough-in, installation and trim shall be provided by ***building installer***.
   1. All underground and/or overhead service to building shall be as specified in the final site plan.
   2. ***Building installer*** is responsible for all necessary wire, connectors, grounding, conduit, and related items to install the building package electrical components and meet all relevant national, state, and local codes.
   3. ***Building installer*** shall supply and install all switches and outlets required to complete the building package installation.

3.5 CAST IN-PLACE CONCRETE FOR BUILDING PACKAGE

A. All equipment, labor, trades, and materials for cast-in-place concrete shall be provided by ***building installer***.
   1. Includes all materials and labor for building package foundations/footings and interior slabs.
B. Footings for the building package are to be dug by the ***building installer*** and poured on-site to meet local code for permanent structures. A prefabricated, modular mat placed on compacted base is not an accepted equal to a site specific, site poured, engineered foundation.
C. Engineered fill shall be ¾" minus crushed aggregate around footings, foundations, and slabs, or as required in the final approved plans.
D. Slab vapor barrier shall be 6-mil continuous plastic under the concrete slab, or as required in the final approved plans.
E. The foundation shall be installed as designed with all cast in-place concrete poured to dimensions specified, or as required in the final plans.
   1. Footings will be built to minimum 24" depth or greater if required by local frost depth or permitting authority.
   2. Minimum compressive strength of foundation concrete shall be 3,000 psi at 28 days, 4" +/-1" slump, with max ¾" aggregate, cured in accordance with ACI 308, or as required in approved final plans.
   3. Slabs shall have a fine broom finish with joints required in flat work as shown on plans.
   4. Steel rebar shall be installed as specified in final plans.
F. ***Building installer*** shall supply and install concrete slab sealer.
   1. Concrete slab sealer shall be a water-based, transparent curing, sealing and dust proofing compound with two (2) coats to be applied per manufacturer's instructions.

3.6 PLUMBING

A. Plumbing rough-in, installation and trim within 10' of the building footprint shall be provided by ***building installer***.
   1. All underground water service and sewer drain(s) from building to be as specified in final approved site plan.
   2. Building water shutoff valve, drain, and all rough piping shall be as shown on final building plans. Final installation location to be determined onsite.
   3. Install the building package plumbing fixtures per the final approved plans.
   4. Piping shall be installed per the final approved plans with minimum pipe sizing per 2009 Uniform Plumbing Code Section 610.
B. Floor drains in the building shall be supplied and installed by ***building installer***.
   1. All floor drains shall be as shown on final approved plans.

3.7 OTHER MATERIALS & EQUIPMENT

A. Unless otherwise specified, the following products and materials are supplied by ***building installer*** (if applicable).
   1. Building package installation
   2. Cast-in-place concrete foundations, footings, interior slabs.
   3. Concrete slab & block sealer
   4. Mortar
   5. Concrete grout
   6. Rebar
   7. Latex epoxy paint
   8. Caulk for siding
   9. Plumbing rough in, installation and trim
   10. Electrical rough in, installation and trim
   11. Switches & outlets

12. Typical fasteners; for example: roofing nails, staples, etc.
13. Fasteners not included in product packaging.
14. Wood sealant for all decking, glulam beams, posts, and extensions
15. All other items within the building footprint indicated on final plans or required by building codes to complete installation of the building package which are not specifically stated as supplied by ***building supplier***.

3.8 DELIVERY, STORAGE, AND HANDLING

A. The ***building installer*** will be responsible for all equipment and labor required for off-loading of the delivered building package onsite.
B. The ***building installer*** will assume responsibility for adequate protection and maintenance of delivered building package materials from weather, damage, and pilferage during installation work. Any failure to adequately protect building package materials that affects the warranty of those materials will be at ***building installer's*** expense.
C. ***Building installer*** shall collect and maintain for final delivery to owner any operation & maintenance manuals included by individual product manufacturers with their respective product packaging. Any failure to collect, maintain, and/or deliver these O&M manuals to the ***owner*** that results in fees from ***building supplier*** for additional copies shall be at ***building installer's*** expense.

SECTION 4: CONTRACTOR SCOPE ITEMS

The items in this section may be provided by the same ***building installer*** as defined in Section 3 above (typically when a single entity is acting as both the ***building installer*** and ***contractor***), or the items in this section may be provided by a separate entity such as a general contractor or site contractor, hereafter designated as ***contractor*** (typically when the ***building installer*** is a separate subcontractor). ***Contractor*** work will generally include site preparation and grading, excavations for structures, backfill and/or structural backfill, and any site or utility work outside the building package footprint.

Items in this section are generally to be completed prior to ***building installer*** beginning its installation work described in Section 3 above.

4.1 CONSTRUCTION SUBMITTALS

A. If required by ***owner*** and/or reviewing authority, ***contractor*** shall submit product data sheets and relevant information about the specified ***contractor*** supplied products below for review and approval.

4.2 WARRANTY

A. ***Contractor's*** work shall be warranted against defects in materials and workmanship for a period of not less than one (1) year from the date of acceptance. Acceptance is the date that installation work for the building package is completed, including any relevant final punch list. In the event that final acceptance of the completed building is delayed for reasons beyond ***contractor's*** control, the warranty shall be one (1) year from the completion of ***contractor's*** installation work and demobilization.

B. ***Contractor*** shall pass through to owner all relevant manufacturers' warranties for individual products and components supplied by ***contractor***.

4.3 ELECTRICAL

A. Incoming electrical utility lines to within approximately 10' of the building shall be provided by ***contractor.***
   1. All underground and/or overhead service to building shall be as specified in the final site plan.
   2. Electric meter base and all rough wiring, switches, plugs and circuit breakers shall be as shown on final plans.

B. C***ontractor*** supplies and installs the meter base and meter.

4.4 CAST IN-PLACE CONCRETE FOR BUILDING EXTERIOR

A. All equipment, labor, trades, and materials shall be supplied by ***contractor***.
   1. Includes all materials and labor for exterior/entry slabs and sidewalks.
B. Refer to drawings for sidewalks and entry slabs.
   1. Minimum concrete compressive strength of 2,500 psi at 28 days, or as required in final approved plans.
   2. Remesh or rebar reinforcement shall be used in sidewalks.
   3. All sidewalks shall be finished with a fine broom with control joints installed per the final approved site plan.

4.5 PLUMBING

A. Incoming plumbing to within approximately 10' of the building shall be provided by ***contractor***.
   1. All underground water service and sewer drain(s) from building to be as specified in final approved site plan.
   2. Building water shutoff valve is to be supplied and installed by ***contractor***.
   3. ***Contractor*** is responsible to ensure that incoming water pressure is sufficient to meet building package fixture demands.
   4. Minimum water pressure at toilet and urinal flush valves shall be 40 psi with minimum pipe sizing as per 2009 Uniform Plumbing Code Section 610, or as required in final approved plans.

B. Water line drain valve shall be supplied and installed by ***contractor***.

C. Sewer line backflow check valve shall be supplied and installed by ***contractor***.

4.6 OTHER MATERIALS & EQUIPMENT

A. Unless otherwise specified, the following products and materials are supplied by ***contractor***.
   1. All items not specifically listed as supplied by ***building supplier*** or ***building installer***.
   2. Any item listed as supplied by "contractor" or "others."

B. Unless specified in the plans or submittals, ***contractor*** supplies the following items (if applicable):
   1. Incoming electrical, water, sewer, and gas utilities.
   2. Asphalt paving
   3. Masonry pavers
   4. Sidewalks
   5. Landscaping
   6. Site grading
   7. Exterior/entry slabs
   8. Drain valves and backflow check valves.
   9. Branch circuit breakers
   10. Irrigation Equipment
   11. Fire alarm and fire suppression equipment.
   12. Lighting equipment not attached to the building.
   13. All other items exterior of the building footprint indicated on final plans or required by building codes which are not specifically stated as supplied by ***building supplier or building installer***.

4.7 DELIVERY, STORAGE, AND HANDLING

A. The ***contractor*** will assume responsibility for adequate protection and maintenance of the installed building package materials after completion of installation work by ***building installer***. Any failure to adequately protect building package materials that affects the warranty of those materials will be at ***contractor's*** expense.

SECTION 5: OWNER'S SCOPE

5.1 ONGOING MAINTENANCE

A. ***Owner*** is responsible for ongoing maintenance of the completed building after completion of work by building installer and contractor.

5.2 SITE PLAN

A. ***Owner*** (or owner's site engineer) is responsible for providing the final approved site plan to ***building supplier*** and/or ***building installer***.

5.3 SPECIAL INSPECTION

A. If required, special inspection(s) services shall be provided by ***owner***.
B. If special inspection(s) are required by the permitting authority or relevant agency(ies), then the ***building supplier***, ***building installer***, and/or ***contractor*** shall provide reasonable assistance to the ***owner*** to accommodate the special inspection(s).

SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Grout.
4. Common electrical installation requirements.

1.2 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways and cable trays will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.2 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

3.1 COMMON REQUIREMENTS FOR ELECTRICAL 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 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.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 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. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Cut sleeves to length for mounting flush with both surfaces of walls.

E. Extend sleeves installed in floors 2 inches above finished floor level.

F. Size pipe sleeves to provide 1/4-inch minimum annular clear space between sleeve and raceway or cable, unless indicated otherwise.

G. 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.

H. Exterior-Wall Penetrations: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.

END OF SECTION 26 05 00

SECTION 26 05 01 EQUIPMENT CONNECTIONS AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION

A. General: Provide final connections to equipment and coordinate same in accordance with the Contract documents.

B. Equipment to receive final connections shall include but not be limited to the following:
   1. Motors and equipment.
   2. Owner furnished equipment.

C. Drawings and general provisions of the Contract, including general and supplementary conditions and Division 01 specification sections, apply to this section.

D. Related work specified in Division 26.
   1. Low-Voltage Electrical Power Conductors and Cables – Section 26 05 19.
   2. Raceways and Boxes for Electrical Systems – Section 26 05 33.
   3. Grounding and Bonding for Electrical Systems – Section 26 05 26.
   4. Enclosed Switches and Circuit Breakers – Section 26 28 16.

E. Related work specified in other division of these specifications:
   1. Motors.
   2. Control Wiring.

1.3 QUALITY ASSURANCE

A. Prior to the submitting of bids, the Contractor shall familiarize himself with all conditions affecting the proposed installation of equipment requiring electrical connections and shall make provisions as to the cost thereof. Failure to comply with the intent of this paragraph shall in no way relieve the Contractor of performing all necessary work required for final electrical connections and equipment and the coordination thereof.

B. Connections and overcurrent protection devices shall be in accordance with the manufacturer's recommendations and approved shop drawings.

PART 2 - PRODUCTS

2.1 Only those products listed in Division 26 shall be employed.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Connections for and coordination of motors and equipment requiring electrical connections shall include but not be limited to the following:
   1. Provide and install a disconnect switch for each motor and each piece of equipment, except where combination starter/disconnects or disconnects integral to equipment are provided by mechanical or plumbing contractor. Provide disconnects where required by code.
   2. Verify that the motor rotation is correct and reconnect if necessary.
   3. Provide separate ground wires in flexible, metal conduit and non-metallic conduit so as to provide an electrically continuous ground path. Ground all equipment.
   4. Provide motor branch circuit conductors and connections to each individual motor controller and from each controller to the motor through an approved disconnect switch. Make final connection per Division 26 Section "Raceways and Boxes for Electrical Systems".
   5. Where equipment is fed from branch circuit routed in or under the slab, terminate branch circuit at junction box on 2 foot rigid conduit stub-up and make final connection to equipment per Division 26 Section "Raceways and Boxes for Electrical Systems". Provide suitable knee brace on conduit stub-up.
   6. Where equipment is fed from overhead support conduit feeder descending from ceiling on flanged floor fitting with conduit type fitting connecting to motor. Make connection per Division 26 Section "Raceways and Boxes for Electrical Systems".
   7. Where nameplate on equipment indicates fuse protection the disconnecting means shall be equipped with dual element fuses.

3.2 OWNER FURNISHED EQUIPMENT

A. The requirement for equipment furnished by the Owner for installation by this contractor shall include but not be limited to the following:
   1. The coordination of the proper delivery scheduling of such equipment.
   2. The receiving and unloading of such equipment at the property line.
   3. The inspection of such equipment for damages, defacement, corrosion, missing components, etc. at the job site. All deficiencies shall be recorded. Deficiencies occurring after inspection shall be corrected by this contractor at his cost.
   4. The safe handling at secure storage of such equipment from unloading to the time of permanent installation.
   5. The completion of field make-up of internal wiring as required.
   6. The lamping of equipment.
   7. The installation of accessories on such equipment.
   8. The installation of such equipment including the transportation of the equipment to the installation area, and the installation of all supports, fasteners, canopies, extensions, etc. required to insure safe support and adaptation to the finished structural, electrical and architectural conditions.
   9. The final connections and grounding to the building electrical system including all necessary labor and materials including but not limited to junction box extensions, lug change outs, etc.
   10. The testing of such equipment in its final location.

3.3 ELECTRICAL COORDINATION

A. Furnish electrical services to Division 22 and/or 23 equipment as outlined below.

B. Unless otherwise indicated, all mechanical equipment motors and controls shall be furnished, set in place, and wired by the Division 22 or 23 contractor. Contractor should note that the intent of

this wiring schedule is to have the Division 23 contractor responsible for coordinating all control wiring as outlined, whether or not specifically called for by the mechanical or electrical drawings and specification. Comply with the applicable requirements of Division 22 or 23 for electrical work of this Division 26 which is not otherwise specified. No extras will be allowed for Contractor's failure to provide for these required items. The Division 26 Contractor shall refer to the Division 22 and 23 specifications and plans for all power wiring and shall advise the Architect/Engineer of any discrepancies prior to bidding.

Item	Furnished By	Set By	Power Wiring	Control Wiring
Equipment Motors	MC	MC	EC	---
Motor Starters and Overload Heaters (See Note 1)	MC	EC	EC	MC
Fused & Unfused Disconnect Switches, Thermal Overload Heaters (if not integral to equipment)	EC	EC	EC	---
Manual Operating & Speed Switches (carrying load currents) (See Notes 3 & 4)	MC	MC	MC	MC
Control Relays & Transformer (See Note 2)	MC	MC	MC	MC
Thermostats (Line Voltage) including Aquastats	MC	MC	MC	MC
Temperature Control Panels	MC	MC	EC	MC
Motor & Solenoid Valves, Damper Motors, PE & EP Switches, Control Valves, Fan Interlocking Wiring, Low Voltage Thermostats	MC	MC	---	MC
Pilot Lights and Manually Operated Switches Not Carrying Load Currents (See Note 3)	MC	MC	---	MC
Temporary Heating Connections	MC	MC	MC	MC
HVAC Water Treatment Interlocks	MC	MC	---	MC

MC = Mechanical Contractor under Division 23 of the work.
PC = Plumbing Contractor under Division 22 of the work.
EC = Electrical Contractor under Division 26 of the work.

Notes for the Electrical Coordination Schedule:

1. All starters, other than those noted on the Drawings, shall be furnished under Division 22 or 23. All starters furnished under Division 22 or 23 shall be complete with three overload heaters and shall conform to NEC and NEMA requirements. All starters shall have 65,000 AIC rating.
2. Control relays and control transformers shall be furnished under Division 22/23 except where furnishing such items are specifically required under Division 26 Specifications and/or Drawings.
3. Switches carrying full load current are to be wired under Division 26 of the work.

C. All temperature control conduit and wiring shall be furnished and installed under Division 23. All motorized damper equipment shall be furnished and installed under Division 23. 120 volt power wiring shall be by Division 26.

D. Control wiring includes all low voltage and 120 volt wiring.

END OF SECTION 26 05 01

SECTION 26 05 19 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

1.2 REFERENCES

A. 2023 National Electrical Code (NEC) (NFPA 70).

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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

1. Alpha Wire Company.
2. Belden Inc.
3. Cooper Industries, Inc.
4. Encore Wire Corporation.
5. General Cable; General Cable Corporation.
6. Senator Wire & Cable Company.
7. Southwire Company.
8. Thomas & Betts Corporation, A Member of the ABB Group.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with NEMA WC 70/ICEA S-95-658.

1. Conductor Insulation: Type THHN/THWN-2.

E. Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with ground wire.

2.2 CONNECTORS AND SPLICES

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

1. 3M.
2. AFC Cable Systems, Inc.
3. Hubbell Power Systems, Inc.
4. Ideal Industries, Inc.
5. ILSCO.
6. O-Z/Gedney; a brand of Emerson Industrial Automation.
7. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Minimum conductor size shall be No. 12 AWG, unless specifically noted otherwise.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.

B. Exposed Branch Circuits: Type THHN/THWN-2, single conductors in raceway.

C. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway or Metal-clad cable, Type MC.

D. The Contractor shall adjust branch circuit wiring sizes as necessary to limit voltage drop to 3%.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."

C. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

D. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, which will not damage cables or raceway.

F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

G. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. All wiring connections made at or below grade shall be waterproof with UL listed waterproof connections.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.6 FIELD QUALITY CONTROL

A. Testing: Upon installation of wires and cables and before electrical circuitry has been energized, the Contractor shall demonstrate product capability and compliance with requirements.

B. The Contractor shall correct malfunctioning conductors and cables at Project site and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION 26 05 19

SECTION 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Burndy; Part of Hubbell Electrical Systems.
2. ERICO International Corporation.
3. Galvan Industries, Inc.; Electrical Products Division, LLC.
4. Harger Lightning & Grounding.
5. ILSCO.
6. O-Z/Gedney; a brand of Emerson Industrial Automation.
7. Siemens Power Transmission & Distribution, Inc.
8. Thomas & Betts Corporation, A Member of the ABB Group.

2.2 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction. Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Equipment Grounding Conductors: Insulated with green-colored insulation.

C. Grounding Electrode Conductors: Stranded cable.

D. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

E. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Sizes and types of conductors in four subparagraphs below are typical examples. 28-kcmil bonding cable in "Bonding Cable" Subparagraph below is slightly larger than No. 6 AWG.
5. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
6. Bonding Conductor: No. 6 AWG, stranded conductor.
7. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
8. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the

ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.5 FIELD QUALITY CONTROL

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

B. Perform tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test well. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

C. Refer to drawings for information on pool bonding system and associated tests.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.4 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.
2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.

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

    a. Allied Tube & Conduit; a part of Atkore International.
    b. Cooper B-Line, Inc.; a division of Cooper Industries.
    c. ERICO International Corporation.
    d. Flex-Strut Inc.
    e. GS Metals Corp.
    f. G-Strut.
    g. Metal Ties Innovation.
    h. Thomas & Betts Corporation, A Member of the ABB Group.
    i. Unistrut; an Atkore International company.

2. Material: Galvanized steel.
3. Channel Width: 1-1/4 inches.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
8. Channel Dimensions: Selected for applicable load criteria.

B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

D. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

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

        1) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Hilti, Inc.
        3) ITW Ramset/Red Head; Illinois Tool Works, Inc.
        4) MKT Fastening, LLC.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems unless requirements in this Section are stricter.

B. Comply with requirements for raceways and boxes specified in Section 26 0533 "Raceways and Boxes for Electrical Systems."

C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Steel: Spring-tension clamps.
5. To Light Steel: Sheet metal screws.
6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03.

C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Boxes, enclosures, and cabinets.
5. Handholes and boxes for exterior underground cabling.

1.2 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

1.3 SUBMITTALS

A. See Section 01 3000 – Administrative Requirements, for submittal procedures.

B. Product Data: For handholes.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a part of Atkore International.
3. Anamet Electrical, Inc.
4. Electri-Flex Company.
5. FSR Inc.
6. O-Z/Gedney; a brand of Emerson Industrial Automation.
7. Robroy Industries.
8. Southwire Company.
9. Thomas & Betts Corporation, A Member of the ABB Group.
10. Western Tube and Conduit Corporation.
11. Wheatland Tube Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. IMC: Comply with ANSI C80.6 and UL 1242.

D. EMT: Comply with ANSI C80.3 and UL 797.

E. FMC: Comply with UL 1; zinc-coated steel.

F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Fittings for EMT:

a. Material: Steel or die cast.
b. Type: Set-screw for conduits less than 2" and compression type for conduits 2" or larger.

H. Joint Compound for IMC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.
3. Arnco Corporation.
4. CANTEX INC.
5. CertainTeed Corporation.
6. Condux International, Inc.
7. Electri-Flex Company.
8. Kraloy.
9. RACO; Hubbell.
10. Thomas & Betts Corporation, A Member of the ABB Group.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ENT: Comply with NEMA TC 13 and UL 1653.

D. RNC: Type EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. LFNC: Comply with UL 1660.

F. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and

material.

G. Fittings for LFNC: Comply with UL 514B.

H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

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

1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Hoffman; a brand of Pentair Equipment Protection.
3. MonoSystems, Inc.
4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

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

1. Adalet.
2. Cooper Technologies Company.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. FSR Inc.
6. Hoffman; a brand of Pentair Equipment Protection.
7. Hubbell Incorporated.
8. Kraloy.
9. Milbank Manufacturing Co.
10. MonoSystems, Inc.
11. O-Z/Gedney; a brand of Emerson Industrial Automation.
12. RACO; Hubbell.
13. Spring City Electrical Manufacturing Company.
14. Thomas & Betts Corporation, A Member of the ABB Group.
15. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

H. Device Box Dimensions: 4 inches by 4 inches by 2-1/8 inches deep, minimum, unless noted otherwise.

I. Gangable boxes are allowed.

J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

K. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of fiberglass.

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

    a. Armorcast Products Company.
    b. Carson Industries LLC.
    c. Oldcastle Precast, Inc.
    d. Quazite: Hubbell Power Systems, Inc.
    e. Synertech Moulded Products.

2. Standard: Comply with SCTE 77.
3. Color of Frame and Cover: Green.
4. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
7. Cover Legend: Molded lettering, "ELECTRIC" or "TELECOM" unless otherwise indicated.
8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: IMC.
2. Concealed Conduit, Aboveground: IMC.
3. Underground Conduit: RNC, Type EPC-80-PVC.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed and Subject to Physical Damage: IMC.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: IMC.
6. Boxes and Enclosures: NEMA 250, Type 1.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless

otherwise indicated. Comply with NEMA FB 2.10.

2. EMT: Use setscrew or compression, steel or cast-metal fittings. Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Complete raceway installation before starting conductor installation.

C. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

D. Arrange stub-ups so curved portions of bends are not visible above finished slab.

E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

G. Support conduit within 12 inches of enclosures to which attached.

H. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

I. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

K. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

L. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

M. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

N. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

O. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

P. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

Q. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where an underground service raceway enters a building or structure.
2. Where otherwise required by NFPA 70.

R. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

S. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

T. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

U. Locate boxes so that cover or plate will not span different building finishes.

V. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

W. Contractor shall not install conductors or cables in a building that is not completely waterproofed, unless the conductors or cable are rated for wet location installations.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit.
2. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete

backfilling with normal compaction.

3. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
4. Underground Warning Tape: Comply with requirements in Section 26 0553 "Identification for Electrical Systems."

B. Minimum burial depth for underground conduit shall be 24”. Provide deeper burial depths where required by utility companies or local requirements.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

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, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Field-cut openings for 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.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 0500 "Common Work Results for Electrical."

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.7 CLEANING

A. Boxes: Remove construction dust and debris from device boxes, outlet boxes and floor-mounted enclosures before installing wall plates, covers and hoods.

END OF SECTION 26 05 33

SECTION 26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identification of power and control cables.
2. Identification for conductors.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Miscellaneous identification products.

B. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.2 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70.

B. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

C. Comply with ANSI Z535.4 for safety signs and labels.

D. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.2 LEGEND REQUIREMENTS

A. Warning labels and signs shall include, but are not limited to, the following legends:

1. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN

FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.3 LABELS

A. Self-Adhesive Labels:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. A'n D Cable Products.
   b. Brady Corporation.
   c. Brother International Corporation.
   d. Emedco.
   e. Grafoplast Wire Markers.
   f. Ideal Industries, Inc.
   g. LEM Products Inc.
   h. Marking Services, Inc.
   i. Panduit Corp.
   j. Seton Identification Products.

2. Write-on, 3-mil-thick, vinyl flexible label with acrylic pressure-sensitive adhesive.

3. Marker for Tags: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

2.4 TAPES:

A. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Brady Corporation.
   b. Carlton Industries, LP.
   c. Emedco.
   d. Marking Services, Inc.

B. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Carlton Industries, LP.
   b. Seton Identification Products.

C. Underground-Line Warning Tape

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

following:
a. Brady Corporation.
b. Ideal Industries, Inc.
c. LEM Products Inc.
d. Marking Services, Inc.
e. Reef Industries, Inc.
f. Seton Identification Products.

2. Tape:
a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications lines.
b. Printing on tape shall be permanent and shall not be damaged by burial operations.
c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

3. Color and Printing:
a. Comply with ANSI Z535.1 through ANSI Z535.5.
b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE.

4. Tag: (Label as Required):
a. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
b. Width: 3 inches.
c. Overall Thickness: 8 mils.
d. Foil Core Thickness: 0.35 mil.
e. Weight: 34 lb/1000 sq. ft.
f. Tensile according to ASTM D 882: 300 lbf and 12,500 psi.

2.5 TAGS

A. Write-On Tags:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Carlton Industries, LP.
b. LEM Products Inc.
c. Seton Identification Products.

2. Specify thicker tags in "Polyester Tags" Subparagraph below where exposed to damage or rough service.
3. Polyester Tags: 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to raceway, conductor, or cable.
4. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.6 SIGNS

A. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.

2. Thickness:
   a. For signs up to 20 sq. inches, minimum 1/16-inch-.
   b. For signs larger than 20 sq. inches, 1/8 inch thick.
   c. Engraved legend with black letters on white face.
   d. Punched or drilled for mechanical fasteners.
   e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Brady Corporation.
   b. Carlton Industries, LP.
   c. Eemedco.
   d. Marking Services, Inc.

2.7 CABLE TIES

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

1. Ideal Industries, Inc.
2. Marking Services, Inc.
3. Panduit Corp.

B. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with

requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

C. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

D. Apply identification devices to surfaces that require finish after completing finish work.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

G. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 12 to 14 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

3.2 IDENTIFICATION SCHEDULE

A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase- and Voltage-Level] Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
   a. Color shall be factory applied, or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
   b. Colors for 240/120-V Circuits:
      1) Phase A: Black.
      2) Phase B: Red.

   c. Colors for 208/120-V Circuits:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.

   d. Colors for 480/277-V Circuits:
      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.

   e. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible

unwinding. Locate bands to avoid obscuring factory cable markings.

B. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

C. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.

E. Arc Flash Warning Labeling: Self-adhesive thermal transfer vinyl labels.

1. Comply with NFPA 70E and ANSI Z535.4.

F. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm unless equipment is provided with its own identification.

1. Labeling Instructions:
   a. Indoor Equipment: Engraved, laminated acrylic or melamine plastic label, punched or drilled for mechanical fasteners. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
   c. Unless labels are provided with self-adhesive means of attachment, fasten them with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment To Be Labeled:
   a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of an engraved, laminated acrylic or melamine label. Fasten to panel cover with screws or rivets.
   b. Enclosures and electrical cabinets.
   c. Enclosed switches.
   d. Enclosed circuit breakers.
   e. Contactors.

END OF SECTION 26 05 53

SECTION 26 09 23 LIGHTING CONTROLS AND DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following lighting control devices:

1. Occupancy and vacancy sensors.
2. Lighting control system.

1.2 REFERENCES

A. 2023 National Electrical Code (NEC) (NFPA 70).

B. 2021 IECC.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.4 SUBMITTALS

A. See Section 01 3000 – Administrative Requirements, for submittal procedures.

B. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, relays, manual switches and plates, and conductors and cables.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories

C. Shop Drawings:

1. Occupancy/vacancy sensors on drawings are shown to convey general intent for lighting control of spaces. Provide scaled drawings of the entire project and indicate the proper number and location(s) of occupancy/vacancy sensors, with coverage templates, to achieve desired control in each room with an occupancy sensor.
2. Show installation details for the following:

a. Occupancy sensors.
b. Vacancy sensors.

3. Drawings will detail all control scenarios included in the project.
4. Indicate a sequence of operation for all control scenarios, including manual on / auto off, auto on / auto off, sensor time delays, time schedules and control zones.

D. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals. Include as-built documentation of the system.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. All components shall be UL listed and meet all applicable state and locate code requirements.

B. Manufacturer shall substantiate conformance to this specification by supplying the necessary documents, performance data and wiring diagrams. Any deviations to this specification must be clearly stated by letter and submitted.

C. Do not install equipment until following conditions can be maintained in spaces to receive equipment:

1. Ambient temperature for outdoor devices: -40°F to 131°F.
2. Relative humidity: Maximum 90 percent, non-condensing.
3. Wireless lighting control system must be protected from dust during installation.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

B. Coordinate site commissioning with manufacturer no less than 21 days prior to required date

1.7 WARRANTY

A. See Section 01 7800 – Closeout Submittals, for additional requirements.

B. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

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

a. Faulty operation of lighting control devices.

2. Warranty Period: Two years from date of Substantial Completion.

C. Contractor shall warrant all equipment furnished in accordance with this specification to be undamaged, free of defects in materials and workmanship, and in conformance with specifications. The supplier’s obligation shall include repair or replacement and testing without

charge to the owner all or any parts of equipment which are found to be damaged, defective or non-conforming and returned to the supplier. The warranty shall commence upon the owner's acceptance of the project. Warranty on labor shall be for a minimum period of two years or longer if specified as such elsewhere in this specification.

PART 2 - PRODUCTS

2.1 MANUAL SWITCHES AND PLATES

A. Push-Button Switches: Modular, momentary contact, three wire, for operating one or more relays and to override automatic controls.

1. Match color and style specified in Section 262726 "Wiring Devices."
2. Retain both subparagraphs below if required.
3. Integral green LED pilot light to indicate when circuit is on.
4. Internal white LED locator light to illuminate when circuit is off.

B. Wall Plates: Single and multi-gang plates as specified in Section 262726 "Wiring Devices."

C. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.2 WIRELESS LIGHTING CONTROL SYSTEM

A. Basis of Design: Cooper Ephesus Airmesh.

B. The wireless lighting control system shall be capable of providing all of the following functions for all sports lighting fixtures:

1. Continuous dimming and automatic on/off controls.
2. Multi-level scene control.
3. Dim 10-100%.
4. Individual light fixture control.
5. Blackout.
6. Unlimited Programmable Static Scenes.
7. 7-Day scheduling.
8. Astronomic scheduling.
9. Mobile device configuration and control.
10. Alarms monitoring console.

C. Functionality - The wireless lighting control system shall:

1. Provide 5-button (minimum) hub with separate preprogrammed light control for each button.
2. Provide communication of all sensor and device data for all wireless devices. Web interface shall be accessed through direct wi-fi connection, through the internet via Ethernet or via built-in cellular.
3. Provide out-of-the-box functionality of all light fixtures with integrated sensors.

4. Include ability to schedule recurring events at fixed time or based on astronomical clock.
5. Provide ability to view light state (on/off/alarm) in graphical mat/satellite view.
6. Provide real-time monitoring of lighting status at fixture and system level, outage notifications.
7. Be able to be completely programmed and configured using a mobile application.

D. Wireless lighting control system includes the following components:

1. Integrated sensors shall include passive infrared sensor, digital photocell, microprocessor, a wireless radio (IEEE 802.15.4), and a load controller for ON/OFF/DIM.
2. Relay Switchpack with 0-10V control shall contain a utility grade power meter chip and a latching relay to control 20 amp load and 120mA 0-10V sink. Device shall include LED indication and pushbutton for device override and identification.
3. Wireless Area Controllers shall support the following features:

    a. Wirelessly communicate (IEEE 802.15.4) with all wireless sensors, wireless wall stations, wireless relays, and wireless receptacles to coordinate control areas and zones.
    b. Wired communications through network switch to touchscreen interface to coordinate control areas and zones.
    c. Power over Ethernet port to power the Wireless Area Controller and allow the connection of a Wireless Area Controller to a local area network (LAN).
    d. 802.11 radio acting as a Wi-Fi AP allowing a mobile device to connect to the Wireless Area Controller to program the lighting system.
    e. 802.11 radio acting as a wireless gateway allowing a mobile application or a supervisory system to communicate with the Wireless Area Controller via a wireless local area controller.
    f. Scheduling configuration.
    g. System backup and restore capabilities.

2.3 DIMMING

A. The contractor shall coordinate the dimming requirements with the lighting control system. Coordination of the devices will be the final responsibility of the contractor. No assumptions should be made in terms of the fixtures and controls indicated on the drawings. Drawings are provided to meet the design intent.

B. All dimmers will be de-rated to no more than 80% of the rated capacity.

2.4 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14

AWG. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panels according to NECA 407.

B. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

C. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.

D. Examine walls and ceilings for suitable conditions where lighting control devices and panels will be installed.

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

3.2 SENSOR INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. It is the contractor’s responsibility to arrange a pre-installation meeting with manufacturer's factory authorized representative, at owner's facility, to verify placement of sensors and installation criteria. Vacancy/occupancy sensors shall be located per the approved vendor submittals.

D. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

E. Set, program and adjust all devices as directed by the Owner.

F. Vacancy sensors will be programmed/installed as manual on/auto off. This shall include a low voltage switch when used in conjunction with a ceiling mounted sensor. Auto on will only be allowed under the exceptions sections of IECC section 405.2.2.2

G. Wall box sensors will be installed so that the majority of the sensor coverage is confined to the room and will provide 100% coverage of the room with minimal coverage of any adjacent corridor. Install manufacturer provided shielding to wallbox sensor switches as required to prevent false operation in locations such as office doors that remain open.

3.3 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install cables in raceways except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental airspaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

F. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

G. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 HUB INSALLATION

A. Comply with NECA 1.

B. Install panels, controls and accessories according to NECA 407.

C. Mount control cabinet plumb and rigid without distortion of box.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section “Identification for Electrical Systems."

1. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.

C. Lighting Control Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. The Contractor will set, test and verify the functionality of all lighting control components.

B. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device and adjust time delays.

C. Lighting control devices that fail tests and inspections are defective work.

3.7 COMMISSIONING

A. Prior to the installation of the system, a factory authorized service technician will meet on site with the electrical foreman for the project. At this meeting, the foreman will be provided a full set of approved lighting control drawings. The lighting control technician will review photocell placement, occupancy sensor requirements, switch locations, wiring requirements and any other information critical to the installation of the system.

B. Upon completion of the installation, the system shall be completely commissioned by the manufacturer's factory authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free lighting control system that meets the design intent of the construction documents.

C. In addition to requirements listed in this section, Commissioning shall include functional testing of all lighting controls in accordance with 2018 IECC C408.3, as well as all required IECC documentation.

D. The electrical contractor shall provide the manufacturer, the Owner, the Architect and the electrical engineer with ten working days written notice of the scheduled commissioning date. Upon completion of the system fine tuning, the factory authorized technician shall provide the proper training to the owner's personnel in the adjustment and maintenance of the sensors.

E. The manufacturer shall provide a factory authorized technician to confirm proper installation and operation of all lighting control system components.

F. The manufacturer shall provide a factory authorized technician to train owner personnel in the operation, programming and maintenance of the lighting control system. The contractor shall also provide, at the owner's facility, the training necessary to familiarize the owner's personnel with the adjustment, and problem-solving diagnosis of the system.

G. System Programming: The manufacturer shall provide system programming including:

1. Wiring documentation.
2. Switch operation.
3. Operating schedules, as confirmed by the Owner.

3.8 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system.

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

SECTION 26 22 00 LOW-VOLTAGE TRANSFORMERS

1.1 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
b. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Match panelboard manufacturer.

B. Source Limitations: Obtain each type of transformer from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.

C. Coils: Continuous windings without splices except for taps.

1. Coil Material: Aluminum.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Welded.

D. Enclosure: Ventilated.

1. Core and coil must be encapsulated within resin compound using vacuum-pressure impregnation process to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
3. Wiring Compartment: Sized for conduit entry and wiring installation.
4. Environmental Protection:

    a. Outdoor: UL 50E, Type 3R.

5. Finish Color: Gray weather-resistant enamel.

E. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.

F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

G. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.

H. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.

I. Low-Sound-Level Requirements: Maximum sound levels when factory tested in accordance with IEEE C57.12.91, as follows:

1. 9.00 kVA and Less: 40 dB(A-weighted).
2. 9.01 to 30.00 kVA: 45 dB(A-weighted).

2.4 IDENTIFICATION

A. Nameplates:

1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met.

E. Environment: Enclosures must be rated for environment in which they are located.

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

3.2 INSTALLATION

A. Install transformers level and plumb.

1. Coordinate installation of tructure-hanging supports with actual transformer provided.

B. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.

C. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Small (Up to 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection.

1) Inspect physical and mechanical condition.
2) Inspect anchorage, alignment, and grounding.
3) Verify that resilient mounts are free and that shipping brackets have been removed.
4) Verify that unit is clean.
5) Perform specific inspections and mechanical tests recommended by manufacturer.
6) Verify that as-left tap connections are as specified.
7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

1) Measure resistance at windings, taps, and bolted connections.
2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
3) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

B. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.

C. Nonconforming Work:

1. Transformer will be considered defective if it does not pass tests and inspections.
2. Remove and replace units that do not pass tests or inspections and retest as specified above.

3.5 ADJUSTING

A. Record transformer secondary voltage at unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals.

Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 00

SECTION 26 24 16 PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lighting and appliance branch-circuit panelboards.

1.2 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. MCCB: Molded-case circuit breaker.

1.3 SUBMITTALS

A. See Section 01 3000 – Administrative Requirements, for submittal procedures.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Panelboard Schedules: For installation in panelboards.

D. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

E. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panelboards for installation according to NEMA PB 1.

1.6 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
b. Altitude: Not exceeding 6600 feet.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.

D. Enclosures: Flush and Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

2. Height: 84 inches maximum.
3. Hinged Front Cover (Door-in-Door type): Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
4. Finishes:

a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

b. Back Boxes: Galvanized steel.

E. Phase, Neutral, and Ground Buses:

1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.

a. Plating shall run entire length of bus.
b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

F. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.

G. NRTL Label: Where indicated, panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices.

H. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.

1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.

2.2 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

1. Eaton Electrical Sector; Eaton Corporation.
2. Siemens Power Transmission & Distribution, Inc.
3. Square D; by Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. MCCB: Comply with UL 489, with series-connected rating or interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

a. Inverse time-current element for low-level overloads.
b. Instantaneous magnetic trip element for short circuits.

2. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Breaker handle indicates tripped status.
c. UL listed for reverse connection without restrictive line or load ratings.
d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
h. Multipole units enclosed in a single housing with a single handle.
i. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
j. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.4 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

D. Equipment Mounting:

1. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Mount top of trim 90 inches above finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box.

G. Install overcurrent protective devices and controllers not already factory installed.

1. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

H. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

I. Install filler plates in unused spaces.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 0553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Panelboards will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 24 16

SECTION 26 27 13 ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes equipment for electricity metering by utility company.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center according to NECA 400.

1.4 COORDINATION

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:

1. Comply with requirements of utilities providing electrical power services.
2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

A. Meters will be furnished by utility company.

B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

C. Meter Sockets: Comply with requirements of electrical-power utility company.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.

END OF SECTION 26 27 13

SECTION 26 27 26 WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Switches and wall-box dimmers.

1.2 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.3 SUBMITTALS

A. See Section 01 3000 – Administrative Requirements, for submittal procedures.

B. Product Data: For each type of product.

C. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
2. Hubbell Incorporated; Wiring Device-Kellems.
3. General Electric (GE)
4. Leviton Manufacturing Co., Inc.
5. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Tamper-Resistant Convenience Receptacles: Square face, 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
2. Standards: Comply with UL 498 and FS W-C-596.
3. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

B. Weather-Resistant Duplex Receptacle, 125 V, 20 A.

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498.
4. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

2.4 TAMPER-RESISTANT GFCI RECEPTACLES

A. General Description:

1. Straight blade, non-feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Square face, 125 V, 20 A, 5-20R
4. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

2.5 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Square face, specification grade, quiet-type, Single Pole, Two Pole, 3-Way and 4-Way:

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

1) Eaton (Arrow Hart).
2) General Electric (GE).
3) Hubbell Incorporated; Wiring Device-Kellems.
4) Leviton Manufacturing Co., Inc.
5) Pass & Seymour/Legrand (Pass & Seymour).

C. Single-Pole Timer Switches: 1000W, 120V AC, 60Hz, Single-Pole, Decora-style, four presets in 2-5-10-15 minute increments. Leviton, no equals allowed.

2.6 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material: 0.035-inch thick, satin-finished stainless steel.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant. Cover shall comply with NEC and maintain wet-location listing while device(s) is(are) plugged in. Coverplate shall be compatible with exterior receptacle box. Refer to Section 26 0533 “Raceways and Boxes for Electrical Systems.”

2.7 FINISHES

A. Device & Wall Plate Colors:

1. Wiring Devices and Wall Plates: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

D. Device Installation:

1. Provide tamper resistant receptacles in all areas.
2. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
3. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
4. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
5. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
6. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
7. Use a torque screwdriver when a torque is recommended or required by manufacturer.
8. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
9. Tighten unused terminal screws on the device.
10. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Group adjacent switches under single, multigang wall plates.

3.2 IDENTIFICATION

A. Comply with Section 26 05 53 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use permanent marker on back of faceplate and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Replace damaged or defective components.

END OF SECTION 26 27 26

SECTION 26 28 13 FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Report Documentation
   1. City of Arvada Standards.
      a. If there are any discrepancies between the City of Arvada's standard specifications and these specifications, the City's standards shall take precedence.
   2. All products and product procurement must comply with 2 CFR 200.322 – Domestic preferences for procurements as required by Build America, Buy America Act (BABA).
      a. Reference part 184 of 2 CFR for definitions for key terms, including iron or steel products, manufactured products, construction materials, and materials identified in section 70917(c) (section 70917(c) materials) of BABA.

1.2 SUMMARY

A. Section Includes:
   1. Cartridge fuses rated 600 V ac and less for use in enclosed switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles. Include the following for each fuse type indicated:
   1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Ambient temperature adjustment information.
   2. Current-limitation curves for fuses with current-limiting characteristics.
   3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit.
   4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than

three of each size and type.

1.6 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bussmann, an Eaton business.
2. Edison; a brand of Bussmann by Eaton.
3. Littelfuse, Inc.
4. Mersen USA.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to

fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Motor Branch Circuits: Class RK1, time delay, unless otherwise recommend by equipment manufacturer.
   2. Other Branch Circuits: Class RK5, time delay.
   3. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 28 16 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers (MCCBs).
4. Enclosures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with NFPA 70.

2.2 FUSIBLE SWITCHES

A. Manufacturer: Match panelboard manufacturer.

B. Type HD, Heavy Duty:
   1. Single throw.
   2. Three pole.
   3. 600-V ac.
   4. 1200 A and smaller.
   5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses.
   6. Lockable handle with capability to accept three padlocks and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Hookstick Handle: Allows use of a hookstick to operate the handle.
   4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

A. Manufacturer: Match panelboard manufacturer.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Hookstick Handle: Allows use of a hookstick to operate the handle.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturer: Match panelboard manufacturer.

B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated. Circuit breaker/circuit breaker MCCBs shall be equipped with a device for locking in the isolated position.

E. Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.

F. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

G. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

H. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

I. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1) or gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (NEMA 250 Types 3R).

C. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the front cover of the enclosure (NEMA 250 Type 1) or directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.

3.3 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NFPA 70 and NECA 1.

3.4 IDENTIFICATION

A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections for Switches:
1. Visual and Mechanical Inspection:
   a. Inspect physical and mechanical condition.
   b. Inspect anchorage, alignment, grounding, and clearances.
   c. Verify that the unit is clean.
   d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
   e. Verify that fuse sizes and types match the Specifications and Drawings.
   f. Verify that each fuse has adequate mechanical support and contact integrity.
   g. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

C. Tests and Inspections for Molded Case Circuit Breakers:
1. Visual and Mechanical Inspection:
   a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
   b. Inspect physical and mechanical condition.
   c. Inspect anchorage, alignment, grounding, and clearances.
   d. Verify that the unit is clean.
   e. Operate the circuit breaker to ensure smooth operation.
   f. Inspect operating mechanism, contacts, and chutes in unsealed units.
   g. Perform adjustments for final protective device settings in accordance with the coordination study.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

END OF SECTION 26 28 16

SECTION 26 56 00 EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior sold-state luminaires that are designed for and exclusively use LED lamp technology.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. Fixture: See "Luminaire."

D. Lumen: Measured output of lamp and luminaire, or both.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

F. Pole: Luminaire support structure.

1.3 SUBMITTALS

A. See Section 01 3000 – Administrative Requirements, for submittal procedures.

B. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

D. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Provide luminaires for a single manufacturer for each luminaire type.

B. Each LED luminaire type shall be binned within a three-step MacAdam Ellipse minimum to ensure color consistency among luminaires.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with IEEE C2, "National Electrical Safety Code."

E. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.6 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect and/or Landscape Architect prior to the start of luminaire installation.

1.7 WARRANTY

A. See Section 01 7800 – Closeout Submittals, for additional warranty requirements.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

C. Lateral Light Distribution Patterns: Comply with IES RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

D. LED: Bulb shape complying with ANSI C79.1 L70 lamp life of minimum 50,000 hours. Internal driver.

E. Shall comply with guidelines set forth in Darksky approved luminaires program version 3.0 published by Darksky International.

2.2 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated on Drawings.

2.3 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Ballast shall automatically disconnect when door opens.

D. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

E. Lens and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY," including specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRLI for all luminaires.

2.4 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, and canopy ceilings for suitable conditions where luminaires will be installed.

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls or attached to a minimum 1/8-inch backing plate attached to wall structural members.

G. Wiring Method: Install cables in raceways. Conceal raceways and cables.

H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.

I. Coordinate layout and installation of luminaires with other construction.

J. Adjust luminaires that require field adjustment or aiming.

K. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables" and 26 0533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.3 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 26 0533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

C. Illumination Tests:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

E. Luminaire will be considered defective if it does not pass tests and inspections.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to one visit to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 26 56 00

SECTION 26 56 13 LIGHTING POLES AND STANDARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Poles and accessories for support of luminaires.

1.2 DEFINITIONS

A. EPA: Equivalent projected area.

B. Luminaire: Complete lighting fixture.

C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.

1.3 SUBMITTALS

A. See Section 01 3000 – Administrative Requirements, for submittal procedures.

B. Product Data: For each pole, accessory, and luminaire-supporting device, arranged as indicated.

1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
2. Include finishes for lighting poles and luminaire-supporting devices.

C. Operation and Maintenance Data: For poles to include in emergency, operation, and maintenance manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on poles until right before pole installation. Handle poles with web fabric straps.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.2 STEEL POLES

A. Manufacturers: Subject to compliance with requirements, provide products by exterior lighting manufacturer.

B. Source Limitations: Obtain poles from single manufacturer or producer.

C. Poles: Comply with ASTM A 500/A 500M, Grade B carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.

1. Shape: See light fixture schedule.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

D. Fasteners: Stainless steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1. Materials: Compatible with poles and standards as well as the substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

E. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size indicated, and accessible through handhole.

F. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

G. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces according to SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high gloss, high-build polyurethane enamel.

    a. Color: As indicated by manufacturer's designations.

2.3 POLE ACCESSORIES

A. Duplex Receptacle (where indicated on drawings): Ground-fault circuit interrupter type, 120 V ac, 20 A in a weatherproof assembly. Comply with requirements in Section 26 2726

"Wiring Devices."

1. Surface mounted 12 inches above finished grade.

    a. NEMA 250, Type 3R, nonmetallic polycarbonate plastic or reinforced fiberglass, enclosure with cover; color to match pole.
    b. Lockable hasp and latch complying with OSHA lockout and tag-out requirements.

2.4 MOUNTING HARDWARE

A. Anchor Bolts: Manufactured to ASTM F 1554, Grade 55, with a minimum yield strength of 55,000 psi.

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
2. Threading: Uniform National Coarse, Class 2A.

B. Nuts: ASTM A 563, Grade A, Heavy-Hex

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.

C. Washers: ASTM F 436, Type 1.

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.

2.5 GENERAL FINISH REQUIREMENTS

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

B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine poles, luminaire-mounting devices, lowering devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.

C. Examine roughing-in for foundation and conduit to verify actual locations of installation.

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

3.2 POLE FOUNDATION

A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123 M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

B. Pre-Cast Foundations: Factory fabricated, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor Bolts: Install plumb using manufacturer-supplied template, uniformly spaced.

3.3 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.

1. Fire Hydrants and Water Piping: 60 inches.
2. Water, Gas, Electric, Communications, and Sewer Lines: 10 feet.
3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
3. Install base covers unless otherwise indicated.
4. Use a short piece of 1/2 -inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a

dissimilar metal, protect aluminum using insulating fittings or treatment.

B. Steel Conduits: Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

3.5 GROUNDING

A. Ground Metal Poles and Support Structures: Comply with requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

END OF SECTION 26 56 13

THE GARDEN SPOT – Berthoud Arboretum

TECHNICAL SPECIFICATIONS

SECTION 31 1000 – SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Protecting existing trees, shrubs, groundcovers, plants, grass, and other vegetation to remain or as designated by Owner in pre-construction conference.
2. Removing existing trees, shrubs, groundcovers, plants, grass, and other vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and abandoning site utilities in place removing site utilities.
7. Removing existing fill.

B. Related Sections include the following:

1. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
2. Division 31 Section “Temporary Erosion and Sedimentation Control” for storm water erosion and sediment mitigation.
3. Division 01 Section “Tree Retention and Protection”.

1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

B. Tree Protection Zone: The Tree Protection Zone shall be the area below ground and the space above ground, equal to one and one-half foot (1.5’) radius from the base of the tree’s trunk for each one (1”) inch of the tree’s diameter at four and one-half feet (4.5’) above grade (referred to as diameter at breast height).

1. With groups of trees, there may be discontinuous (non-overlapping) perimeters of Tree Protection Zones which result in difficult to maintain or ineffective tree protection fencing. In these cases, if the distance between the perimeters of such areas is less than thirty feet (30), they should be treated as one contiguous Tree Protection Zone. In effect, this will

enlarge the area of tree protection but will result in a more clearly defined and manageable area.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to be stockpiled or to remain on Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Record drawings, identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions. Information required may also be included in Division 1 Section "Project Record Documents."

1.6 QUALITY ASSURANCE

A. Preconstruction Conference: Conduct conference at Project site as directed by Owner's Representative prior to start of construction. Contractor to comply with requirements, which may also be included in Division 1 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing indicated removal and alteration work on property adjoining Owner's property will be obtained by Owner before award of Contract. Authority and permits for performing indicated removal and alteration work on adjacent rights-of-way shall be obtained by Contractor.

1. Do not proceed with work on adjoining property until directed in writing by Owner's Representative.

C. Protect improvements on adjacent and Owner's property.

D. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

E. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

F. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

G. Restore damaged improvements to their original condition, as acceptable to parties having jurisdiction.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving," (PART 2 – PRODUCTS).

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks, survey control points, monuments, property line pins and other reference points from disturbance during construction. If disturbed or destroyed, restore or replace at no cost to Owner.

B. Provide erosion control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust from leaving project site.

C. Locate and clearly flag trees and vegetation to remain or to be relocated.

D. Protect existing site improvements to remain from damage during construction.

1. Restore or replace damaged improvements to their original condition, as acceptable to Owner.

3.2 UTILITIES

A. Contractor will locate, identify, arrange for disconnect and seal or cap off utilities indicated to be removed before site clearing.

1. Verify that utilities indicated as abandoned have been disconnected and capped before proceeding with site clearing.
2. Arrange with utility companies having jurisdiction to shut off indicated utilities.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner’s Representative not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner’s Representative’s written permission.

C. Excavate for and remove underground utilities indicated to be removed.

D. Removal of underground utilities may also be included in Division 2 Sections covering site utilities.

E. After removal of underground utilities, as indicated, properly cap and/or plug existing lines to remain in accordance with authorities having jurisdiction.

3.3 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Cut roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
3. Grind stumps and completely remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
4. Use only hand methods for grubbing within critical root zone of remaining trees.
5. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earth moving is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.4 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered or as determined by Geotechnical Engineer in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Limit height of topsoil stockpiles to 72 inches unless authorized by Owner's Representative.
2. Do not stockpile topsoil within critical root zone of remaining trees.
3. Stockpile surplus topsoil to allow for respreading a thicker layer of topsoil.

3.5 SITE IMPROVEMENTS

A. Remove existing above and below grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated on plans.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

C. Remove existing fill. Refer to Geotechnical Investigation and/or drawings for information regarding suitability for re-use and estimates of location/extent of existing fill.

3.6 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

1. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION 31 1000

THE GARDEN SPOT – Berthoud Arboretum

TECHNICAL SPECIFICATIONS

SECTION 31 2000 – EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, specification sections, apply to this section.

B. Additional information concerning earth moving may be found on the civil drawings, in the Project Geotechnical Report and Town of Berthoud construction standards. In case of conflict between the drawings, jurisdictional criteria, and the information specified herein, the more stringent requirements shall govern.

C. Additional information concerning earth moving may be found in the geotechnical investigation report by Berthoud Arboretum at Waggener Farm Park, Prepared by Rocksol Consulting Group, Inc., dated August 5, 2024. All applicable recommendations of this report shall be followed unless otherwise noted. Contractor to confirm with geotechnical engineer recommendations prior to the commencement of any earth moving activities. The information shown in this report is for information and it shall be the Contractor's responsibility to field verify conditions indicated.

1.2 SUMMARY

A. This Section includes the following:

1. Preparing and grading subgrades for slabs-on-grade, walks, pavements, lawns and grasses, and exterior plants.
2. Excavating and backfilling for buildings and structures, including over-excavation of existing unsatisfactory on-site soil materials and replacement with structural fill.
3. Drainage course for slabs-on-grade.
4. Base course for asphalt or concrete paving.
5. Subsurface drainage backfill for walls and trenches.

B. Related Sections include the following:

1. Division 31, Section "Site Clearing" site stripping, grubbing, stripping and stockpiling topsoil, and removal of above-grade and below-grade improvements and utilities.
2. Division 31, Section "Trenching and Backfilling" for excavating and backfilling of utilities.
3. Division 31, Section "Temporary Erosion and Sedimentation Control" for erosion and sedimentation control measures.

C. References:

1. Americans with Disabilities Act ("ADA"); Architectural Barriers Act Accessibility Standard- ABAAS as provided for in the regulations of the United States Access Board
2. Uniform Federal Accessibility Standards (UFAS)
3. American National Standards Institute (ANSI) - *ANSI A117.1*
4. United States Department of Transportation and Federal Highway Administration accessibility standards principally listed in 2010 ADA Standards for Accessible Design and Proposed Guidelines for Pedestrian Facilities in the Public Right of Way Accessibility Guidelines ("PROWAG")
5. Local Jurisdiction Having Authority – standards, rules and regulations.

D. Permits and Fees: Obtain and pay for all permits and fees required for the work of this section, including erosion and sediment control and water quality permits required by the Town of Berthoud and the Colorado Department of Public Health and Environment, Water Quality Control Division.

1.3 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill approved by the Geotechnical Engineer.

E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of all material of various characteristics required for the work encountered above subgrade elevations and to lines and dimensions indicated, including boulders. See Section 3.4 "EXCAVATION, GENERAL" for definition of unclassified and classified excavation.

G. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions, as directed or approved by the Owner's Representative and the testing and inspections agency to correct unsatisfactory conditions. Authorized additional excavation and replacement material will be paid for according to contract provisions for changes in the work.

H. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.

I. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by the Owner's Representative. Unauthorized excavation, including disposition of over-excavated materials and other work resulting from slides, cave-ins, swelling,

upheaval, or remedial work, as well as remedial work directed by the Owner's Representative, shall be without additional compensation.

J. Fill: Fill is all material placed to raise the grade of the site or to backfill excavation, upon which the Geotechnical Engineer has made sufficient tests and observations to enable him/her to issue a written statement that, in his/her opinion, the fill has been placed and compacted in accordance with the requirements of these specifications.

K. Structural Fill: Select granular material for use below floor slabs and to 5 feet beyond the building lines. On-site material may be used if approved by the Geotechnical Engineer.

L. Underslab Gravel: Imported Class 6 road base per Colorado Department of Transportation Standard Specifications for Road and Bridge Construction (current addition) or material approved by the Geotechnical Engineer.

M. Rock Excavation: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for Bulk Excavation or 3/4 cu. yd. for footing, trench, and pit excavation which in the Geotechnical Engineer's opinion cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,090 lbf and stick-crowd force of not less than 18,650 lbf; measured according to SAE J-1179.
2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 210-hp flywheel power and developing a minimum of 48,510-lbf breakout force with a general-purpose bare bucket; measured according to SAE J-732.

N. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

O. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

P. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

Q. Utilities: Include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Material Test Reports: Provided by the Contractor from a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D2487 of each on-site or borrow soil material proposed for fill and backfill.

2. Laboratory compaction curve according to ASTM D698 for each on-site or borrow soil material proposed for fill and backfill.

B. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.5 QUALITY ASSURANCE

A. Comply with applicable codes, ordinances, regulations, references, and standards in effect at bid date:

1. International Building Code (IBC) per jurisdiction criteria.
2. American Society for Testing and Materials (test methods as specified hereafter) (ASTM).
3. State and local codes.

B. In case of conflict between the above codes, regulations, references and standards, and these specifications, the more stringent requirements shall govern.

C. Testing Agency: The Owner will employ a qualified independent geotechnical testing agency. The Contractor shall furnish testing agency access to work, facilities and incidental labor required for testing. Notify the testing and inspection agency not less than 48 hours in advance of all work requiring testing.

D. Geotechnical Engineer: All materials and operations under this section of the specifications shall be executed under the supervision of a Geotechnical Engineer who will place qualified personnel on the site during earth moving operations as necessary.

The Geotechnical Engineer shall approve all foundation excavations and give written approval of the completed foundations to the Owner's Representative at the following times:

1. When excavations are first open.
2. Just prior to placing of concrete, shall test and control the fill compaction, approve the materials and method of placing and compacting and give written approval to the Owner's Representative that all bearing surfaces and fill requirements have been inspected.
3. The Contractor shall be responsible to notify the Geotechnical Engineer when tests are to be made.

E. For approval of imported or on-site fill material, notify the Geotechnical Engineer at least four working days in advance of intention to import material, designate the proposed borrow area, and permit the Geotechnical Engineer to sample, as necessary, from the borrow area for the purpose of making acceptance tests to prove the quality of the material. The Geotechnical Engineer report on the acceptability shall be final and binding.

F. Reference Standards:

1. Compaction Standard: Standard Proctor Density ASTM D698.

G. Preconstruction Conference: Conduct conference at Project site as directed by the Owner's Representative prior to start of construction. The Contractor is to comply with requirements.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Locations, sizes and depths, or invert elevations of existing utilities, as shown on the drawings, are based on information provided by others and believed to be correct but may not be absolutely so. Such information is therefore presented only as approximations and should be verified prior to construction. Protect from damage any sewer, water, gas, electric, phone, or other pipe lines or conduits uncovered during the work until they have been examined by the Owner's Representative. If such lines are found to be abandoned and not in use, remove affected sections without extra cost. If such lines are found to be in use, carefully protect and carry on work around them. If the Owner's Representative deems it advisable to move such lines, the Owner will pay cost of moving. Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted in writing by the Owner's Representative and then only after arranging to provide temporary utility services according to requirements indicated.

1. Contact utility-locator service for area where project is located before excavating.
2. Notify the Owner's Representative not less than two days in advance of proposed utility interruptions.
3. Do not proceed with utility interruptions without the Owner's Representative’s written permission.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

C. Remove all existing fill deemed by the Geotechnical Engineer to be unsatisfactorily placed.

D. Existing Contours and Elevations: Contours and spot elevations of existing ground elevations at the site, and approximate elevations of finish-grade cuts, fills, and excavations for the work are shown on the drawings. Contours and elevations for existing ground lines are based on information provided by others, and are believed to be correct, but may not be absolutely so. Existing contours and elevations should therefore be considered approximate and should be verified at the site prior to construction.

E. Verification of Existing Conditions: Visit the site prior to submission of bids. Verify existing conditions, elevations, and contours. In the event of discrepancies between existing conditions and those indicated on the contract documents or survey, contact the Owner's Representative for clarification.

F. Existing Benchmarks: Carefully preserve and maintain existing benchmarks, monuments, property line pins, and other reference points. if disturbed or destroyed, restore or replace by a professional land surveyor at no additional cost to the Owner.

G. Frost Protection: When freezing temperatures may be expected, do not excavate to the full depth indicated unless the footing or slabs are to be poured immediately after the excavation has been completed. If placing of concrete is delayed, protect the bottoms of excavations from frost and snow until concrete is placed.

1.7 WARRANTY

A. Settlement in backfill, fill, or in structures built over backfill or fill, which may occur within the specified project warranty period, shall be corrected at no cost to the Owner. Any structures damaged by settlement shall be restored to their original condition by the Contractor, at no cost to the Owner.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Shall meet approval of the Geotechnical Engineer and shall be free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Clean, on-site, natural soils, or imported materials, as approved by the Geotechnical Engineer.

C. Unsatisfactory Soils: Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups, as identified by the Geotechnical Engineer.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Backfill and Fill: Approved by the Geotechnical Engineer.

E. Structural Fill: Approved by the Geotechnical Engineer.

F. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

G. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

H. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

I. Drainage Course: Narrowly graded mixture of washed crushed stone or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

J. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

K. Sand: ASTM C33; fine aggregate, natural, or manufactured sand.

L. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Subsurface Drainage and Separation Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M288. Utilize Mirafi 140N or as recommended by Geotechnical Engineer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, vegetation not to be removed, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Preparation of subgrade for earth moving operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31, Section “Site Clearing.”

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31, Section “Temporary Erosion and Sediment Control,” during earth moving operations. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil bearing water runoff or airborne dust to adjacent properties and rights-of-way.

D. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials, as necessary.

E. Cold Weather Work: Prevent frost from entering bearing stratus upon which construction will take place or in areas where fill will be placed in that season.

3.2 DEWATERING

A. Prevent surface water and subsurface ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey groundwater away from excavations. Maintain until dewatering is no longer required.
3. Obtain and comply with all provisions of the Colorado Department of Public Health and Environment, Water Quality Control Division, Construction Dewatering Permit.

C. Protection of Persons and Property:

1. Provide all necessary measures to protect workmen and passersby. Barricade open excavations occurring as part of the work, as required by municipal or other authorities having jurisdiction.
2. Protect adjacent streets, roadways, and properties throughout the entire operation. Protect newly graded areas from destruction by weather or runoff. Protect structures, utilities, sidewalks, pavements, and other improvements from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: All excavation (other than rock excavation) is considered as unclassified and is defined as removal of all material encountered, regardless of soil type. Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include soil materials, and obstructions. Unclassified excavation is considered normal excavation and no extra costs will be allowed.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove material of every nature or description encountered in obtaining required lines and grades. Excavate and/or place and compact fill to provide for building pad elevation(s) required by drawings.
3. Excavate wide enough at foundations and retaining walls to permit erection and removal of forms, application of dampproofing or waterproofing.
4. Pitch grading around excavations to prevent water from running into excavated areas.
5. Pre-rip hardpan and soft bedrock with single-tooth ripper or other suitable equipment to facilitate excavation with conventional earth-moving equipment.
6. Bearing soils disturbed by excavating equipment must be recompacted to 95 percent of maximum Standard Proctor Density (ASTM D698) prior to placing concrete.
7. Exposed areas which will receive fill once properly cleaned, shall be scarified to a minimum depth of 8 inches, conditioned to near optimum moisture content, and compacted.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth excavation and rock excavation. Do not excavate rock until it has been classified and cross sectioned by the Owner's Representative.

1. Earth excavation includes excavating pavements and obstructions visible on surface, underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

    a. Intermittent drilling; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

C. Stability:

1. Slope sides of excavations in compliance with OSHA requirements and local codes or ordinances, with a maximum slope of 1:1 (H:V) or as recommended by the Geotechnical Engineer. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
2. Continuously monitor cut slopes for distress. Take all necessary precautions to safeguard workers, structures, and utilities.
3. Provide all necessary shoring, sheeting, or bracing of sides of excavations required to prevent caving, erosion, and gullying. Provide underpinning of existing structures or other improvements adjacent to excavations which are subject to damage.

D. Unanticipated Conditions: Notify the Owner's Representative immediately upon finding evidence of previous structures or filled materials which penetrate below designated excavation levels, groundwater or water-bearing strata, or other conditions which are not shown, or which cannot be reasonably assumed from existing surveys and geotechnical reports. Secure the Owner's Representative instruction before proceeding with further work in such areas.

E. Rock Excavation: Includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction. Rock excavation in unconfined areas is defined as removal and disposal of material which in the Geotechnical Engineer’s opinion, cannot be excavated without continuous and systematic drilling and blasting, or continuous use of a suitable ripper or other special equipment.

1. Unanticipated Rock Excavation: Rock excavation that is not indicated on existing surveys or which cannot be reasonably assumed from geotechnical studies of the site and which could not have been anticipated without extensive investigations. Unanticipated rock excavation shall be subject to change order procedures or previously agreed upon unit prices.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 0.10 feet. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb the bottom of excavation. Excavate by hand to final-grade before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Pile Foundations: Stop excavations 6 inches to 12 inches above the bottom of the pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final-grade, leaving solid base to receive concrete pile caps.
3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1-inch. Do not disturb bottom of excavations intended as bearing surfaces.
4. Excavation Below Slab on Grade, or Walks, or Pavement: Over-excavate within the proposed footprint of the building slab-on-grade to a minimum depth as recommended in Geotech Report and replace with on-site or imported materials as approved by the Geotechnical Engineer.

B. Existing man-made fill shall be removed under structures, as required by the Geotechnical Engineer.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

B. Scarify subgrade soils beneath exterior slabs, sidewalks, and pavements to a minimum depth of 8 inches, moisture condition and recompact, as specified.

C. Existing man-made fill shall be removed under walks and pavements, as required by the Geotechnical Engineer.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Refer to Division 31, Section “Trenching and Backfilling,” for excavating and backfilling of utilities.

3.8 SUBGRADE INSPECTION

A. Notify the Geotechnical Engineer when excavations have reached required subgrade.

B. If the Owner's Representative and Geotechnical Consultant determine that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Remove and replace soft areas. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Owner's Representative, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to contract provisions for changes in the work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Owner's Representative, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2,500 psi, may be used when approved by Geotechnical Engineer. If approved by the Geotechnical Engineer, structural fill placed at 100 percent ASTM D698, 2 percent below to 1 percent above optimum moisture may be used.

1. Fill unauthorized excavations under other construction or utility pipe, as directed by the Owner's Representative.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials in approved locations without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below-finish-grade, including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for record documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
8. Acceptance of subgrade by the Geotechnical Engineer.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Refer to Division 31, Section “Trenching and Backfilling,” for excavating and backfilling of utilities.

3.13 SOIL FILL

A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.

1. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
2. In areas of fill, scarify natural soil following removal of unsatisfactory material, to a depth of 8 inches.

B. Place and compact fill material in layers to required elevations per the geotechnical report and as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill or structural fill, as approved by the Geotechnical Engineer.

4. Under building slabs, use engineered fill or reconditioned on-site soils or imported fills of native soils, as approved by the Geotechnical Engineer.
5. Under footings and foundations, use engineered fill or reconditioned on-site soils or imported fills of native soils as approved by the Geotechnical Engineer.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to optimum or to 3 percent over optimum moisture content for clay soils, or within 2 percent of optimum moisture content for granular soils. Refer to the geotechnical study for additional recommendations.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content beyond the tolerances described above and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D698:

1. Under exterior flatwork, slabs, steps, and pavements, scarify and recompact top 8 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Underfootings and interior floor slabs, excavate to approved natural soils, in fill condition, compact to 95 percent.
3. Under lawn or unpaved areas, scarify and recompact top 6 inches below-subgrade and compact each layer of backfill or fill soil material at 90 percent.
4. Compact foundation wall backfill to 95 percent.
5. Compact scarified subgrade soils to 95 percent.
6. Compact retaining wall backfill to 95 percent.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Grading tolerances identified herein apply to non-accessible routes, unless within this paragraph or specifically stated. Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 0.10 feet.
2. Walks: Plus or minus 0.10 feet.
3. Pavements: Plus or minus 0.10 feet.
4. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

C. Accessible Routes: For accessible routes, finished construction of accessible areas to meet published values for dimension and slope. **No tolerance** is permitted below minimum or above maximum values and must meet accessible requirements such as ADA, ANSI A117.1 and as provided for in regulations of the United States Access Board, the United States Department of Transportation and Federal Highway Administration which requirements are principally listed in 2010 ADA Standards for Accessible Design, Proposed Guidelines for Pedestrian Facilities in the Public Right of Way Accessibility Guidelines ("PROWAG") and Local standards. All construction or alterations of accessibility routes (walks, ramps, entrances, etc.) shall comply with standards, rules and regulations set forth above, including but not limited to 5% maximum longitudinal grade on walks without handrails, 8.33% maximum longitudinal grade on walks with handrails, and landings 2% maximum composite slope. 2% maximum cross slope on walks, and 2% maximum composite slope in handicap parking/loading areas. No tolerance regarding maximum slope will be allowed.

Prior to construction, contractor shall coordinate as necessary with Owner/Developer, Engineer, Architect or designated official if rules and regulations of accessibility routes cannot be met or a discrepancy of requirements are indicated on drawings.

3.17 BASE COURSES

A. Place base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place base course under pavements and walks as follows:

1. Install separation geotextile, if requested by Geotechnical Engineer, on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape base course to required crown elevations and cross-slope grades.
4. Place base course 6 inches or less in compacted thickness in a single layer.
5. Place base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
6. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

C. Pavement Shoulders: Place shoulders along edges of base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.18 DRAINAGE COURSE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile, if required by the Geotechnical Engineer, on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.19 FIELD QUALITY CONTROL

A. Testing Agency: The Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow the testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test the results for the previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Owner's Representative.

D. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, and ASTM D 2937, as applicable. Perform field moisture tests in accordance with ASTM D6031. Tests will be performed at the following locations and frequencies at a minimum:

1. Sidewalks, Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2,000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for each 100 feet or less of wall length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.20 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by the Owner's Representative; reshape and recompact.

C. Where settling occurs before the Project correction period elapses, remove finished surfacing and backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off the Owner’s property.

END OF SECTION 31 2000

THE GARDEN SPOT – Berthoud Arboretum

TECHNICAL SPECIFICATIONS

SECTION 31 2333 – TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Additional information concerning trenching and backfilling may be found on the civil drawings, in the project geotechnical study/report and Town of Berthoud construction standards. In case of conflict between the drawings, jurisdictional criteria and the information specified herein, the more stringent requirements shall govern.

C. Additional information concerning earthwork may be found in the geotechnical investigation report by Berthoud Arboretum at Waggener Farm Park, prepared by Rocksol Consulting Group, Inc, dated August 5, 2024. All requirements of this report shall be followed unless noted otherwise. The information shown in this report is for information and it shall be the Contractor's responsibility to field verify conditions indicated.

1.2 SUMMARY

A. This Section includes the following:

1. Subsurface drainage backfill for walls and trenches.
2. Excavating and backfilling for utility trenches.
3. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.
4. Excavating and backfilling trenches within building lines.

B. Related Sections include the following:

1. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2. Division 31 Section "Earth Moving" for soil materials, site excavating, filling and grading.
3. Division 31 Section "Temporary Erosion and Sedimentation Control" for erosion and sediment control.
4. Divisions 22, and 26 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures, if available.
5. Division 33 Section "Water Utility Distribution Piping" for water main installation.
6. Division 33 Section "Storm Utility Drainage Piping" for storm sewer system installation.
7. Division 33 Section "Sanitary Utility Sewerage Piping" for sanitary sewer main installation.

C. Shoring Design: Provide the services of a professional engineer to design all shoring, bracing, and underpinning required to protect the safety of workers and integrity of adjacent existing structures or other improvements.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as backfill approved by Geotechnical Engineer.

E. Unclassified Excavation: Removal of all material of whatever-character required for the work encountered above subgrade elevations and to lines and dimensions indicated, including boulders.

F. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed or approved by Owner's Representative and the testing and inspections agency to correct unsatisfactory conditions. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

G. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.

H. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Owners Representative. Unauthorized excavation including disposition of overexcavated materials and other work resulting from slides, cave-ins, swelling, upheaval, or remedial work, as well as remedial work directed by Owners Representative, shall be without additional compensation.

I. Rock Excavation: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,090 lbf and stick-crowd force of not less than 18,650 lbf; measured according to SAE J-1179.
2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 210-hp flywheel power and developing a minimum of 48,510-lbf breakout force with a general-purpose bare bucket; measured according to SAE J-732.

J. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

L. Utilities: Includes on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

M. Controlled Low Strength Material (CLSM): Controlled Low Strength Materials (CLSM) consists of a well-graded mixture of mineral aggregates, cementitious materials, water and admixtures. Other common names for CLSMs include: flowable fill, flowfill, non-shrink backfill, fly ash fill and controlled density fill.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Each type of plastic warning tape.

B. Samples: Contractor to submit representative samples of all materials proposed for use in bedding and trench backfilling operations to the testing and inspections agency for analysis and determination of compliance with the requirements specified herein.

C. Material Test Reports: Provided by Contractor from a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D 698 for each on-site or borrow soil material proposed for fill and backfill.

D. Pre-Excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

E. CLSM: The Contractor will be required to submit a mix design and test data for approval, prior to excavating the area for which CLSMs are proposed for use. All materials of this category placed without previous approval, or which do not perform as specified, will be rejected by the Owner and all costs incurred for removal and replacement of these materials will be at the Contractor’s expense.

1.5 QUALITY ASSURANCE

A. Testing Agency:

1. All testing and inspections required herein will be performed by an independent testing and inspection agency employed by the Owner.
2. Notify the testing and inspection agency not less than 48 hours in advance of all work requiring testing or inspection services.

B. Regulatory Requirements: Comply with all applicable requirements of the Occupational Safety and Health Administration and local and State rules, regulations, and ordinances concerning shoring, bracing, or sloping of excavations and safety of workers. Safety of workers is the responsibility of the Contractor.

C. Coordination: Coordinate scheduling and procedures for trench excavation, bedding, and backfilling with other Sections whose work relates to or is affected by this work.

D. Pre-Construction Conference: Conduct conference at Project site as directed by Owner's Representative prior to start of construction. Contractor to comply with requirements, which also may be included in Division 1 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS

A. Existing Utilities: Locations, sizes and depths or invert elevations of existing utilities as shown on the drawings are based on information provided by others, and are believed to be correct, but may not be absolutely so. Such information is therefore presumed only as approximations and should be verified prior to construction. Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Owner's Representative and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Owner's Representative not less than two (2) days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner's Representative's written permission.
3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

C. Existing Bench Marks: Carefully preserve and maintain existing bench marks, monuments, property line pins, and other reference points. If disturbed or destroyed, restore or replace them at no additional cost to the Owner.

D. Verification of Existing Conditions: Visit the site prior to submission of bids. Verify existing conditions, elevations, and utility locations. In the event of discrepancies between existing conditions and those indicated on the Contract Documents or survey, contact the Owner's Representative for clarification.

1.7 WARRANTY

Settlement in backfill, fill or in structures built over backfill or fill, which may occur within the specified project warranty period, shall be corrected at no cost to the Owner. Any structures damaged by settlement shall be restored to their original condition by the Contractor, at no cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Utility Trench Bedding Materials:

1. Agency Requirements: Bedding requirements shall be in accordance with jurisdiction having control over utility.

B. Utility Trench Backfill Materials:

1. Existing soils obtained from trench excavations, including granular or aggregate base course from removed pavements, broken and pulverized claystone or claystone-sandstone bedrock may be used for backfilling trenches, provided it meets any special requirements of the Utility Agency and Geotechnical Engineer. Bedrock must be processed and broken or pulverized so that the maximum particle or fragment size does not exceed three-inches (3-inches).

C. Unsuitable Utility Trench Materials: Materials unsuitable for bedding and backfilling include highly organic soils, ASTM D2487 Group PT topsoil, and soils containing roots, vegetable matter, trash, and debris.

2.2 ACCESSORIES

A. Shoring and Bracing: Provide all materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross-braces, in good and serviceable condition, as required for safety and by governing authorities.

B. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work of this Section will be performed. Do not proceed with the work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Temporary Erosion and Sediment Control," during earthwork operations.

D. Existing Utilities:

1. General: Location of existing utilities shown on the plans are approximate only. The Contractor shall be responsible to locate all existing underground utilities in areas of the work. If utilities are to remain in place, provide protection during excavation and backfilling operations. Should uncharted or incorrectly charted piping or other utilities be encountered during excavations, consult the Owner's Representative immediately for direction. Cooperate with the Utility Agency in keeping respective services and facilities in operation. Repair damaged utilities to the satisfaction of the Utility Agency.
2. Active Utilities: Do not interrupt existing utilities serving facilities occupied and used by the Owner or by adjacent properties, except when permitted in writing by the Owner's Representative, and then only after acceptable temporary utility services have been provided. Remove or relocate utilities only as indicated or specified.
3. Inactive Utilities: Report inactive or abandoned utilities encountered in excavating or grading operations, and remove, plug, or cap as required. In the absence of specific requirements, plug or cap such utility lines at least 5-feet -0-inches outside new building walls, or as required by local requirements.
4. Removal: Demolish and completely remove from the project site all existing underground utilities indicated to be removed. Coordinate with Utility Agencies for discontinuance of services if lines are active.

E. Protection of Persons and Property:

1. Provide all necessary measures to protect workmen and passersby. Barricade open excavations occurring as part of the work, as required by municipal or other authorities having jurisdiction.
2. Protect adjacent streets, structures, and other improvements from damage caused by settlement, undermining, washout, and other hazards created by trench excavations.

F. Protect subgrades and trench bottoms soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

G. Cold Weather Work: Prevent frost from entering bearing strata upon which construction will taken place or in areas where fill will be placed in that season.

3.3 DEWATERING

A. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations and to collection or runoff areas. Establish and maintain temporary drainage ditches and diversions away from trench excavations. Do not use trench excavations as temporary drainage ditches.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.
3. Obtain and comply with all provisions of the Colorado Department of Public Health and Environment, Water Quality Control Division, Construction Dewatering Permit.

3.4 SHORING AND BRACING

A. Provide shoring and bracing of excavations as required for safety and by governing authorities. Carry down shoring and bracing as excavation progresses. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

3.5 PAVEMENT REMOVAL AND REPLACEMENT

A. Where trenches or other utility excavations are made in existing paved areas, saw-cut pavement surface to create a clean break line. Cut pavement a minimum of 12-inches beyond trench width on each side of trench; remove and dispose of existing surface course and aggregate base course, leaving a 12-inches wide undisturbed subgrade lip on each side of trench.

B. After trench has been backfilled and compacted, place new pavement in accordance with applicable requirements of Division 32 Sections as applicable, for Asphaltic or Portland cement concrete pavement and in accordance with Authorities having jurisdiction.

3.6 EXPLOSIVES

A. Explosives: Do not use explosives.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated on the drawings.

C. Clearance: 12 inches each side of pipe or conduit.

1. Slope sides of trenches or provide shoulders in accordance with OSHA requirements and as required by Utility Agency standards.
2. Continuously monitor cut slopes and trenches for distress or movement. Provide all necessary shoring and bracing required to protect the life and safety of workmen performing excavation or installing piping or conduit.

D. Trench Bottoms: Excavate trenches a minimum of 6 inches deeper than bottom of pipe elevation to allow for bedding course per Town of Berthoud DCS Appendix A 33-40-00 Section 2.6.C.2. Hand excavate for bell of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course and backfill with a 6-inches layer of crushed stone or gravel prior to installing pipe.

3.8 BEDDING OF PIPES:

A. After completion of trench excavation and before installation of piping, install not less than 6-inches of approved bedding material in trench bottom for support of pipe. Dig bell holes in bedding deep enough to provide a minimum of 2-inches clearance between the bell and bedding material. Fully support pipe on bedding material for the full length of the pipe barrel.

B. After pipe is adjusted for line and grade, and all jointing is complete, carefully place and tamp bedding material under the haunches of the pipe and in the previously dug bell holes.

C. Install bedding to a minimum depth of 12-inches above top of pipe prior to starting placement of compacted backfill. Lightly compact or tamp bedding material in a manner to avoid displacement of or damage to the pipe.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials in approved locations without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 UTILITY TRENCH BACKFILL

A. After installation of utility piping or lines have been completed, locations recorded, trash or other debris removed from excavations, and bedding placed and approved, backfill promptly as work and weather conditions permit. Do not backfill trenches until all required pipe system tests and inspections have been made, unless partial backfilling is required to restrain pipe under test pressures. Use care in backfilling to avoid damage or displacement of pipe systems.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

C. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

D. Place backfill materials in layers not more than 8-inches in loose depth for material compacted by heavy compaction equipment, and not more than 4-inches in loose depth for material compacted by hand operated tampers. Use hand held tools or compacting devices for trench backfill, until a minimum compacted thickness of 3-feet -0-inches above top of pipe is achieved. Mechanical or power compactors may be used thereafter.

E. Before compaction, moisten or aerate each layer of backfill to specifications.

F. Compact each layer to not less than 95% of maximum standard Proctor density (ASTM D698). Thoroughly compact by means of mechanical tampers areas which cannot be properly compacted by means of rolling equipment.

G. Backfill to subgrade elevation shown for finish grading, topsoil placement, or paving.

H. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

I. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

J. Place and compact final backfill of satisfactory soil to final subgrade elevation.

K. Install warning tape directly above utilities, 12 inches below finished grade, and 6 inches below subgrade under pavements and slabs.

L. Controlled Low Strength Material: Place initial backfill of controlled low strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

M. Controlled Low Strength Material: Place final backfill of controlled low strength material to final subgrade elevation.

N. When CLSMs are placed within the right-of-way, or they are to be covered by paving materials, the final set product must achieve a maximum indentation diameter of 3 inches prior to covering and opening the area to traffic. Penetration resistance shall be as measured by ASTM C6024, “Standard Test Method for Ball Drop on Controlled Low Strength Material to Determine Suitability for Load Application”.

O. CLSM must be placed in a uniform manner that will prevent voids or segregation of the backfill and shifting of pipelines, structures and appurtenances. Foreign material that falls into the trench prior to, or during placement shall be immediately removed.

3.11 SUBSURFACE DRAINAGE

A. Subdrainage Pipe: Specified in Division 33 Section "Subdrainage Systems."

B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.

C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with 1 layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.
2. Place and compact impervious fill over drainage backfill in 6-inches thick compacted layers to final subgrade.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Perform field moisture tests in accordance with ASTM D3017. Tests will be performed at the following locations and frequencies at a minimum:

1. Trench Backfill: The density tests shall be performed during backfilling at specified depths in the trench to ensure that the required density and moisture is obtained throughout. For trenches less than 30-inches in depth, density tests shall be taken within 18-inches above the top of pipe or conduit and at the surface/toplift as a minimum. For trenches greater than 30-inches in depth, density tests shall be taken within 18-inches of the top of the pipe or conduit, and at 2-foot vertical intervals to the top of the trench with the final test at the surface/toplift. For utility mains conduct one (1) set of tests per 100 feet of linear trench at specified depths and for service lines conduct one (1) test per every service line per utility type at specified depths. At a minimum, test intervals and quantities shall meet or exceed the requirements of the local utility agency.

D. When testing agency reports that backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.13 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Owner's Representative; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.14 CLEANING AND ADJUSTMENT

A. Cleanup: Remove excess materials not required for backfilling purposes, including excess spoil material, accumulated debris, and rubbish from site. Burning of waste material is prohibited.

3.15 RESTORATION

A. Adjacent Improvements: Restore all fences, irrigation ditches, yards, lawns, and other structures or surfaces to condition equal to or better than before work began.

3.16 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 31 2333

THE GARDEN SPOT – Berthoud Arboretum

TECHNICAL SPECIFICATIONS

SECION 31 2500 – TEMPORARY EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Additional information concerning temporary erosion and sedimentation control may be found on the civil drawings and Town of Berthoud construction standards. In case of conflict between the drawings, jurisdictional criteria and the information specified herein, the more stringent requirements shall govern.

C. Additional information concerning erosion may be found in the geotechnical investigation report by Berthoud Arboretum at Waggener Farm Park, Prepared by Rocksol Consulting Group, Inc., dated August 5, 2024. All requirements of this report shall be followed unless stated otherwise.

D. Additional information concerning erosion control may be found in the SWMP, Storm Water Management Plan by Martin/Martin, Inc.

1.2 SUMMARY

A. Work Included. Furnish, install, maintain, and remove temporary erosion and sedimentation controls as shown on the drawings or specified herein, or as required to complete the work. Provide documentation as required by Town of Berthoud.

B. Related Sections include the following:

1. Division 31 Section "Site Clearing" site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2. Division 33 Section "Subdrainage" for drainage of foundations slabs-on-grade walls and landscaped areas.
3. Division 31 Section “Earth Moving” for soil materials, site excavating, filling and grading.
4. Division 31 Section “Trenching and Backfilling” for excavating and backfilling of utilities.

C. Permits and Fees: Obtain and pay for all permits and fees required for the work of this section, including erosion and sediment control and water quality permits required by the authority having jurisdiction and the Colorado Department of Public Health and Environment, Water Quality Control Division.

D. Erosion Control: The Erosion and Sedimentation Control Drawings included in the Contract Documents is the minimum requirement to be implemented. Provide additional control as necessary to meet applicable local State and Federal criteria, as applicable authority having jurisdiction, owner, and engineer requirements.

1.3 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Unclassified Excavation: Removal of all material of whatever character required for the work encountered above subgrade elevations and to lines and dimensions indicated, including boulders.

C. Fill: Fill is all material placed to raise the grade of the site or to backfill excavation, upon which the Soils Engineer has made sufficient tests and observations to enable him to issue a written statement that, in his opinion, the fill has been placed and compacted in accordance with the requirements of these specifications.

D. BMP: Best Management Practice. Erosion and sediment control devices, which may consist of silt fence, crates, filter fabric, riprap, etc.

E. SWMP: Storm Water Management Plan. Identifies BMPs, which are erosion and sediment control measures for the project.

F. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

G. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

H. Utilities: Include on-site underground pipes, conduits, ducts, and cables, as well as underground services to buildings.

1.4 SUBMITTALS

A. Submittal Procedures: All submittals are to be made to the Owner's Representative. If provided refer to Division 1 section "Submittal Procedures."

B. Product Data: Submit manufacturer's published descriptive literature and complete specifications for manufactured products specified herein and utilized on the project.

1. Geotextiles.
2. Erosion Control Fabric.

C. Storm Water Management Plan:

1. The Engineer will provide a Storm Water Management Plan (SWMP) and report addressing erosion and sediment control measures for all sites with over one acre of disturbed ground. The Engineer may also assist in preparation of the General Permit application.
2. The Contractor is responsible for obtaining all required permits including a General Permit application for Storm Water Discharges associated with construction activities at least ten

(10) days prior to start of construction. Permits are to be filed with the Colorado Department of Public Health and Environment, Water Quality Control Division.

3. Contractor shall have the Storm Water Management Plan (SWMP) and report available on-site at all times.
4. The Storm Water Management Plan should be reviewed and modified as part of the overall process of assessing and managing storm water quality issues at the site. Erosion and sediment control measures outlined in the report are intended as the minimum requirement for the construction of this project as anticipated at the time of design. Additional measures are to be implemented and updated in the SWMP per authority having jurisdiction, as necessary and as required by authority having jurisdiction, owner, and engineer requirements, by the Contractor to control erosion and the release of sediment into the surrounding streets, storm sewer, or existing drainage facilities.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable local, State and Federal ordinances, rules and regulations concerning sedimentation control and storm water runoff.

B. In case of conflict between the above codes, regulations, references and standards and these specifications, the more stringent requirements shall govern.

C. Preconstruction Conference: Conduct conference at Project site as directed by Owner's Representative prior to start of construction. Contractor to comply with requirements, which may also be included in Division 1 Section "Project Management and Coordination."

1.6 PROJECT/SITE CONDITIONS

A. Existing Conditions: Verify all existing conditions affecting the work of this section prior to submitting bids or proposals. Additional compensation will not be allowed for revisions or modification of work resulting from failure to verify existing conditions.

1.7 WARRANTY

A. Temporary Erosion and Sediment Control measures shall be maintained until permanent measures are in place. All damaged, disturbed or devices filled with sediment, which may occur within the specified project warranty period, shall be corrected at no cost to the Owner. Any devices damaged by erosion or sediment shall be restored to their original condition by the Contractor, at no cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Erosion and Sedimentation Control Materials: Provide one or more of the following materials, as shown on the plans or as applicable for site conditions:

1. Sand bags.
2. Silt fences.
3. Rock riprap.
4. Temporary seeding.

5. Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh.
6. Biodegradable twisted jute or spun-coir mesh, 0.92 lb/sy minimum, with 50 to 65 percent open area.
7. Drainage geotextile.
8. Impervious fill.
9. Other materials proposed for use on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. General:

1. Determine the existing ground elevations, drainage patterns, and changes to such patterns during excavation in order to satisfactorily plan and provide materials for adequate erosion and sediment control devices.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and rights-of-way according to requirements of authorities having jurisdiction.

B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

D. Secure grading permit from agency having jurisdiction prior to commencing grading operations.

3.3 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work of this section will be performed. Do not proceed with the work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.

3.4 INSTALLATION

A. Erosion and Sedimentation Control Devices. Erosion and sedimentation control measures to be taken during construction include, but are not necessarily limited to the following:

1. Apply soil stabilization within 14 days to all disturbed areas that are to be dormant for a period longer than 30 calendar days after reaching grade. Stabilize soil with mulch anchored per criteria of authorities having jurisdiction. Temporarily revegetate areas that will remain in an interim condition for more than sixty (60) days.
2. Roads and parking areas indicated to be paved may be covered with an appropriate aggregate base course in lieu of mulch. Temporary mulching or aggregate base course is not required if final pavement construction will take place within 30 days after grading to final contours.

3. Soils that will be stockpiled for more than 30 days must be mulched and seeded within 14 days after stockpile construction.
4. Prevent sediment from leaving the project site by installing a silt fence or other BMPs as indicated on the plans. Protect existing storm inlets adjacent to the site by an approved gravel filter.
5. Excavate the future detention/water quality pond and construct the outlet structure/storm sewer such that the pond may function as a temporary sediment basin during development of the site. Construct the sediment basin in accordance with authority having jurisdiction's criteria. Provide temporary swales to convey site runoff to the pond.
6. Locate stone stabilization pads at all points of vehicular ingress and egress to the construction site.
7. Provide temporary erosion controls consisting of berms at the top of slopes and interceptor ditches at ends of berms and at those locations which will eliminate or minimize erosion during construction, along with temporary seeding, temporary diversion, chutes, and down pipes and lining of water courses.
8. Temporary sedimentation controls shall consist of silt dams, traps, silt fence, barriers, and appurtenances at the top of spoil and borrow area slopes and where runoff water exits the site.
9. Maintain the available silt holding capacity of silt dams, fence traps and barriers until no longer needed. The sediment capacity of sediment retainage areas shall be at a minimum, the capacity shown on the plans in conformance with Urban Drainage Criteria Manual, Volume 3. Prior to removal, obtain concurrence of the Owner and Engineer.
10. Remove accumulated sediment and debris from a BMP when the sediment level reaches one-half the height of the BMP, or at any time the sediment or debris adversely impacts the functioning of the BMP.
11. The erosion/sediment control plan shows the minimum required for the project. If it becomes apparent that additional controls are necessary, the Engineer shall be notified and with approval of the Owner's Representative additional controls shall be installed.

B. Chemicals and Pollutants:

1. Store construction materials and chemicals that could contribute pollutants to the runoff within an enclosure, container, or dike located around the perimeter of the storage area, to prevent discharge of these materials into runoff from the construction site.
2. Locate areas used for collection and temporary storage of solid and liquid waste away from the storm drainage system. Provide covering or fencing as required to prevent windblown materials; construct perimeter dike to contain liquid runoff. These measures may not be necessary if materials are immediately placed in covered waste containers.
3. Perform equipment maintenance in designated areas using measures such as drip pans to control petroleum products spillage.
4. Immediately clean up and properly dispose of spills of construction related materials such as paints, solvents, or other chemicals.

C. Final Stabilization and Long-Term Management: Town of Berthoud

1. Final stabilization shall be achieved through permanent vegetation and landscaping after construction of all buildings and paved surfaces.
2. With approval of authorities having jurisdiction, temporary erosion and sediment control measures may be removed within 30 days after final site stabilization is achieved or after temporary measures are no longer needed.

D. Inspection and Maintenance: Inspect erosion and sediment control measures weekly during construction. In addition, inspect all facilities immediately after any significant runoff or snowmelt which results in runoff. Repair or otherwise mitigate any damage to the erosion and sediment control facilities at no additional cost to the Owner.

3.5 CLEANING

A. Removal of Controls: Remove controls upon completion of that portion of the work for which controls were furnished. Leave the site and work area in a clean condition.

END OF SECTION 31 2500

PART 1 GENERAL

1.1 SCOPE OF WORK

This section covers work related to the importation of clay fill material to achieve an impervious lining for designated areas of The Berthoud Arboretum pond. Work includes grading and compaction of subgrade, placement and compaction of clay liner material, and placement and compaction of a one-foot-thick cover layer of site soil.

1.2 SUBMITTALS

A. Where gradations or other material properties are specified, information certifying these properties shall be submitted. All gradation and soil property characteristics must be approved by the Project Manager before incorporating into the work.

B. Test results of clay material

C. Contractor shall submit a detailed plan for placement of the liner for Project Manager's review and approval before placing liner.

D. Contractor shall submit construction details for where clay liner meets adjacent materials or equipment for review and approval.

1.3 QUALITY ASSURANCE

A. Installation shall be by a contractor and crew with at least three (3) years of experience in placing clay liner on projects of similar nature or dollar cost.

B. Contractor to submit five (5) similar previously completed projects and a reference for each of the projects.

C. All gradation and plasticity index tests for the imported clay liner material shall be made by an acceptable independent testing laboratory at the expense of the Owner, coordinated by the Contractor. Test results shall be submitted prior to delivery of material.

D. Review of the clay lining material test results and subgrade preparations shall be reviewed by the Geotechnical Engineer on the project.

E. No material shall be placed until both the clay lining material and the subgrade preparations have been approved.

PART 2 MATERIALS

2.1 GENERAL

Clay liner material shall consist of low to highly plastic material with at least 70 percent passing the No. 200 sieve, a maximum particle size of one-inch, and shall have a plasticity index of 25 or greater. Material may require temporary stockpiling, protection, moisture conditioning, and possible screening to reduce clay balls to acceptable sizes

and further processing to achieve best installation moisture conditions. All such work shall be at the contractor's expense.

PART 3 EXECUTION

3.1 In the event that temporary stockpiles are utilized, such stockpiles shall not exceed 100-feet in width, 10-feet in height, and shall not have slopes steeper than 2-horizontal to 1-vertical. Stockpiled material shall be placed in neat, even piles in designated areas.

3.2 No clay liner material shall be placed until the subgrade is approved, and grading/pond shaping completed. Subgrade preparation shall be in accordance with Section 310000 Earthwork and in addition, the areas to receive clay liner shall be wheel rolled to achieve a seal on the top surface of the subgrade. Surveys to confirm the finally prepared subgrade elevations prior to the placement of liner shall be conducted by the Contractor. The clay liner shall be installed with approved material in two 6-inch layers after compaction in accordance with this specification. Material shall be compacted to at least 95 percent of the maximum standard Proctor density (ASTM D-698) within +/- 2 percent of the optimum moisture content. A sheepsfoot roller shall not be used for compaction of the clay liner. The specified compaction of the clay liner shall be obtained using a rubber-tire roller, or other suitable approved means. Care should be taken not to damage the liner during subsequent construction activities.

3.3 The Contractor is cautioned that the liner may be placed on sandy clay material that is at or slightly lower than the groundwater level. Subgrade preparation shall include control of groundwater such that the liner can be placed on a firm, compacted subbase. Subgrade preparation shall also include any pre-mixing of subbase stabilization material required and the first six-inch lift only, and re-compaction of subgrade materials to achieve a stable base. Further, Contractor shall take special precaution to prevent contamination of liner from mixing with subbase during the installation process. Placement of the liner may require processing of liner material to remove/reduce oversize clayballs and other deleterious materials as well as to achieve a workable moisture content.

3.4 The clay liner will be installed under and around all irrigation pond components including pond fill energy dissipation and aeration structure, intake structure well rip rap surface stabilization, cobble border, and any materials that support these items. Small equipment will be required to compact to achieve a consistent watertight liner.

In the event that clay liner installation occurs after walls and pond components are already in place, liner Contractor shall avoid damaging other improvements. In the event of damage to other improvements, Contractor shall restore improvements to original condition at no cost to the Project.

END OF SECTION 31 35 26

SECTION 32 05 23 CAST IN PLACE CONCRETE FOR LANDSCAPE

PART 1 GENERAL

1.1 SUMMARY

A. This Section of the Work includes furnishing, placing, shoring, bracing, and anchorage of formwork, concrete reinforcement, accessories, and placing concrete in connection with cast-in-place concrete installation including installation of control and expansion joints, concrete curing and concrete finishing

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.3 REFERENCES

A. Note: All references below shall be from the most current edition.

B. American Concrete Institute (ACI):
1. ACI 117 - Standard Tolerances for Concrete Construction and Materials.
2. ACI 301 - Specifications of Structural Concrete for Buildings.
3. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
4. ACI 305 and 306 - Hot and Cold Weather Protection for Concrete.
5. ACI 315 - Details and Detailing of Concrete Reinforcement.
6. ACI 318 - Building Code Requirements for Reinforced Concrete.
7. ACI 347 - Recommended Practice for Concrete Formwork.

C. American National Standards Institute (ANSI):
1. ANSI/ASTM A82 - Cold Drawn Steel Wire for Concrete Reinforcement.
2. ANSI/ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement.

D. American Society for Testing and Materials (ASTM):
1. ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement.
2. ASTM C33 - Concrete Aggregates.
3. ASTM C94 - Ready-Mixed Concrete.
4. ASTM C150 – Portland Cement.
5. ASTM C260 - Air Entraining Admixtures for Concrete.
6. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
7. ASTM C494 - Water Reducing Admixtures for Concrete.
8. ASTM C618 - Fly Ash Mineral Admixture for Concrete.
9. ASTM C672 - Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals.
10. ASTM-C800 - Curing Compound, Concrete, for New and Existing Surfaces.
11. ASTM-C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

E. Concrete Reinforcing Steel Institute (CRSI) - Manual of Standard Practice.

F. Colorado Department of Transportation (CDOT) - Standard Specifications for Road and Bridge Construction.

G. National Ready Mixed Concrete Association (NRMCA)

1.4 QUALITY CONTROL

A. Reference Standards: Comply with following standards except where more stringent requirements are shown or specified:
   1. American Concrete Institute (ACI) Publications: Comply with the following unless modified by requirements in the Contract Drawings. Note: All references below shall be from the most current edition.

      a. ACI 117 - Standard Tolerances for Concrete Construction and Materials.
      b. ACI 301 - Specifications of Structural Concrete for Buildings.
      c. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
      d. ACI 305 and 306 - Hot and Cold Weather Protection for Concrete.
      e. ACI 315 - Details and Detailing of Concrete Reinforcement.
      f. ACI 318 - Building Code Requirements for Reinforced Concrete.
      g. ACI 347 - Recommended Practice for Concrete Formwork.
      h. ANSI/ASTM A82 - Cold Drawn Steel Wire for Concrete Reinforcement.
      i. ANSI/ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement.
      j. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
      k. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
      l. ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement.
      m. ASTM C33 - Concrete Aggregates.
      n. ASTM C94 - Ready-Mixed Concrete.
      o. ASTM C150 - Portland Cement.
      p. ASTM C260 - Air Entraining Admixtures for Concrete.
      q. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
      r. ASTM C494 - Water Reducing Admixtures for Concrete.
      s. ASTM C618 - Fly Ash Mineral Admixture for Concrete.
      t. ASTM C672 - Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals.

   2. ASTM-C800 - Curing Compound, Concrete, for New and Existing Surfaces.
   3. Concrete Reinforcing Steel Institute (CRSI) - Manual of Standard Practice.

B. Pre-Construction Conference: Conduct conference at location approved by Project Manager.

   1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Ready-mix concrete manufacturer.
      d. Concrete subcontractor.
      e. Special concrete finish subcontractor.

   2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semi-rigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, concrete repair procedures, and concrete protection.

C. Refer to Part 3 QUALITY CONTROL for Contractor's testing requirements.

1.5 SUBMITTALS

A. See Section 01 3000 – Administrative Requirements, for submittal procedures.

B. Product Data: For each type of product specified.

C. Mix Designs:
1. Submit substantiating data for each concrete mix design specified for use to the Project Manager not less than four (4) weeks prior to first concrete placement. Data for each mix shall, as a minimum, include the following:
   a. Mix identification designation (unique for each mix submitted).
   b. Statement of intended use for mix.
   c. Mix proportions.
   d. Admixtures (must be approved by the Project Manager).
   e. Wet and dry unit weight.
   f. Entrained air content.
   g. Design slump.
   h. Strength qualification data.

D. Submit shop drawings for fabrication, bending and placement of concrete reinforcement. Comply with ACI Detailing Manual SP 66. Include all accessories specified and required to support reinforcement.

E. Qualification Data: Installer to document for Owner's Representative experience on projects of similar scope and scale successfully completed within the past five (5) years.

F. Material Certificates: For each of the following, signed by manufacturers:
1. Cementitious materials and aggregates.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Fiber reinforcement.
6. Waterstops.
7. Curing compounds.
8. Floor and slab treatments.
9. Bonding agents.
10. Adhesives.
11. Vapor retarders.
12. Semirigid joint filler.
13. Joint-filler strips.
14. Repair materials.
15. Epoxy joint filler.

G. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

H. Submit samples of form material with a medium grain finish for board form finish for approval by landscape architect prior to construction.

I. Field quality-control reports.

J. Minutes of Pre-Construction conference.

1.6 MOCK-UPS

A. Install an 6'L x 18" W x 18" T mock of the boardform wall. This area shall be the standard from which the work will be judged. Mock-ups shall not be included as part of the finished work.

1.7 DELIVERY, STORAGE AND HANDLING

A. General: Materials handling and batching shall conform to applicable provisions of ASTM C94.

B. Reinforcing: Unload and store reinforcing bars so they are kept free of mud and damage.

C. Hauling Time for Concrete: Deliver and discharge all concrete transmitted in a truck mixer, agitator, or other transportation device not later than one and one-half (1-1/2) hours, or three-hundred (300) revolutions of the drum after the initial mixing water has been added, whichever is earliest.

D. Extra Water:
1. Deliver concrete to site in exact quantities required by design mix.
2. Should extra water be required for workability before depositing concrete, and the water/cement ratio of accepted mix design will not be exceeded, the General Contractor's superintendent shall have the sole authority to authorize addition of water. Additional water shall not exceed one (1) gal/cu. yd. Any additional water added to mix after leaving batch plant shall be indicated on truck ticket and signed by person responsible.
3. Where extra water is added to concrete it shall be mixed thoroughly for thirty (30) revolutions of drum before depositing.
4. Water may be added at the site only once for each batch.
5. A full set of tests shall be performed after addition of water. Excessive slump or other out of range tests will be cause for rejection.

1.8 PROJECT CONDITIONS

A. Environmental Requirements:
1. Cold Weather Placement:
a. When for three successive days prior to concrete placement the average daily outdoor temperature drops below forty degree (40°) F or when the average outdoor temperature is expected to drop below forty degrees forty degree (40°) F on the day of concrete placement, preparation, protection and curing of concrete shall comply with ACI 306R.
b. Minimum temperature of concrete upon delivery shall conform to ACI 301 Table 7.6.1.1. Concrete at time of placement shall conform to minimum values of ACI 306R Table 1.4.1, and shall not exceed minimum values by more than twenty degrees (20°) F.
c. Subject to acceptance of the Project Manager an accelerating admixture may be used. Admixtures shall meet requirements of Part 2. Calcium Chloride and other chloride-type accelerating admixtures are not allowed.
d. Comply with concrete protection temperature requirements of ACI 306R. Record concrete temperatures during specified protection period at intervals not to exceed sixteen (16) hours and no less than twice during any twenty four (24) hour period.

2. Hot Weather Placement:
a. When depositing concrete in hot weather, follow recommendations of ACI 305R.
b. Temperature of concrete at time of placement shall not exceed eighty-five degrees (85°) F.
c. When air temperatures on day of placement are expected to exceed ninety degrees (90°) F, mix ingredients shall be cooled before mixing. Flake ice or well-crushed ice of a size that will melt completely during mixing may be substituted for all or part of mix water.

d. Retarding admixture may be used subject to acceptance of the Project Manager. Admixtures shall meet requirements of Part 2.
e. Protect to prevent rapid drying. Start finishing and curing as soon as possible.

B. Protection: Protect newly finished slabs from vandalism and all weather related damage. Protect finished slabs from mortar leakage from pouring of concrete above. Cover masonry walls, glazing, and other finish materials with polyethylene or otherwise protect from damage due to pouring of concrete.

PART 2 PRODUCTS

2.1 FORM MATERIALS

A. Hand Placed Steel Forms: Hand placed steel forms are only to be used for sections that are straight and have no bend, radii, or curvature in the sections to be used.

B. Plywood Forms: Are to be used on any section of concrete that have bends, radii or curvature. Forms shall be made of Douglas Fir or Spruce species; solid one side grade; sound, undamaged sheets with straight edges.
1. Curved elements shown on plans are to be constructed with smooth-curved forms. Faceted forms composed of straight sections will not be accepted.

C. Lumber: Douglas Fir or Spruce species; construction grade; with grade stamp clearly visible.

D. Form Coatings: Provide commercial formulation form coating compounds that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

E. Boardform: Form lumber for all exposed concrete surfaces shall be dressed at least on one side and two edges and shall be constructed so as to produce mortar-tight joints and smooth, even concrete surfaces.
1. Shall be a horizontal random pattern created from 6x lumber. Boards shall have a minimum eighteen inches overlap from the end of one board to the start of adjacent board.
2. Forms shall be chamfered on all exposed corners or as indicated on the plans. Unless otherwise specified, forms for exposed surfaces shall be constructed with chamfers 3/8” by 3/8” at all exterior corner.
3. The top of boardform seatwall shall be level and receive a smooth trowel finish.

F. Form Liner: Fitzgerald Formliners, 1500 East Chestnut Avenue, Santa Ana, CA 92701, 800.547.7760. www.formliners.com.
1. Pattern shall be pattern 16020 Rough Sawn Plank with 4.364 board width with interior butt joints.

2.2 REINFORCING STEEL

A. Reinforcing Steel: ASTM A615, grade forty (40) for, ties and stirrups; grade sixty (60) for all other bar; billet-steel deformed bars, uncoated finish.

B. Tie Wire: ASTM A82, minimum sixteen (16) gauge annealed type.

C. Chairs, Bolsters, Bar Supports, and Spacers: Sized and shaped for strength and support of reinforcement during installation and placement of concrete. Wood, brick or other unacceptable material is not permitted.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade sixty (60), plain-steel bars, cut true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class one (1) plastic-protected steel wire or CRSI Class two (2) stainless-steel bar supports.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.4 CONCRETE MATERIALS

A. Provide materials in accordance with ACI 301, unless amended or superseded by requirements of this section or general notes on structural drawings.
1. General: Ready-mixed Concrete: ASTM C94. On-site mixed concrete not allowed.
2. Cement: ASTM C150. Type II
3. Fly ash: ASTM C618 Class C or F.
4. Aggregate: ASTM C33.
   a. Obtain from same source throughout project.
   b. All sand and aggregates to meet C-33 Table 3 for Class 4S “Severe Weathering Region”.
      1) Fine Aggregate: Clean, natural sand.
      2) Coarse Aggregate: Clean gravel or crushed stone.

5. Water: ASTM C 94/C 94M, clean and not detrimental to concrete.

2.5 ADMIXTURES

A. General: Unless specified, no admixtures may be used without specific approval of the Project Manager.

B. Prohibited Products: Calcium chloride or admixtures containing more than one half of one percent (0.05%) chloride ions or thiocyanates are not permitted.

C. Air-Entraining Admixture: ASTM C260. Subject to compliance with requirements, provide one of the following:
1. “Air Mix” by Euclid Chemical Co.
2. “Darex ARA” by W. R. Grace.
3. “Micro-Air” by Master Builders.
4. Acceptable substitution.

D. Water Reducing Admixture: ASTM C494, Type A. Subject to compliance with requirements, provide one of the following:
1. “Eucon WR-75” by Euclid Chemical Co.
2. “Rheobuild 1000” by Master Builders.
3. “Plastocrete 106” by Sika Chemical Co.
4. Acceptable substitution.

E. High Range Water Reducing Admixture (Superplasticizer): ASTM C494, Type F or G. Subject to compliance with requirements, provide one of the following:

1. "Eucon 37" by Euclid Chemical Co.
2. "Pozzolith 400N" by Master Builders.
3. "Sikament" by Sika Chemical Co.
4. Acceptable substitution.

F. Warm Weather Admixtures: ASTM C494. Use of admixtures will not relax warm weather placement requirements.

G. Cold Weather Admixtures: ASTM C494. Use of admixtures will not relax cold weather placement requirements.

2.6 ACCESSORIES

A. Form Release Agent: Colorless material which will not stain concrete, absorb moisture, contain oils or waxes, or impair natural bonding or color characteristics of coating intended for use on concrete. Subject to compliance with requirements, use one of the following:
1. "Pro-Cote" by Protex.
2. "Cast Off" by Sonneborn.
3. "Debond" by L&M Construction Chemicals.

B. Epoxy Adhesive: ASTM C881; two (2)-component material suitable for use on dry or damp surfaces. Subject to compliance with requirements, use one of the following:
1. "Sikadur Hi-Mod LV" by Sika Chemical Corp.
2. "Patch and Bond Epoxy" by Burke.
3. "Epoxtite" by A.C. Horn.
4. "Sure-Poxy" by Kaufman Products, Inc.
5. "Euco Epoxy 463 or 615" by Euclid Chemical Co.

C. Expansion Joints:
1. Interior Use or Exterior Use Where Sealants are Specified: Bituminous saturated fiber conforming to ASTM D1751, one half inch (1/2") thick. Provide manufacturer's certification of compatibility with specified sealants where required.
2. Exterior Use Where Sealants are not Specified: Premolded asphalt and fiber conforming to ASTM D994, one half inch (1/2") thick.

D. Slip Joints:
1. Speed Dowel Model PSD09/#4TX, nine inch (9") long sleeve to accommodate eighteen inch (18") smooth steel round bar. Manufactured by Sika/Greenstreak, (800)325-9504.
2. Dowel, eighteen inch (18") long smooth round steel bar, five eighth inch (5/8") diameter. De-bur cut ends.

E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

F. Chamfer Strips: Wood, metal, PVC, or rubber strips, shaped as sized on the drawings.

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

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

1. Formulate form-release agent with rust inhibitor for steel form-facing materials. Form-release agent is not to stain or discolor final concrete surface.

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

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

J. Spray Curing Compound: All spray curing compound shall meet ASTM C-1315, and be prepared by manufacturer's instructions. Use per where required in Section 3.9.

2.7 CONCRETE MIX

A. All Concrete mixes from the approved list or submitted for approval shall meet the following criteria:

1. Mix concrete in accordance with ASTM C94 and ACI 301 Chapter 3.
2. Cement Content: Type II cement, minimum of five hundred sixty four (564) pounds per cubic yard.
3. Fly ash: ASTM C618 Class C or F. Fly ash shall not exceed fifteen (15%) of total cementitious material by weight unless approved by Project Manager.
4. Maximum water-cement ratio: 0.45.
5. Slump: Four inches (4") maximum.
6. Air Entrainment: Five percent (5%) to eight percent (8%).
7. Aggregate Size: three quarter inch (3/4"), maximum.
8. Deliver concrete and discharge all concrete transmitted in a truck mixer, agitator, or other transportation device not later than one and one-half (1-1/2) hours from batch time, or three hundred (300) revolutions of the drum after the initial mixing water has been added, whichever is earliest.
9. During cold weather (below forty-five degree (45°) F), use heated water and aggregates if necessary to maintain concrete temperature between sixty degree (60°) F. and ninety degree (90°) F.
10. Concrete for Footings, Walls, and Interior Slabs-on-Grade shall be Class B or Class D, as approved by the Project Manager.
11. Fly Ash: Per CDOT Standard Specifications for Road and Bridge Construction Section 701.02.

B. All concrete mixes for boardform and form liner walls shall be a self-consolidating concrete that does not require vibration. SCC mix requires a combination of a low yield stress and a moderate plastic viscosity with the ability to retain its self-compacting properties until placed. Self-consolidating concrete mix shall meet the following criteria:
1. Slump flow to be between 550 to 650 mm.
2. Segregation resistance of class SR1 with less than or equal to 20% sieve segregation.
3. V-funnel flow time of 5-9 seconds.
4. The surface should have a minimal number of air pockets (bugholes) and none should be greater than 1/4" in diameter. The maximum number of air pockets (bugholes) shall be four per square foot of exposed surface.

2.8 FABRICATING REINFORCEMENT

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

2.9 CONCRETE MIXING

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

1. When air temperature is between eighty-five (85°) and ninety degrees (90°) F, reduce mixing and delivery time from one and one-half (1-1/2) hours to seventy-five (75) minutes; when air temperature is above ninety degrees (90°) F, reduce mixing and delivery time to sixty (60) minutes.

2. Project-Site Mixing: Not allowed without prior approval from Project Manager. If allowed, submit process description to Project Manager for approval prior to construction.

PART 3 EXECUTION

3.1 QUALITY CONTROL

A. Requirements of Regulatory Agencies: Comply with all applicable provisions of the state and local building and safety codes.

B. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer, unless otherwise approved by Project Manager.

C. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

D. Testing: All testing shall be completed by the Contractor at their expense unless otherwise specified by the contract.

E. Testing Agency Qualifications: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures. Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

F. Testing Frequency: Obtain at least one composite sample for each one hundred (100) cubic yards, or fraction thereof of each concrete mixture placed each day.
a. When frequency of testing will provide fewer than five (5) compressive-strength tests for each concrete mixture, testing shall be conducted from at least five (5) randomly selected batches or from each batch if fewer than five (5) are used.
2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one (1) test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one (1) set of four (4) standard cylinder specimens for each composite sample.

5. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at twenty-eight (28) days. and keep one for backup in the event a sample should break.
    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at twenty-eight (28) days.

G. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than two-hundred (200) psi.

H. Test results shall be reported in writing to Project Manager, concrete manufacturer, and Contractor within forty-eight (48) hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at twenty-eight (28) days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both seven (7) and twenty-eight (28) day tests.

I. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Project Manager.

J. Concrete work will be considered defective if it does not pass tests and inspections.

K. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

L. Prepare test and inspection reports.

M. Record of Work: A record shall be kept by the Contractor listing the time and date of placement of all concrete for the structure. Such record shall be kept until the completion of the project and shall be available to the Project Manager for examination at any time.

N. Mockups: If requested by the Project Manager, prior to starting any concrete work, provide a sample panel using materials indicated for project work. For each type, color and finish of concrete specified, build panel at the site of full thickness and approximately ten feet (10') by 10 feet (10'), including reinforcement, expansion joints, control joint, scales, fillers, and one radial edge. Provide the workmanship proposed for the work. Correct and replace sample panel until Project Manager's acceptance of the work. Retain panel(s) during construction as a standard for completed paving work.
    1. Build panel approximately one-hundred (100) sq. ft. in the location indicated or, if not indicated, as directed by Project Manager.
    2. Approved mockups may become part of the completed Work if approved prior to the construction of the mock up and is undisturbed at time of Substantial Completion.
    3. Notify the Project Manager a minimum of seven (7) days in advance of dates and times when mockups will be constructed.
    4. Obtain the Project Manager's written approval of the mockups before starting construction.
    5. If the Project Manager determines that the mockup does not meet the requirements, demolish and remove from the site and cast another until the mockup is approved.
    6. Maintain the mockups during construction in an undisturbed condition as a standard for judging the completed Work.
    7. Demolish and remove mockups when directed by Project Manager.

O. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semi-rigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage

device installation tolerances, steel reinforcement installation, concrete repair procedures, and concrete protection.

3.2 FORMWORK ERECTION

A. Construct formwork to maintain tolerances in accordance with ACI 301.

B. Verify lines, levels, and measurement before proceeding with formwork.

C. The inside surfaces of forms shall be cleaned of all dirt, mortar, and foreign material. Forms which will later be removed shall be thoroughly coated with form oil prior to use. The form oil shall be a commercial quality form oil or other equivalent coating which will permit the ready release of the forms and will not discolor the concrete.

D. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, one eighth inch (1/8") for smooth-formed finished surfaces.
2. Class B, one-quarter inch (1/4") for rough-formed finished surfaces.

E. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

F. Form Tie Holes: Form tie holes are to be filled with grout and finished to match adjacent concrete surface.

G. Elements shown as curved on plans are to be formed with flexible form material to form smooth curve transitions. Disjointed, poorly transitioned form alignments will not be accepted. Curved sections formed with straight facets will not be accepted.

H. Contractor shall notify the Project Manager a minimum of forty eight (48) hours in advance of placing concrete for review of formwork. Contractor shall make correction within twenty four (24) hours of review. If formwork is not in place at time of the scheduled inspection, then the Contractor will be responsible for compensation of the Project Manager's time and expenses per the General Contract Conditions.

I. Minimize form joints. Symmetrically align form joints and make watertight to prevent leakage of mortar.

J. Provide chamfer strips on all exposed corners or as indicated on construction documents.

K. Do not apply form release agent other than specified materials where concrete surfaces receive special finishes or applied coatings which may be affected by agent. Soak contact surfaces of untreated forms with clean water. Keep surfaces wet prior to placing concrete.

L. Coordinate work of other Sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, dowels, anchors, and other inserts and embedded materials.

M. Do not remove forms, shoring and bracing until concrete has sufficient strength to support its own weight, and construction and design loads which may be imposed upon it.

N. During cold weather, remove ice and snow from forms. Do not use deicing salts. Do not use water to clean out completed forms unless formwork and construction proceed within heated enclosure. Use compressed air to remove foreign matter.

3.3 SURFACE TREATMENT

A. Wood forms shall be thoroughly moistened with water immediately before placing the concrete.

B. For members with exposed faces, the forms shall be treated with an approved form release agent to prevent the adherence of concrete. Material which will adhere to or discolor the concrete shall not be used.

C. All concrete forms for surfaces to which Architectural Coating is to be applied shall be treat with a water based concrete form release agent prior to placing reinforcement.

D. Tops of boardform walls shall receive a smooth trowel finish.

3.4 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than fifty degrees (50°) F for twenty four (24) hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.

1. Leave formwork for structural elements that supports weight of concrete in place until concrete has achieved at least seventy percent (70%) of its twenty-eight (28) day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Project Manager.

3.5 SHORES AND RESHORES

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

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

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

3.6 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.7 REINFORCEMENT

A. Place, support, and secure reinforcement against displacement.

B. Locate reinforcing splices per ACI 318 unless indicated otherwise on the Contract Drawings.

3.8 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Project Manager.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.

C. Retain one of two subparagraphs below only if a bonding material is required.
1. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
2. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

D. Joint Sealants: See Division 3 Section “Concrete Paving Joint Sealants”.

3.9 CONCRETE PLACEMENT

A. Contractor’s Review: Contractor shall inspect forms and reinforcing prior to concrete placement to assure accurate placement of embedded items and overall acceptability.

B. Project Manager’s Review: Contractor shall provide minimum of forty-eight (48) hours notice to the Project Manager to allow review of forms and reinforcement before concrete is placed and to observe placing of concrete.

C. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

D. Do not add water to concrete during delivery, at Project site, or during placement. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least six inches (6”) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for concrete pavements in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces as indicated on drawings.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
6. Allow time for bleed water to appear, then scrape or push off all bleed water. Do not work water into surface.
7. Final level, light bull float, but do not trowel surface.
8. Broom or drag surface or other specified finish, per Subsection 3.3 this Section.
9. Do not use evaporative retarders as finishing aid.

F. Cold-Weather Placement: Comply with ACI 301, ACI 304, ACI 306R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below forty degrees (40°) F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

G. Hot-Weather Placement: Comply with ACI 301, ACI 304, ACI 305R, and as follows:

1. Maintain concrete temperature below ninety degrees (90°) F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is prohibited.
2. Spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

H. Ensure reinforcement, inserts, embedded parts and formed joints are not disturbed during concrete placement.

3.10 FINISHING

A. Rough Form Finish: All texture imparted by form facing material, including tie holes and defective areas, shall be repaired and patched, and all fins and other projections exceeding one-quarter inch (1/4”) shall be removed.

B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.11 CONCRETE CURING, PROTECTION, AND SURFACE TREATMENTS

A. General:

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Maintain concrete with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of concrete.
2. Curing shall commence as soon as free water has disappeared from the concrete surface after placing and finishing. The curing period shall be seven days for all concrete unless test cylinders, made and kept adjacent to the structure and cured by the same methods, are tested with the average compressive strength equal to seventy percent (70%) of the specified twenty-eight (28) day strength.
3. Curing shall be in accordance with ACI 301 procedures. Avoid rapid drying at the end of the curing period. During hot and cold weather, cure concrete in accordance with ACI 305R and ACI 306R.

B. Curing Methods: Perform curing of concrete by moisture curing, by moisture-retaining cover curing, by curing compound, and by combinations thereof, as herein specified and in accordance with ACI 308.1. Coordinate with and choose a curing method that is compatible with the requirements for subsequent material usage on the concrete surface.

1. Provide moisture retaining cover curing as follows: Cover concrete surfaces with a moisture-retaining cover for curing concrete, placed in widest practical width with sides and ends lapped at least three inches (3") and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
2. Provide curing and sealing compound to interior slabs left exposed, and to exterior slabs, walks and curbs as follows:
    a. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within thirty (30) minutes). Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Recoat areas subjected to rainfall within three hours after initial application.
    b. Maintain continuity of coating and repair damage during period.
    c. Do not use membrane curing compounds on surfaces which are to be covered with materials applied directly to concrete: liquid floor hardener, waterproofing, dampproofing, painting, and other coating and finish materials.

C. Curing Formed Surfaces: Where wooden forms are used, cure formed concrete surfaces by moist curing with forms in place for full curing period or until forms are removed. When forms are removed, continue curing by methods specified above for specified curing time.

D. Curing Unformed Surfaces:
1. Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of appropriate curing method.

3.12 FORM REMOVAL

A. Removal of Forms: Supplement and Modify ACI 301 as follows:
1. ACI 301 4.5.4: Formwork not supporting weight of concrete such as sides of grade beams, walls, and similar parts of the work, may be removed after cumulatively curing at not less than fifty degrees (50°) F for twenty-four (24) hours after placing the concrete provided:
    a. The concrete is sufficiently cured to be undamaged by form removal.
    b. Required shores and supports are so arranged that they will not be loosened or disturbed during form removal.
    c. Supplemental curing and protection is provided for exposed concrete surfaces.

3.13 TOLERANCES

A. Formed Surfaces and Building Lines: Conform to ACI 301 4.3.

B. Embedded Items: Unless noted otherwise on drawings, tolerances shall be as follows:
   1. Anchor Bolts:
      a. Adjacent anchor bolts in a group receiving a single fabricated setting piece: Plus or minus one-eighth inch (1/8”).
      b. Location and alignment of anchor bolt groups from designated location and alignment: Plus or minus one-eighth inch (1/8”).

3.14 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Project Manager. Remove and replace concrete that cannot be repaired and patched to Project Manager's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a Number sixteen (#16) sieve, using only enough water for handling and placing. Achieve approval of Project Manager prior to any patching as to location of patches and patch material.

C. Patch Testing: On a portion of the work which will, in the finished condition, be concealed, test patch materials and methods and obtain Project Manager’s approval prior to patching concrete surfaces needing repair that will be visible in the final construction.

D. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than one half inch (1/2”) in any dimension to solid concrete. Limit cut depth to three quarter inch (3/4”). Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
   2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color and texture. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
   3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Project Manager.

E. Repairing Unformed Surfaces: Test unformed surfaces, such tops of walls, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped for trueness of slope and smoothness; use a sloped template.

   1. After obtaining approval of Project Manager, repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of one-one hundredths inch (0.01”) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
      a. If, after repairs are complete, the Project Manager deems the repairs did not successfully correct the original deficiencies, the pavement or concrete element in question is to be removed and replaced per Subsection 3.14.A above.

   2. After concrete has cured at least fourteen (14) days, test for low and high spots in finished surface. Areas that do not conform to the tolerances set forth in Division 32 and in other reference standards identified in this specification are to be sawcut to the nearest joint as approved by the Project

Manager, defective concrete removed, and new conforming paving reinstalled. Color and finish is to match adjacent concrete.

3. If approved by Project Manager, repair random cracks and single holes one inch (1") or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least seventy-two (72) hours.

F. Perform structural repairs of concrete, subject to Project Manager's approval, using epoxy adhesive and patching mortar.

G. Repair materials and installation not specified above may be used, subject to Project Manager approval.

END OF SECTION

SECTION 32 11 16 AGGREGATE BASE COURSE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the requirements for furnishing and placing crushed aggregate, bonded with fine aggregate, constructed on a prepared underlying course in accordance with these specifications and in conformity with the dimensions, typical cross section, and the lines and grades shown on the Contract Drawings. The locations where aggregate base course will be used is shown on the Contract Drawings.

B. Related Sections:
1. Division 01 Section “Layout of Work and Surveys”.
2. Division 01 Section “Contractor Quality Control”.
3. Division 01 Section “Tree Retention and Protection”.
4. Division 01 Section “Erosion and Sedimentation Control”.
5. Division 03 Section “Cast-In-Place Concrete”.
6. Division 11 Section “Playground Equipment and Structures”.
7. Division 31 Section “Earth Moving”.
8. Division 32 Section “Asphalt Pavement”.
9. Division 32 Section “Concrete Walks, Curbs, and Miscellaneous Flatwork”.
10. Division 32 Section “Playground Protective Surfacing”.

1.3 SUBMITTALS

A. See Division 01 Section “Submittals” for submittal requirements.

B. Certification: Contractor shall provide a certificate of compliance for any imported Aggregate Base Course materials.

C. Gradation and Standard Proctor Density Test Results: For imported backfill materials, at a minimum, submit results of gradation tests and standard proctor density test.

D. Sample: Provide a 1-pound (1#) sample of material(s) for approval.

PART 2 - PRODUCTS

2.1 AGGREGATE BASE COURSE

A. Aggregate base course shall meet the requirements of Section 703 of the Standard Specifications for Road and Bridge Construction of the Colorado Department of Highways, latest revision for Class (6), or as specified by the Engineer on the Contract Drawings.

2.2 RECYCLED CONCRETE

A. May be substituted for Class (6) Aggregate, if acceptable to the Project Manager.

2.3 AGGREGATE

A. The use of this term implies the use of Aggregate Base Course within this Section only.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. All equipment necessary for the proper construction of this work shall be in working condition, and shall be free of fluid leaks. Project Manager reserves the right to have any piece of equipment removed from the site if it is deemed inoperable and/or is leaking fluids.

3.2 PREPARING SUBGRADE

A. The underlying subgrade or base course shall be tested at the Contractors expense and accepted by the Project Manager before placing and spreading operations are started. See Division 01 Section “Contractor Quality Control”.

3.3 METHOD OF SPREADING

A. The aggregate material shall be placed on the prepared underlying course and compacted in layers not to exceed six-inches (6”) in depth before compaction. The depositing and spreading of material shall commence where designated and shall progress continuously without breaks. The material shall be deposited and spread in a uniform layer and without segregation of size to a uniform thickness.

B. The aggregate spread shall be of uniform grading with no pockets of fine or course materials. During the spreading process, sufficient caution shall be exercised to prevent the incorporation of underlying materials in the aggregate.

3.4 COMPACTION OF AGGREGATE BASE COURSE

A. When aggregate base course is used as part of asphalt roadway system (asphalt and base course composite section), the aggregate base course shall be compacted to 95% of Modified Proctor per ASTM D-1557, within 2% of optimum moisture.

B. Aggregate material shall be placed and mixed in evenly spread layers. After each fill layer has been placed, it shall be uniformly compacted. Fill materials shall be placed such that the thickness of loose material does not exceed eight-inches (8”) and the compacted lift thickness does not exceed six-inches (6”).

C. Compaction shall be obtained by the use of vibratory rollers, multiple-wheel pneumatic-tired rollers, or other equipment approved by the Project Manager. Granular fill shall be compacted using vibratory equipment or other equipment approved by the Project Manager. Compaction of each layer shall be continuous over the entire area. Compaction equipment shall make sufficient passes to ensure that the required density is obtained.

D. Prior to placement of any base or surfacing materials, one-hundred percent (100%) of the subgrade shall be proof rolled with a fully loaded tandem-axle truck.

3.5 CLEANING

A. Perform cleaning during installation of the Work and upon completion of the Work. Remove all excess materials, debris, and equipment from site. Repair any damage resulting from installation of aggregate base course.

3.6 PROTECTION AND MAINTENANCE

A. Spreading of aggregate shall not take place when temperatures are below freezing. When the aggregate base course contains frozen material or the underlying subgrade is frozen, construction shall not occur.

B. Following the completion of the aggregate base course, the Contractor shall perform all maintenance work necessary to keep the aggregate in a satisfactory condition until final acceptance of the project. The surface shall be kept clean and free from foreign material. The aggregate base course shall be properly drained at all times. Any work, maintenance or necessary repairs shall be performed at the expense of the Contractor.

END OF SECTION 32 11 16

THE GARDEN SPOT – Berthoud Arboretum

TECHNICAL SPECIFICATIONS

SECTION 32 1216 – ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Additional information concerning asphalt paving may be found on the civil drawings, in the project geotechnical report and Town of Berthoud construction standards. In case of conflict between the drawings, jurisdictional criteria and the information specified herein, the more stringent requirements shall govern.

C. Additional information concerning asphalt paving may be found in the geotechnical investigation report by Berthoud Arboretum at Waggener Farm Park, Prepared by Rocksol Consulting Group, Inc., dated August 5, 2024. All applicable recommendations of this report shall be followed unless otherwise noted. Contractor to confirm with geotechnical engineer recommendations prior to the commencement of any paving activities. The information shown in this report is for information and it shall be the Contractor's responsibility to field verify conditions indicated.

1.2 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving overlay.
4. Asphalt surface treatments.
5. Cold milling of existing hot-mix asphalt pavement.

B. Relate Sections include the following:

1. Division 31, Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
2. Division 32, Section "Pavement Markings" for pavement striping and symbols.

C. References:

1. Town of Berthoud Standard Specifications for Design and Construction, latest edition.
2. Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition and all appropriate standard special provisions.
3. Americans with Disabilities Act ("ADA"); Architectural Barriers Act Accessibility Standard- ABAAS as provided for in the regulations of the United States Access Board
4. American National Standards Institute (ANSI) - *ANSI A117.1*

5. United States Department of Transportation and Federal Highway Administration accessibility standards principally listed in 2010 ADA Standards for Accessible Design and Proposed Guidelines for Pedestrian Facilities in the Public Right of Way Accessibility Guidelines ("PROWAG")
6. Local Jurisdiction Having Authority – standards, rules and regulations.

1.3 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D8 for definitions of terms.

B. CDOT: State of Colorado Department of Transportation.

C. CDOT Specifications: Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition and all appropriate standard special provisions.

1.4 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving in accordance with Section 401 of the CDOT Specifications.

1. Standard Specification: CDOT Specifications.
2. Measurement and payment provisions and safety program submittals included in CDOT Specifications do not apply to this Project.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated, include technical data and tested physical and performance properties.

B. Job-Mix Designs: For each job mix proposed for the work.

C. Material Test Reports: For each paving material.

D. Material Certificates: For each paving material, signed by providers.

1.6 QUALITY ASSURANCE

A. Manufacturer and Installer Qualifications:

1. Manufacturer Qualifications: Engage a firm experienced in manufacturing hot-mix asphalt similar to that indicated for this Project and with a record of successful in-service performance.
2. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Testing Agency:

1. All testing and inspections required herein will be performed by an independent testing and inspection agency employed by the Owner.
2. Notify the testing and inspection agency not less than 48 hours in advance of all work requiring testing or inspection services.

C. Testing Requirements: Asphalt Paving shall be tested for gradation, asphalt content, and in-place density in accordance with CDOT Specifications, the current edition of CDOT Field Materials Manual, and local Regulatory Agency requirements, whichever are the most stringent.

D. Preconstruction Conference: Conduct conference at Project site as directed by the Owner's Representative. The Contractor to comply with requirements, which may also be included in Division 1, Section “Project Management and Coordination.”

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:

1. Tack Coats: Minimum surface or air temperature in the shade of 60 degrees F.
2. Slurry Coat: Comply with weather limitations of ASTM D3910.
3. Asphalt Base Course: Minimum surface or air temperature in the shade of 40 degrees F and rising at time of placement.
4. Asphalt Surface Course: Minimum surface or air temperature in the shade of 50 degrees F and rising at time of placement.

B. Coordination and Scheduling:

1. Cooperate with other trades and arrange scheduling to avoid damage to other work, including grading, site utilities and piping, exterior concrete, landscaping, and irrigation systems.
2. Before commencing pavement operations, ascertain that utility lines, site lighting and wiring, piping, curb and gutter work, general grading, and heavy trucking is complete so that such operations will not damage paving work.
3. Mask off and protect exposed building surfaces and abutting concrete from damage or staining by tack coat and paving operations.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations meeting the requirements of the CDOT Specifications.

B. Asphalt Concrete Aggregate: Clean, hard, durable particles of crushed stone, crushed slag, crushed gravel, or natural gravel conforming to the requirements of Subsection 703.04 of the CDOT Specifications and Grading SX and S (Table 703-4).

C. Mineral Filler: Rock dust, slag dust, hydrated lime, hydraulic cement, or other suitable mineral material conforming to the requirements of Subsection 703.06 of the CDOT Specifications.

2.2 ASPHALT MATERIALS

A. Asphalt Cement: The asphalt cement to be used on this project shall be PG 64-22 conforming to the requirements of Subsection 702.01 of the CDOT Specifications.

B. Tack Coat: AASHTO M140, emulsified asphalt or AASHTO M208, cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

C. Fog Seal: AASHTO M140, emulsified asphalt or AASHTO M208, cationic emulsified asphalt, slow setting, diluted at the factory in water, of suitable grade and consistency for application.

D. Water: Potable.

2.3 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes. Furnish job-mix formulas for each pavement type, conforming to the requirements of Subsection 401.02 of the CDOT Specifications. Mix aggregates and bituminous materials in accordance with the requirements of Subsection 401.15 of the CDOT Specifications. Use approved job mix formulas. Mix to comply with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: Grading S.
3. Surface Course: Grading SX.

B. Emulsified-Asphalt: Shall conform to AASHTO M140 or AASHTO M208 in accordance with Subsection 702.02 of the CDOT Specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is unfrozen, free of water, snow, and ice otherwise in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction. Scarify, regrade, and recompact surface of subgrade that is pumping or deforming as required to provide true levels, uniform slopes, and proper total thickness of paving as required in Division 31, Section “Earth Moving.”

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

3.2 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of a minimum 2 inches, or as indicated on the plans.
2. Mill to a uniform finished surface free of gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Transport milled hot-mix asphalt to asphalt recycling facility.
7. Keep milled pavement surface free of loose material and dust.

3.3 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 gal./sq. yd. to 0.2 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.4 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch; in existing pavements.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4-inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4-inch wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4-inch wide. Fill flush with surface of existing pavement and remove excess.

C. Hot-applied joint sealant being a single-component formulation complying with ASTM D6690.

1. Refer to CDOT Standard Specification, Section 702.06 for joint and crack sealant material requirements.
2. Refer to CDOT Standard Specification, Section 408.01 and Section 408.03 for joint and crack sealant installation requirements.

3.5 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 gal./sq/ yd. to 0.20 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.6 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated on the plans or as directed by Geotechnical Report. Maximum lift thickness shall be 3 inches. Minimum lift thickness shall be 1-1/2 inches for Grading SX and 2 inches for Grading S.
2. Place hot-mix asphalt surface course in single lift. Maximum lift thickness shall be 2 inches.
3. Spread mix at minimum temperature of 235 degrees F per in accordance with Subsection 401.15 of the CDOT Specifications, Table 401-5.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.7 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, 6 inches to 12 inches.
4. Construct transverse joints as described in AI MS-22, “Construction of Hot Mix Asphalt Pavements.”
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.8 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. When paving surface temperature falls below 185 degrees F no further compaction effort will be permitted unless approved.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density in accordance with Subsection 401.17 of the CDOT Specifications.

1. Pavement shall be compacted to a density of 92 percent to 96 percent of the maximum theoretical density, determined according to Colorado Procedure 51. Field density determination will be in accordance with Colorado Procedure 44 or Colorado Procedure 81.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.9 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/4-inch.
2. Surface Course: Plus or minus 1/4-inch.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas (Construction tolerances identified herein apply to non-accessible routes, unless within this paragraph or specifically stated):

1. Base Course: 1/4-inch.
2. Surface Course: 3/16-inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4-inch.

C. Accessible Routes: For accessible routes, finished construction of accessible areas to meet published values for dimension and slope. **No tolerance** is permitted below minimum or above maximum values and must meet accessible requirements such as ADA, ANSI A117.1 and as provided for in regulations of the United States Access Board, the United States Department of Transportation and Federal Highway Administration which requirements are principally listed in 2010 ADA Standards for Accessible Design, Proposed Guidelines for Pedestrian Facilities in the Public Right of Way Accessibility Guidelines ("PROWAG") and Local standards. All construction or alterations of accessibility routes (walks, ramps, entrances, etc.) shall comply with standards, rules and regulations set forth above, including but not limited to 5% maximum longitudinal grade on walks without handrails, 8.33% maximum longitudinal grade on walks with handrails, and landings 2% maximum composite slope. 2% maximum cross slope on walks, and 2% maximum composite slope in handicap parking/loading areas. No tolerance regarding maximum slope will be allowed.

Prior to construction, contractor shall coordinate as necessary with Owner/Developer, Engineer, Architect or designated official if rules and regulations of accessibility routes cannot be met or a discrepancy of requirements are indicated on drawings.

3.10 MANHOLE FRAME ADJUSTMENTS

A. Set frames for manholes and other such units within areas to be paved to 1/4-inch minimum to 1/2-inch maximum below final grade as part of this work. Include existing frames or new frames furnished under other sections of these specifications.

B. Set cover frames to 1/4-inch minimum and 1/2-inch maximum below surface of adjacent pavement. Surround frames set to grade with a ring of compacted asphaltic concrete base prior to paving. Place asphaltic concrete mixture up to 1-inch below top of frame, slope to grade, and compact with hand tamping. Adjust frames as required for paving.

C. Provide temporary closures over openings until completion of rolling operations. Remove closures at completion of work.

3.11 ASPHALT CURBS

A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at minimum temperature of 250 degrees F.

1. Asphalt Mix: Same as pavement surface-course mix.

B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.12 SURFACE TREATMENTS

A. Fog Seals: Apply fog seal at a rate of 0.10 gal./sq. yd. to 0.15 gal./sq. yd. to existing asphalt pavement and allow to cure. With a fine sand, lightly dust areas receiving excess fog seal.

B. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D3910 and allow to cure.

1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested work complies with or deviates from specified requirements.

B. Additional testing and inspecting, at the Contractor 's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D979.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D1188 or ASTM D2726.

a. One core sample will be taken for every 350 sq. yd. or less of installed pavement, with no fewer than three cores taken.
b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D2950 and correlated with ASTM D1188 or ASTM D2726.

F. Asphalt Content and Gradation. Testing agency will take sample of uncompacted paving mixtures at a minimum frequency of every 1,000 tons according to Colorado Procedure – Laboratory CPL-5120 and Colorado Procedure CP-31.

G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements. Conforming to the specified requirements will be in accordance with Subsection 105.03 of the CDOT Specifications.

3.14 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from project site, and legally dispose of them in an EPA-approved landfill.

1. Do not allow excavated materials to accumulate on-site.

END OF SECTION 32 1216

THE GARDEN SPOT – Berthoud Arboretum

TECHNICAL SPECIFICATIONS

SECTION 32 1313 – CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes constructing exterior concrete paving on prepared subgrade or base course in accordance with these specifications. This work shall be in conformity with the lines, grades, thicknesses, and typical cross-sections shown on the plans for the following:

1. Driveways and roadways.
2. Parking lots.
3. Curbs and gutters.
4. Sidewalks, steps, and ramps.
5. Base material for unit paver.
6. Dumpster and loading dock pads.
7. As detailed on the plans.

B. Related Sections include the following:

1. Divisions 31, Section "Earth Moving" for subgrade preparation, grading, and subbase course.
2. Division 32, Section "Pavement Marking" for pavement striping and symbols.
3. Division 32, Section "Concrete Pavement Joint Sealants" for expansion and contraction joints.

1.3 REFERENCES

A. Town of Berthoud Standard Specifications for Design and Construction, latest edition.

B. Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition.

C. Americans with Disabilities Act ("ADA"); Architectural Barriers Act Accessibility Standard-ABAAS as provided for in the regulations of the United States Access Board

D. American National Standards Institute (ANSI) - *ANSI A117.1*

E. United States Department of Transportation and Federal Highway Administration accessibility standards principally listed in 2010 ADA Standards for Accessible Design and Proposed

Guidelines for Pedestrian Facilities in the Public Right of Way Accessibility Guidelines ("PROWAG")

F. Local Jurisdiction Having Authority – standards, rules and regulations.

1.4 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, expansive hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

B. CDOT: State of Colorado Department of Transportation.

C. CDOT Specifications: Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition.

D. ADA Handbook: Americans with Disabilities Act Standards for Accessible Design, U.S. Department of Justice.

E. ANSI A117.1: Standard for Accessible and Usable Buildings and Facilities, American National Standard Institute.

F. Refer to ACI 301: (American Concrete Institute – Standard Specifications for Structural Concrete), for additional definitions.

1.5 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixes: For each concrete pavement mix, and includes alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

1. Aggregates.
2. Cement.
3. Admixtures.

D. Material Certificates: Signed by manufacturers certifying that each of the following materials used in the project complies with requirements:

1. Cementitious materials and aggregates.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or adhesive.

8. Joint fillers.

E. Field quality-control test reports.

F. Pavement Joint Layout Plan: Plan to show joint locations and typical dimensions for review and approval by the Engineer.

G. Traffic Control Plan: For work in the public right-of-way.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed pavement work similar in material, design, and extent to that indicated for this project, and whose work has resulted in construction with a record of successful in-service performance.

B. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C94 requirements for production facilities and equipment.

1. Manufacturer must be certified according to the National Ready Mix Concrete Association's (NRMCA) Plant Certification Program.

C. Testing Agency Qualifications: An independent agency qualified according to ASTM C1077 and ASTM E329 for testing indicated, as documented according to ASTM E548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.

E. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by the requirements of the Contract Documents.

F. Concrete Testing Service: The Owner will engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

G. Preconstruction Conference: Conduct conference at project site as directed by the Owner's Representative prior to start of construction. The Contractor is to comply with requirements, which may also be included in Division, 1 Section "Project Management and Coordination."

H. Regulatory Requirements:

I. Comply with Town of Berthoud standards for sidewalks, curbs, ramps, gutters, and driveway approaches or aprons, including standard dimensions, profiles, thicknesses, reinforcing, and compressive strength. In the event of conflict between the Contract Documents and the standards, the more stringent requirements will apply.

1. Accessible Routes: For accessible routes, finished construction of accessible areas to meet published values for dimension and slope. No tolerance is permitted below minimum or above maximum values and must meet accessible requirements such as ADA, ANSI A117.1 and as provided for in regulations of the United States Access Board, the United

States Department of Transportation and Federal Highway Administration which requirements are principally listed in 2010 ADA Standards for Accessible Design, Proposed Guidelines for Pedestrian Facilities in the Public Right of Way Accessibility Guidelines ("PROWAG") and Local standards. All construction or alterations of accessibility routes (walks, ramps, entrances, etc.) shall comply with standards, rules and regulations set forth above, including but not limited to 5% maximum longitudinal grade on walks without handrails, 8.33% maximum longitudinal grade on walks with handrails, and landings 2% maximum composite slope. 2% maximum cross slope on walks, and 2% maximum composite slope in handicap parking/loading areas. No tolerance regarding maximum slope will be allowed.

1.7 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic, as required for other construction activities.

B. Coordination and Scheduling: Coordinate with other trades and arrange scheduling to avoid damage to other work, including grading, site utilities and piping, asphalt paving, landscaping, and irrigation systems.

C. Field Measurements: Verify dimensions and existing conditions shown on the drawings by taking field measurements prior to start of work. Report discrepancies to the Owner's Representative for clarification and make minor adjustments in layout as required by field conditions and as approved by the Owner's Representative, at no additional cost to the Owner.

D. Environmental Requirements: Perform work only under suitable weather conditions. Comply with the environmental requirements of Section 3.6 for concrete placement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. 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.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves of a radius 100 feet or less.

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

2.3 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Fabric: CDOT Section 709 and ASTM A497, fabricated from as-drawn steel wire into flat sheets. For use within building envelope only.

B. Reinforcement Bars: CDOT Section 709 and ASTM A615, Grade 60, deformed. Cut bars true to length with ends square and free of burrs.

C. Joint Dowel Bars: Plain steel bars, CDOT Section 709 and ASTM A615, Grade 60. Cut bars true to length with ends square and free of burrs.

D. Tie Bars: CDOT Section 709 and ASTM A615, Grade 60, deformed.

E. Supports for Reinforcement: Chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base materials will not support chair legs.

2.4 COLORED ADMIXTURE

A. Colored Admixture: L.M. Scofield Co. "Chromix" or Rockwood Industries "Davis Colors," color as selected by the Owner's Representative. Use for colored concrete where indicated on the drawings.

2.5 EXPANSION JOINT FILLER

A. Sealed Joints: Preformed, compressible fiber or cork filler material complying with ASTM D1751 or ASTM D1752, Type II, guaranteed compatible with expansion joint sealant materials, 1/2 inch thick, unless otherwise indicated. Provide high-impact polystyrene removable "void cap" to create 1/2-inch deep reveal for installation of sealant.

B. Self-Sealing Joints: Preformed, compressible asphalt fiber joint filler complying with ASTM D994, 1/2 inch thick unless otherwise indicated. Do not use asphalt fiber filler in joints to receive elastomeric joint sealants.

2.6 CONCRETE MATERIALS

A. Cementitious Material: Use one of the following cementitious materials, of the same type, brand, and source throughout the Project:

1. Portland Cement: CDOT Section 701 and ASTM C150, Type I/II.

a. Fly Ash: ASTM C618, Class F.
b. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.

B. Normal-Weight Aggregates: CDOT Section 703 and ASTM C33, coarse aggregate, uniformly graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 3/4-inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
3. Do not use fine or coarse aggregates containing substances that cause spalling.

C. Water: CDOT Section 712 and ASTM C94 potable.

2.7 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain no more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures.

B. Air-Entraining Admixture: CDOT Section 711 and ASTM C260.

C. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C494, Type A.
2. Retarding Admixture: ASTM C494, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494, Type D.
4. Water-Reducing and Accelerating Admixture: ASTM C494, Type E.
5. High-Range, Water-Reducing Admixture: ASTM C494 Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C494, Type G.
7. Plasticizing and Retarding Admixture: ASTM C1017, Type II.

2.8 FIBER REINFORCEMENT

A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C1116, Type III, 1/2-inch to 1-1/2 inches long.

2.9 CURING MATERIALS: CDOT SECTION 711

A. Absorptive Cover: AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq.yd. dry.

B. Moisture-Retaining Cover: ASTM C171, waterproof paper, polyethylene film, or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C309, Type I, Class B.

1. Provide material that has a maximum volatile compound (VOC) rating of 350 g/L.

F. White Waterborne Membrane-Forming Curing Compound: ASTM C309, Type II, Class B.

1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/L.

2.10 RELATED MATERIALS

A. Color Pigment: ASTM C979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.

1. Available Manufacturers:

a. Bayer Corporation.
b. ChemMasters.
c. Conspec Marketing & Manufacturing Co., Inc.
d. Davis Colors.
e. Elementis Pigments, Inc.
f. Hoover Color Corporation.
g. Lambert Corporation.
h. Scofield, L. M. Company.
i. Solomon Colors.

2. Color: As selected by Owner's Representative from manufacturer’s full range.

2.11 CONCRETE MIXTURES

A. Prepare design mixes, proportioned according to ACI 211 and ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the trial batch method.
2. Do not use the Owner’s field quality-control testing agency as the independent testing agency.

B. Proportion mixes to provide concrete with the following properties:

1. Compressive Strength (28 days): 4,500 psi.
2. Modulus of Rupture (28 days): Minimum 650 psi.
3. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.44.
4. Slump Limit: 4 inches +/- 1”.
5. Minimum 520 lb. Cement per cubic yard. (CDOT Class P).

C. Add air-entraining admixture at the manufacturer’s prescribed rate to result in concrete at point of placement having an air content of 4.0 percent to 8.0 percent.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to the manufacturer's written instructions.

1. Use water-reducing admixture and plasticizing and retarding admixture in concrete, as required, for placement and workability.

2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals as follows:

1. Fly Ash: 20 percent to 30 percent Class F Fly Ash CDOT Section 601.02, Class P Concrete.

G. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd.

2.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94 and ASTM C1116. Furnish batch certificates for each batch discharged and used in the work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
3. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2-inch require correction according to requirements in Division 2, Section “Earth Moving.”

C. Subgrade shall be tested by the Geotechnical Engineer and pass required tests prior to concrete pavement placement.

D. Proceed with concrete pavement operations only after non-conforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 12-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Construct/install construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.
2. Contractor to provide plan of joint placement for the Engineer's approval.
3. The distance between joints shall not exceed in feet, 1.7 times the pavement thickness in inches. (i.e.: 6-inch PCC pavement to utilize maximum 10-foot joint spacing.)

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at expansion joints.

1. The Contractor may utilize preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
2. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
3. Provide tie bars at sides of pavement strips where indicated.

4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.

C. Expansion Joints: Form expansion joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Extend joint fillers full width and depth of joint.
2. Terminate joint filler no less than 1/2-inch or no more than 1 inch below finished surface for joint sealant.
3. Furnish joint fillers in one-piece lengths. Where more than one length are required, lace or clip joint-filler sections together.
4. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to the indicated radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
3. Tied Contraction Joints: Install deformed bars and support assemblies at joints where indicated.

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces or on standing water.

C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

D. Comply with ACI 301 and ACI 304R requirements and recommendations for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery to the project site.

F. Do not add water to fresh concrete after testing.

G. Do not add water to concrete surface during finishing operations.

H. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

I. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

J. Screed pavement surfaces with a straightedge and strike off.

K. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry-shake surface treatments.

L. Curbs and Gutters: Produce curbs and gutters to required cross section, lines, grades, finish, and jointing, as specified with expansion joints at intervals of approximately 100 feet and tooled contraction joints at 10-foot intervals. When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements.

M. Walks: Minimum 4 inches thick, with expansion joints at intervals of approximately 100 feet and tooled contraction joints at intervals equal to width of walks or maximum 5-foot intervals. Tool edges to rounded profile and finish as noted herein or shown on the drawings. The Contractor may utilize sawed contraction joints. Pitch walks 3/16-inch per foot for drainage, unless otherwise indicated.

N. Ramps: Construct ramps similar to walks. Comply with applicable ADA Handbook, ANSI A117.1, and local and State codes, ordinances, and details including maximum allowable slope not to exceed 1-foot vertical in 12-foot horizontal, with maximum rise not to exceed 30 inches between level landings.

O. Steps: Minimum 6 inches thick at intersection of treads and risers reinforced, as indicated. Slope treads 1/4-inch to nosing, and tool nosings to uniform 1/2-inch radius. Finish as specified below.

P. Paving: Minimum 6 inches thick, unless otherwise indicated. Provide expansion joints, as indicated on the drawings, and contraction joints at a minimum 10-foot EWW. Provide fibermesh reinforcing. Place concrete paving over compacted subgrade as specified in Division 2, Section "Earth Moving." Provide minimum 1 percent slope for drainage unless otherwise indicated.

Q. Driveway Approaches: Minimum 6 inches thick, unless otherwise indicated or required by local public works standards or building codes. Construct to radius of flare indicated, and taper or warp into alignment with adjacent curbs, gutters, and walks. Place approaches over compacted subgrade as specified in Division 2, Section "Earth Moving." Refer to drawing and details for any reinforcing requirements.

R. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing, as required for formed pavement.

Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

S. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

T. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F and not more than 80 degrees F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.

U. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees F. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is the Contractor's option.
2. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, reinforcement steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

V. Wet-Weather Placement: Do not begin to place concrete while rain, sleet, or snow is falling unless adequate protection is provided and, when required, acceptance of protection is obtained.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

C. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots, and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection and follow the recommendations of ACI 305R for hot-weather protection during curing.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb./sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 PAVEMENT TOLERANCES

A. Tolerances identified herein apply to non-accessible routes, unless within this paragraph or specifically stated. See section 1.6.I for ADA tolerance requirements. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4-inch.
2. Thickness: Plus 3/8-inch, minus 1/4-inch.
3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/4-inch.
4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
5. Vertical Alignment of Tie Bars and Dowels: 1/4-inch.
6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2-inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4-inch per 12 inches.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4-inch, no minus.
10. Joint Width: Plus 1/8-inch, no minus.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 50 cu. yd. or fraction thereof of each concrete mix placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each type of concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231, pressure method; one test for each composite strength test, but not less than one test for each day’s pour of each type of concrete mix.
4. Concrete Temperature: ASTM C1064; one test hourly when air temperature is 40 degrees F and below and when 80 degrees F and above, and one test for each set of composite strength specimens.
5. Compression Test Specimens: ASTM C31; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.
6. Compressive-Strength Tests: ASTM C39; one set for each day's pour of each concrete class exceeding 5 cu. yd., but less than 25 cu. yd., provide at least two tests for every 100-cu. yd., (one set for each 50-cu. yd.). One specimen shall be tested at seven days and two specimens at 28 days; one specimen shall be retained in reserve for later testing, if required.
7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, current operations shall be evaluated and corrective procedures shall be provided for protecting and curing in-place concrete.

C. Strength of each concrete mix will be satisfactory if average of any three-consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to the Owner's Representative, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, concrete type and class, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both seven-day tests and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Owner's Representative, but will not be used as the sole basis for approval or rejection.

F. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Owner's Representative. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods, as directed.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at the Contractor’s expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this section.

B. Drill test cores where directed by the Owner's Representative when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with Portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 1313

THE GARDEN SPOT – Berthoud Arboretum

TECHNICAL SPECIFICATIONS

SECTION 32 1373 – CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Additional information concerning concrete paving may be found on the civil drawings, in the project geotechnical report and agency having jurisdiction construction standards. In case of conflict between the drawings, jurisdictional criteria and the information specified herein, the more stringent requirements shall govern.

1.2 SUMMARY

A. This Section includes the following:

1. Expansion and contraction joints within cement concrete pavement.
2. Joints between cement concrete and buildings and structures.
3. Surface preparation including primers.
4. Joint backup material.

1.3 REFERENCES

A. Town of Berthoud Standard Specifications for Design and Construction, latest edition.

B. Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition.

1.4 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

C. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.

E. Warranty: As required by Division 1 – Warranty Section: Contractor agrees to repair or replace joint sealers (including labor, materials, and any necessary associated costs) which fail to perform as watertight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance or general durability; or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of material for exposure indicated. Provide warranty signed by Installer and Contractor.

1.5 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Work under this section shall be subject to all applicable provisions of federal, state, and local rules and regulations.

B. Applicator: Company specializing in application of sealants with five years minimum experience and be acceptable to manufacturer. Manufacturer's field representative shall visit site and make suggestions.

C. Adhesion Tests: Prior to any sealant application, perform adhesion tests as directed by sealant manufacturer's technical representative.

D. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multi-component materials.

B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Install sealant materials in strict accordance with all safety and weather conditions recommended by manufacturer, product literature, or Material Safety Data Sheets. Do not proceed with installation of sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation. Proceed only when forecasted weather conditions are favorable for proper cure and development of high-early bond strength. Wherever joint width is affected by ambient temperature variations, install elastomeric sealants only when temperatures are in lower third of manufacturer's recommended installation temperature range.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and

application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: Match color of hardened concrete closely.

2.2 COLD-APPLIED JOINT SEALANTS

A. Approved Sealants:
1. Sealants shall be selected for performance under applicable conditions as approved by Project representative and manufacturer.

For each application, provide the grade of sealant (non-sag, self-leveling, no-track knife grade preformed, etc.) as recommended by the manufacturer for the particular condition of installation (location, joint shape, ambient temperature, and similar conditions), to achieve the best possible overall performance. Grades specified herein are for normal condition of installation.

2. Silicone Sealant: ASTM C-920-79, Type S, Class 25, Grade NS.

2.3 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

D. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

2.4 PRIMERS

A. Primers: Product recommended by join-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from manufacturers recommendation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 JOINT DESIGN

A. Sealant depth is measured at the center (thin) section of sealant bead.

B. Install sealants to depths and widths as recommended by sealant manufacturer and as shown on the drawings. Also, conform to the following general limitations if not in conflict with sealant manufacturer’s recommendations.

1. For sidewalks, pavements and similar joints subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75 percent of joint width, but neither more than 5/8 inch deep nor less than 3/8 inch deep.
2. For normal moving joints not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but neither more than 5/8 inch deep nor less than 1/4 inch deep.
3. Depth of sealant must not exceed width of joint.
4. Sealant joints shall not be less than 1/4 inch in width and 1/4 inch in depth.
5. Sealant joints shall not exceed 2 inches in width.

3.4 SURFACE PREPARATION

A. Preparation work shall result in clean surfaces in all areas where sealant is to be adhered. Such surfaces shall be free of any old sealant, contaminants, and impurities, which are deleterious to bonding or adhesion of primers or sealant.

B. Clean ferrous metals of all rust, mill scale, and coatings by wire brush or grinding. Any equipment used to remove rust shall be free of oil contaminants.

C. Wire brush masonry joint surfaces, then blow clean with oil free compressed air.

D. Apply primer per manufacturer’s recommendations. Allow primer to dry prior to applying sealant.

E. Do not caulk joints until they are clean, dry, and free of dust, loose mortar, old sealant, foreign matter or other bond inhibiting materials, and in compliance with requirements of manufacturer of materials, details shown on drawings, and specific requirements of other sections of specifications.

3.5 JOINT BACKING

A. Use joint backing to control depth of joint to specified thickness.

B. Select joint backing size to allow for 25 percent compression of backing when inserted into joint.

C. Where shown on drawings where depth of joint will not permit use of joint backing, or wherever recommended by sealant manufacturer, install bond-breaker tape to prevent three (3) sided adhesion.

D. Do not leave voids or gaps between ends of joint backing units.

E. Backer shall be installed in single lengths with no bends, twists, or kinks.

3.6 APPLICATION/INSTALLATION OF JOINT SEALANT

A. Apply sealants neatly, in a good and workmanlike manner, which meets following minimum requirements or standards. Specific instructions of manufacturer must also be followed.

B. Apply sealant using a gun with proper size nozzles. Use sufficient pressure to fill all voids and joints solid to backup material, with complete wetting of all joint bond surfaces.

C. Applied sealant shall form a full, smooth, uniform bead, free of ridges, wrinkles, sags, air pockets and embedded impurities.

D. After joint has been completely filled with sealant, neatly tool joint sealant to eliminate air pockets, or voids, and to provide a smooth, slightly concave, neat appearing finish, with sealant surface slightly below adjoining surfaces. Wetting of finished surface will not be allowed.

E. Where horizontal joints are located between a horizontal surface and vertical surface, fill joint to form a slight cove, so joint will not trap moisture and dirt.

F. Protect adjacent surfaces and systems from sealant material. Use masking tape where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

G. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

H. Tooling of Non-Sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealants from surfaces adjacent to joint.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

I. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.

J. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.7 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.8 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes, so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

3.9 JOB SITE CLEAN-UP

A. Sealant applicator must remove all excess materials from job site.

B. Leave all surrounding areas where joint sealant has been applied free of excess sealant, debris, and foreign substances.

END OF SECTION 32 1373

SECTION 32 15 40 CRUSHED STONE PAVING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes requirements for demolition, earthwork, grading, furnishing, and placement of crushed stone paving.
   1. Furnish and place crushed stone paving, bonded with fine aggregate, constructed on a prepared underlying base course in accordance with these specifications and in conformity with the dimensions, typical cross section, and the lines and grades shown on the Contract Drawings. The locations where crushed stone paving will be used are shown on the Contract Drawings.

B. Related Sections:
   1. Division 01 Section “Layout of Work and Surveys”.
   2. Division 01 Section “Contractor Quality Control”.
   3. Division 01 Section “Erosion and Sedimentation Control”.
   4. Division 31 Section “Earth Moving”.

1.3 REFERENCES

A. ASTM C117 – Test Method for Materials Finer than No. 200 (75-um) Sieve in Mineral Aggregates by Washing.

B. ASTM C136 – Method for Sieve Analysis of Fine and Coarse Aggregates.

C. ASTM D4318 – Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

1.4 SUBMITTALS

A. Material Analysis: Contractor shall provide copies of the following test data required by ASTM:
   1. ASTM C136 - Sieve Analysis.
   2. ASTM C127 - Specific Gravity and Absorption.
   3. ASTM C131 - L.A. Abrasion.

B. Samples: Provide a one (1) quart sample of material for approval.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

B. Bulk Materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas, plant materials or within critical root zones.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

C. Rejection of material.
1. Evidence of inadequate protection or improper handling or storage shall be cause for rejection.
2. Any product or material exhibiting signs of damage due to nonconformity to specifications or due to delivery, storage or handling shall be rejected by the Project Manager. Contractor shall be responsible for hauling off-site and disposing of according to general conditions and codes of the governing jurisdiction.

1.6 PROJECT CONDITIONS

A. Environmental requirements: Work shall occur only when weather and soil conditions permit in accordance with locally accepted practice.

B. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with proposed crushed stone paving areas by field measurements before proceeding with work.

C. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others.

D. Existing Conditions:
1. Utilities: Determine location of existing and proposed underground utilities. Perform work in a manner to avoid damage. Hand excavate, as required.
2. Excavation: Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.

E. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained.

1.7 MAINTENANCE SERVICE

A. General: Maintain Work in accordance with Division 01.
1. Maintenance Period: Begin maintenance immediately after Work is completed. Maintain areas until the end of the Warranty period.

1.8 WARRANTY

A. See Division 01 Section “Warranty”.

PART 2 PRODUCTS

2.1 CRUSHED STONE PAVING

A. Type 1: Crushed granite stone or gravel. Shall be unused material free of shale, lay, friable materials, organics and debris.
1. Size Range: 3/8 inch maximum

Sieve Size	Percent Passing

2 inch	100
3/8 inch	100
No. 4	85
No. 8	63
No. 16	50
No. 30	39
No. 50	29
No. 100	18

2. Color: shall be "Tan Breeze as supplied by Colorado Materials, Inc. (T) 303-682-2314, Longmont, CO, or approved equal by the Project Manager.

3.

B. Type 2: Crushed granite stone or gravel. Shall be unused material free of shale, lay, friable materials, organics and debris.
1. Size Range: 3/8 inch maximum

Sieve Size	Percent Passing
2 inch	100
3/8 inch	100
No. 4	85
No. 8	63
No. 16	50
No. 30	39
No. 50	29
No. 100	18

2. Color: shall be "Mountain Granite Breeze" as supplied by Colorado Materials, Inc. (T) 303-682-2314, Longmont, CO, or approved equal by the Project Manager.

2.2 SOIL STABILIZER

A. Soil stabilizer or binder: Natracil by Gail Materials or approved equal.
1. Local supplier:
2. Swell volume: 35 ml/gm minimum in accordance with USP procedures.
3. 90% minimum shall pass a No. 40 mesh screen.

B. Factory blended stabilized crushed stone paving. Provide in all locations shown on the drawings.
1. Mix crushed stone paving material with Natracil with a pug mill that includes a weigh-belt feeder.
a. Mix fourteen (14) pounds of binder per two thousand (2,000) pounds of aggregate.

2.3 GEOTEXTILE FABRIC

A. Mirafi 140 N as supplied by TC Mirafi, 706-693-2226, or approved equal

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas where the Work of this Section will be performed for compliance with requirements and conditions affecting installation and performance.
   1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within the work area.
   2. Verify that final grades are completed in accordance with the drawings.

B. Proceed with installation only after unsatisfactory conditions have been corrected and approved by Project Manager.

3.2 QUALITY CONTROL

A. Mock-up: Provide field constructed sample installation of crushed stone paving, and prepared subgrade.
   1. Mock-up to be ten foot (10') x ten foot (10') and located where directed by Project Manager. Mock-up shall include proposed edge and banding, and surface stabilization if specified.
   2. Project Manager shall review mock up within forty-eight (48) hours of notification by the contractor.
   3. Make necessary adjustments as directed by Project Manager.
   4. Obtain approval from Project Manager before proceeding with the Work.
   5. Retain and protect mock-up during construction as a standard for judging completed crushed stone paving work. Do not remove or destroy mock-up until work is completed.
   6. Accepted and properly maintained sample installations may remain in completed work if approved in writing by Project Manager.
   7. All work shall match accepted field mock-up.

3.3 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, turf areas, existing landscape areas, and trees from damage.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of

C. Install edging of type and in locations shown on drawings. Obtain acceptance of layout by Project Manager before excavating or installing. Make minor adjustments as required.

3.4 PLACEMENT OF CRUSHED STONE PAVING

A. Cut earthwork to width of trail/area to receive crusher fines paving to approximate depth section as specified on the Contract Drawings. Remove, haul and dispose of excess material off site, or use on-site with approval of Project Manager.

B. Complete excavation required in sub-grade before fine grading and final compaction of sub-grade is performed. Extend sub-grade compaction one foot (1') beyond proposed edge of crushed stone paving or as indicated on drawings.
   1. Where earth moving is required the sub-grade shall be compacted to ninety-five percent (95%) minimum standard proctor within two percent (2%) of the optimum moisture.

2. Keep areas being graded or compacted shaped and drained during construction. Ruts greater than or equal to 1-inch-deep in sub-grade shall be graded out and reshaped as required, and re-compacted before crushed stone paving placement.
3. If the trail is part of a cross slope it should drain in the direction of the slope no greater than two percent (2%). Ensure that no low spots exist so that ponding does not occur.

C. Prior to placement of Crushed Stone Paving material, the sub-grade shall be proof rolled. Where soft spots are detected, scarify subgrade beneath Crushed Stone Paving trail to a minimum of six inch (6") depth. Moisture treat and compact to a minimum ninety-five percent (95%) proctor density as determined by ASTM D698 or AASHTO T-99. Take moisture density tests every two hundred fifty (250) lineal feet of trail or proof roll. Treat and compact sub-grade, leaving it 5-inches below final grade for placement of Crushed Stone Paving. Compact material and retest by proof rolling to achieve approval of Project Manager.

D. Install crushed stone paving only after excavation and construction work which might injure it have been completed, and after edging has been completely installed on the compacted sub-grade. Install crushed stone paving, over compacted base course in areas indicated on plan.

E. Spread crushed stone evenly to fifty percent (50%) of specified depth. Avoid segregation of aggregate and contamination with lower courses or sub-grade.

F. Compact to ninety-five percent (95%) of maximum density as determined by ASTM D1557.
1. Maintain surface course moisture content within plus/minus three percent (± 3%) of optimum. Add water to quarry fines paving as required to achieve optimum moisture content and a uniform, compacted surface conforming to the finish grades indicated.
2. Compact areas inaccessible to rolling by mechanical tamping.

G. Protect crushed stone paving from soil or other contaminates during and following installation.

H. Spread and compact additional crushed stone paving to achieve the required minimum compacted thickness. Compact per 3.4.F above.

3.5 PLACEMENT OF STABILIZED CRUSHED STONE PAVING

A. Complete items 3.4 A through H above using specified crusher fines material with pre-incorporated specified binder at specified application rates.

B. Do not allow traffic on stabilized crushed stone paving for two days.

3.6 MAINTENANCE AND REPAIRS:

A. Crusher Fines Paving:
1. Areas that do not compact, become eroded or are degraded in visual quality and/or performance as determined by the Project Manager are to be removed and/or repaired. Obtain approval of repair methods from Project Manager prior to affecting repairs.

B. Stabilized Crusher Fines Paving:
1. To repair, excavate damaged area leaving a minimum one-inch depth of existing stabilized crushed stone paving. Apply stabilized crusher fines to existing surface as described above. Compact per 3.4 F above.
2. Do not allow traffic on repaired stabilized crushed stone paving for two days or until paving has fully cured.

3.7 CLEANUP AND PROTECTION

A. All areas shall be clean at the end of each workday.

B. The contractor shall maintain protection during installation, curing, and maintenance periods.
   1. Erect temporary fencing or barricades and warning signs as required protecting newly installed Crushed Stone Paving areas from traffic, other trades, and trespassers. Maintain fencing and barricades throughout initial maintenance period and remove with approval of Project Manager.

C. Project completion: All debris, soil, trash, and excavated and/or stripped material resulting from Crushed Stone Paving operations and unsuitable for or in excess of requirements for completing work of this Section shall be disposed of off-site.

D. Maintain protection during installation and maintenance periods. See Division 1. Treat, repair or replace damaged work as required.

3.8 QUALITY ASSURANCE

A. Refer to Division 1 Section “Quality Assurance”.

END OF SECTION 32 15 40

THE GARDEN SPOT – Berthoud Arboretum

TECHNICAL SPECIFICATIONS

SECTION 32 1723 – PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the contract, including General and Supplementary Conditions, and Division 1 specification. Sections apply to this Section.

1.2 SUMMARY

A. This Section includes the following: Furnish and install all painted lines, directional arrows, handicapped symbols, or similar markings on paved surfaces, as shown on the drawings or specified herein, as required by jurisdiction having authority, and as required to complete the work.

B. Related Work:

1. Division 32 Section “Asphaltic Paving” for materials, installation and minimum requirements.
2. Division 32 Section “Concrete Paving” for materials, installation and minimum requirements.

1.3 REFERENCES

A. Reference Standards: Comply with the requirements of the reference standards noted herein, except where more stringent requirements are described herein or otherwise required by the Contract Documents.

B. Town of Berthoud Standard Specifications for Design and Construction, latest edition.

C. Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, current edition.

D. “Manual on Uniform Traffic Control Devices” latest edition.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer’s published descriptive literature and complete specifications for products specified herein.

1.5 QUALITY ASSURANCE

A. Qualifications: Pavement marking applicator shall be regularly engaged in this type of work, and shall provide adequate, experienced manpower and proper equipment to complete the work.

B. Regulatory Requirements: Comply with applicable provisions of Colorado State Department of Highways Specification Sections 627, 708, and 713.

1.6 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping: Deliver materials in manufacturer's original, unopened containers, with labels intact and legible.

1.7 PROJECT CONDITIONS

A. Environmental Requirements: Do not apply pavement marking when ambient air and pavement surface temperature is below 40°F for paint and below 50°F for epoxy and thermoplastic marking materials, or when moisture in any form is present on the pavement surface.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Traffic Marking Paint: Acrylic Waterborne Paint or Low Volatile Organic Compound (VOC) solvent base paint, lead and chromate free, ready-mixed, cold-applied traffic marking paint complying with CDOT specification table 708-1, white or yellow color as designated on the plans for striping and lane markings, white and blue at international handicapped parking symbols. Acceptable products include Devoe Exterior "Safety Line" or approved equal.

B. Preformed Thermoplastic Pavement Marking: Markings shall consist of a resilient white or yellow thermoplastic product with glass beads uniformly distributed. Capable of being affixed to bituminous pavement by heating and applied to concrete per manufacture recommendations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work of this Section will be performed. Do not proceed with the work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.

3.2 PREPARATION

A. Surface Preparation: Allow fresh pavement surfaces to weather at least 30 days prior to application of traffic marking paint.

3.3 APPLICATION

A. Traffic Marking Paint: Unless otherwise indicated, apply traffic marking paint in nominal 4-inches wide stripes at the rate of 100 to 110 sf/gal.

B. Preformed Plastic Pavement Marking: Apply per manufacturers recommendations.

C. Patterns and Symbols:

1. Unless otherwise indicated, apply traffic markings in nominal 4-inches wide stripes with clear and sharp dimensions. See drawings for striping patterns, directional arrows and symbols.
2. Unless otherwise indicated, use yellow markings at lane striping and directional symbols, white markings at parking striping and white and blue markings at international handicapped symbols.
3. Comply with ANSI 117.1 and ADA requirements for graphic symbols, stall widths, and access aisles at handicapped parking spaces. Provide approved templates for symbols and directional arrows.

END OF SECTION 32 1723

SECTION 32 18 16 PLAYGROUND PROTECTIVE SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
1. Engineered Wood Fiber surface.
2. Synthetic turf surfacing, including artificial turf, [subbase preparation and placement of aggregate base course,] and turf infill.
3. Pea Gravel
4. Sand
5. Cobble Stone

B. Related Sections:
1. Division 01 Section “Layout of Work and Surveys”.
2. Division 01 Section “Contractor Quality Control”.
3. Division 01 Section “Erosion and Sedimentation Control”.
4. Division 01 Section “Material and Equipment”.
5. Division 01 Section “Tree Retention and Protection”.
6. Division 03 Section “Cast-In-Place Concrete”.
7. Division 31 Section “Earth Moving”.
8. Division 32 Section “Crushed Stone Paving”.
9. Division 32 Section “Concrete Walks, Curbs, and Miscellaneous Flatwork”.
10. Division 33 Section “Subdrainage”

1.3 DEFINITIONS

A. CPSC: U.S. Consumer Products Safety Commission

B. Critical Height: Standard measure of shock attenuation. According to Consumer Products Safety Commission (CPSC) No. 325, this means "the fall height below which a life-threatening head injury would not be expected to occur."

C. SBR: Styrene-butadiene rubber.

D. EPDM: Ethylene propylene diene terpolymer rubber.

E. EWF: Engineered Wood Fiber; natural processed wood product manufactured expressly for use as a playground surface.

F. IPEMA: International Play Equipment Manufacturer’s Association.

1.4 PERFORMANCE REQUIREMENTS

A. Impact Attenuation: According to ASTM F 1292.

B. Accessibility of Surface Systems: According to ASTM F 1951.

C. Minimum Characteristics for EWF Surfaces: According to ASTM F 2075.

1.5 SUBMITTALS

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

B. Shop Drawings: For each playground surface system, include materials, plans, cross sections, drainage, installation details, penetration details, and edge termination. Include patterns made by varying colors of surfacing. Installation details includes roll and seaming layout, methods of attachment and details at penetrations and terminations.

1. Show layout of marking plan if any, indicating details for specified activity areas.

C. Samples for Initial Selection: For each type of playground surface system indicated.
1. Include similar samples of playground surface system and accessories involving color selection.

D. Samples for Verification: For each type of playground surface system indicated.
1. Minimum 1-quart loose-fill surface sealed in a container.
2. Minimum 12-by-12-inch- square sample of synthetic turf surface with tufted perimeter line and carpet seam.
3. Twelve-inch (12”) long by full-size cross section of border edging.
4. Provide a one (1) quart sample of material, engineering wood fiber, sand, and cobble for approval.
5. Minimum twelve-inch (12”) by- twelve-inch (12”) Sample of geosynthetic fabric.
6. Minimum six-inch (6”) by six-inch (6”) Sample of geosynthetic, molded-sheet drainage panel.
7. Subdrainage materials as required by Division 33 Section “Subdrainage”.

E. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
1. Extent of surface systems and use zones for equipment.
2. Critical heights for playground surfaces and fall heights for equipment.

F. Qualification Data: For qualified Installer and testing agency.

G. Material Certificates: For each type of playground surface system, from manufacturer.

H. Material Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each playground surface system.

I. Product Certificates: For each type of unitary synthetic playground surface system, from manufacturer.

J. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each unitary synthetic playground surface system.

K. Warranty: Sample of special warranty.

L. Maintenance Data: Maintenance manuals to include manufacturer’s data on maintenance of playground surface system.

M. Installation Schedule: Showing planned commencement and completion dates for each portion of the Work; include critical dates indicated on Owner's project schedule.

1.6 QUALITY CONTROL

A. Manufacturer Qualifications: A firm experienced in manufacturing synthetic turf surfacing materials similar to those specified for this project, with a record of successful service for a minimum of 5 years.

B. Installer Qualifications: An employer of workers trained and approved by manufacturer. Installer's Site Superintendent is to have a minimum of five (5) years of experience successfully installing similar materials on similarly scaled projects.

C. Source Limitations: Obtain playground surface system materials, including primers and binders, from single source from single manufacturer.
   1. Provide secondary materials including adhesives, primers, and geosynthetics, and repair materials of type and from source recommended by manufacturer of playground surface system materials.

D. Standards and Guidelines: Comply with CPSC No. 325, "Handbook for Public Playground Safety"; ASTM F 1292; and ASTM F 1487.

E. Testing Agency: Contractor to engage a qualified testing agency to perform tests and inspections.

F. Testing Services: Testing and inspecting of completed applications of playground surface system shall take place according to ASTM F 1292.

G. Remove and replace applications of playground surface system where test results indicate that it does not comply with requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with requirements.

1.7 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit playground surface system installation to be performed according to manufacturers' written instructions and warranty requirements.

B. Coordinate installation of synthetic turf surfacinges with installation of site paving, playground equipment, adjacent lawns, landscaping materials, site lighting, and related work.

1.8 COORDINATION

A. Coordinate installation of synthetic turf surfaces with installation of site paving, playground equipment, adjacent lawns, landscaping materials, site lighting, and related work.

1.9 WARRANTY

A. Manufacturer's Warranty: Submit manufacturer's standard published limited warranty form in which manufacturer agrees to repair or replace components of synthetic turf surfacing installation installed by manufacturer-certified Installer that fail in materials under normal use and maintenance, or provide other relief, within specified warranty period.

   1. Failures include ultraviolet degradation, backing integrity, more than 50 percent loss of face fiber, and loss of tuft bind strength.
   2. Warranty Period: Life of product.

PART 2 PRODUCTS

2.1 ENGINEERED WOOD FIBER SURFACE

A. Engineered Wood Fiber:

1. Random-sized wood fibers, in manufacturer's standard fiber size, approximately ten (10) times longer than wide; containing no bark, leaves, twigs, or foreign or toxic materials according to ASTM F 2075; in conformance with ASTM F 1292; graded according to manufacturer's standard specification for material consistency for playground surfaces and for accessibility according to ASTM F 1951.
2. Certified to be in conformance with IPEMA materials standards for EWF.
3. Products: Subject to compliance with requirements, provide one of the following or an approved equal.
    a. Fibar Group LLC (The); Fibar System.

4. Critical Height: As per Contract Drawings.
5. Uncompressed Material Depth: Not less than as indicated on the Contract Drawings.

2.2 DRAINAGE

A. Engineered Wood Fiber Underdrain System:
1. FibarSystem 300 or approved equal, consisting of:
    a. FibarDrain:
        1) Minimum flow rapte of 10gpm/ft
        2) Needle punched 100% non-woven geotextile sleeve encasing a monofilament nylon mesh.
        3) Laid out on 6’-0 centers in the direction of the grade.

    b. FibarFelt:
        1) Needle-punched 100% non-woven geotextile fabric that separates the Engineered Wood Fiber from soil below.
        2) Shall allow water to flow through, and prevent rock and soil contamination of the Engineered Wood Fiber.
        3) Shall cover the sub-grade and drainage matrix to encourage proper drainage. Seams should be overlapped 3”.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, subgrade and substrate conditions, drainage, and other conditions affecting performance of the Work.

B. Surface Substrates: Verify that substrates are satisfactory for unitary playground surface system installation and that substrate surfaces are dry, cured, and uniformly level or sloped to drain within recommended tolerances according to playground surface system manufacturer's written requirements for cross-section profile.
1. Concrete Substrates: Verify that substrates are dry, free from surface defects, and free of laitance, glaze, efflorescence, curing compounds, form-release agents, hardeners, dust, dirt, loose particles, grease, oil, and other contaminants incompatible with playground surface system or that may interfere with adhesive bond. Determine adhesion, dryness, and acidity characteristics by performing procedures recommended in writing by playground surface system manufacturer.
2. Gravel Substrate: Three quarter-inch (3/4”) angular gravel drainage stone, clean and washed; depth as indicated on Contract Drawings.

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

3.2 PREPARATION

A. General: Prepare substrates to receive surfacing products according to playground surface system manufacturer's written instructions. Verify that substrates are sound and without high spots, ridges, holes, and depressions.

B. Concrete Substrates: Provide sound supportive surface for playground surface system.
1. Repair unsatisfactory surfaces and fill holes and depressions.
2. Mechanically scarify or otherwise prepare concrete substrates to achieve recommended degree of roughness.
3. Saw cut concrete for terminal edges of playground surface systems as indicated.
4. Treat control joints and other nonmoving substrate cracks to prevent telegraphing through playground surface system.

C. Gravel Substrates: Provide sound supportive surface for playground surface system.
1. Gravel substrate is to be an approved substrate as stated by the manufacturer of the final play surface. Provide documentation from manufacturer prior to construction of play surface.
2. Edge boundary structures and drainage systems are to be installed prior to placement of gravel substrate.
3. Place and consolidate gravel substrate within edge boundary structures shown on Contract Drawings. Depth as shown on Contract Drawings.
4. Smooth gravel surface by raking. Obtain Project Manager’s approval prior to placing surface.
5. Repair any damage to gravel surface from foot traffic prior to placing final surface.

3.3 INSTALLATION, GENERAL

A. General: Comply with playground surface system manufacturer's written installation instructions. Install playground surface system over area and in thickness indicated.

3.4 DRAINAGE SYSTEMS

A. Install drainage systems as indicated on Drawings, Details, and per Division 33 Section “Subdrainage Systems”.

B. Installation of FibarSystem 300:
1. Excavate area to proper depth, based on Critical Fall Height.
2. Minimum 1% downward grade to ensure proper drainage to FibarDrain Strip.
3. Accurately grade and firmly compact entire area, especially where fill materials have been utilized.
4. Excavate trench 2” wide x 6” deep, perpendicular to grade at lowest point of playground area.
5. Install FibarDrain and connect low end of strip to storm drain or similar device to remove collected water.
6. Install playground equipment.
7. Install retaining border or curb.
8. Install FibarDrain strips at 6’ centers in direction of grade.
9. Cover sub-grade and drainage trench with FibarFelt.
10. Allowing 3” overlap at all seams.
    a. Slit to fit around footings of equipment.
    b. Overlap all slits with either next piece of FibarFelt or scrap piece, to ensure complete coverage.
11. Install FibarMat wear mats either on FibarFelt, in middle of Fibar Engineered Wood Fiber® or on top of system.
12. Permanently mark, with paint or other type of permanent marker, all the legs of the playground equipment with the compacted system design depth.
13. Spread Fibar®EngineeredWood Fiber using a Bobcat, small front-end loader or our Express Blower Trucks.
    a. Care should be taken when driving over FibarDrain.
    b. Do not make sharp turns on FibarFelt or FibarDrain.
14. Install all materials delivered.
15. Additional materials are supplied to account for natural compaction.

16. Material may be several inches high, until it compacts.
17. Feather edges to make smooth transition to grade or border.
18. Hand spread and rake for smooth, finished surface.
19. After two weeks of active use, surface should be raked again.

3.5 INSTALLATION OF ENGINEERED WOOD FIBER PLAYGROUND SURFACE SYSTEMS

A. Engineered Wood Fiber: Place playground surface system materials including manufacturer's standard amount of excess material for compacting naturally with time to required depths after installation of playground equipment support posts and foundations.

B. Finish Grading: Hand rake to a smooth finished surface and to required elevations.

3.6 PROTECTION

A. Maintain a neat and orderly work site at all times. Upon completion of site work, clean up area, remove tools, equipment, materials and debris

END OF SECTION 32 18 16

SECTION 32 35 00 FINISH CARPENTRY FOR LANDSCAPE

PART 1 GENERAL

1.1 SUMMARY

A. Provide high density hardwood lumber.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions.

B. Samples: Submit representative sample of actual high density hardwood lumber material.

C. Shop Drawings: Include plans, elevation, sections, details, and attachments to metal structure. Shop Drawings shall include all lumber, hardware and fasteners, and connections to metal structure.

1.3 QUALITY ASSURANCE

A. Manufacturer: Minimum 5 years experience producing similar products.

B. Regulatory Requirements: Comply with requirements of authorities having jurisdiction and applicable codes at the location of the project.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle hardwood lumber materials in accordance with manufacturer's recommendations. Protect from soiling, damage and construction operations.

1.5 WARRANTY

A. Provide manufacturer's standard 25-year warranty for high density hardwood lumber materials against insect damage and decay.

PART 2 PRODUCTS

2.1 MATERIALS

A. Hardwood Lumber: Mataverde Premium Hardwood Lumber, as distributed by General Woodcraft, Inc., 531 Broad Street, New London, CT 06320; telephone 860-444-9663; fax 860-444-0517; email sales@mataverdecking.com; web www.mataverdecking.com. or approved equal.

B. Specification criteria for individual species as follows:

Ipe / Bethabara (Tabebuia Species)

The high density hardwood lumber must be Mataverde® Premium Export Grade double sawn lumber, surfaced on 4- sides and eased on 4 edges (3 mm radius). All Mataverde® Premium Hardwood Lumber will have the following allowable working stresses:

	Mataverde® Ipe
Bending Strength (psi)	25,400
Modulus of Elasticity (1,000 psi)	3,260
Maximum Crushing Strenth (psi)	13,010
Janka side hardness (12% moisture content)	3,680

C. High Density Hardwood Lumber typical species and sizes

Hardwood Lumber: Mataverde Premium Ipe Lumber.

a. Size: 1 x 4 nominal Ipe or Cumaru lumber.
b. Lumber Finish: Manufacturer's standard oil finish.
c. Exposed Fasteners: Type 305 stainless steel decking screws.
d. Adhesive: Titebond Adhesive or equivalent acceptable to manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to start of installation, inspect existing conditions to ensure surfaces are suitable for installation of lumber. Starting work indicates installer's acceptance of existing conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions including the following:

1. Install materials plumb, true to line, cut and fitted.
2. Scribe and cope as required for accurate fit to adjacent construction.
3. Use manufacturer's recommended fasteners.

3.3 CLEANING AND PROTECTING

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

B. Clean using materials recommended by the manufacturer to remove stains, dirt and debris prior to final acceptance.

END OF SECTION 32 35 00

SECTION 32 40 00 SITE STONE

PART 1 - GENERAL

1.1 Related Documents

A. The General Contract Conditions, Drawings, and Division - 1 Specification sections, apply to Work of this section.

1.2 Description

A. The work in this section consists of furnishing and installation of cobble swale, stone outcrops, stone at playground edges, stone at terraces, and stone benches.

1.3 Related Sections

A. Section 02200 – Earthwork
B. Section 02232 – Aggregate Base Course
D. Section 04105 – Mortar and Grout

1.4 Quality Assurance

A. Source: Specified stone shall come from a single source.

B. Boulder retaining walls and single/multiple boulder placement: Prior to placement of stone material contractor shall meet on site with the Owner's Representative to review placement and aesthetic approaches for the stone placement of each stone feature. The Contractor shall install a mockup of material, which may remain part of the work if approved by Owner's Representative. The mockup shall constitute the area of the feature as shown on the drawings. The Contractor should anticipate rehandling of stone to achieve desired design intent.

C. Construct a sample mock up of approved materials at the playground edge, where includes two stones for the retaining stone wall, 15 -feet long by two stones high. Show color, range of stone sizes and projection, proportion, and craftwork. Owner's representative must approve sample location prior to construction. Do not begin any other stone work until the mock-up is approved. Approved panel shall become the standard of comparison for all stone work. Do not alter, move or destroy panel until the contract is complete.

D. The firm that is employed to construct the stonework shall be customarily employed in the landscape stone masonry industry. Prior to beginning construction of the walls, the Contractor must demonstrate to the Owner's Representative that the firm has at least three years of previous experience constructing stone walls and has completed at least five generally similar projects. The firm shall employ skilled labor with a working knowledge of stone masonry techniques. Journeyman or lead mason must have a minimum experience of 3 years.

E. The Owner's Representative reserves the right to reject the Contractor's masonry personnel or stonework subcontractor based on these experiences and skill requirements.

If rejected, the Contractor shall obtain personnel and/or a subcontractor having qualifications acceptable to the Owner's Representative.

F. No adjustments in prices or completion time will be allowed due to changes in personnel or delays in obtaining satisfactory personnel or subcontractor.

G. Contractor shall guarantee their respective work against defective materials or faulty workmanship as specified in the General Conditions and Division One Specifications.

H. All stone walls exceeding 3 feet height shall be mortared with joint dug out for dry look on face.

I. Contractor shall obtain mortar ingredients of uniform quality, from one manufacturer for each cementitious component and from one source and producer for each aggregate for the entire project.

J. Contractor shall comply with the following standards, except where more stringent requirements are stated on the drawings or herein:

1. American National Standards Institute, ANSI/NSB 211 (A41.1), "Building Code Requirements for Masonry"

2. American Society for Testing Materials, ASTM.

3. National Concrete Masonry Association, NCMA, "A Manual of Facts on Concrete Masonry."

4. Uniform Building Code, UBC, Chapter 24 – Masonry.

1.5 Submittals:

A. Samples: Samples shall be submitted for the following:

1. Boulders: Site photos of each type of boulder and stone shall be submitted for approval. Once a source of boulders for each type has been determined, contact the Owner's Representative and the Landscape Architect for a site visit. Boulders may be tagged for use at selected locations.

2. Grout colors: Provide a cut sheet of colors. Landscape Architect will select color to match stone

B. Product Data:
1. Quarry Facility: complete data on quarry facilities for stone type and on fabrication facilities for stonework. Include information of location and production capabilities
2. Photographs of the nature and character of each stone type selected
3. Stone Adhesive: Provide product data sheet
4. Type of Equipment to be used for equipment hours
5. Mix Design for Embedment Concrete

1.6 Inspection

A. The Landscape Architect will accompany the Subcontractor on selection trip(s) to the quarry. The Landscape Architect will select stone. Prior to this trip, the Subcontractor shall have preselected the Quarry to ascertain that stone in size and type required are available for proper selection.

1.7 Delivery, Storage And Handling

A. Store masonry materials on platforms or pallets. Store mortar materials under cover in a dry location. Protect steel materials from moisture and keep free of loose scale and rust. Handle masonry materials carefully to avoid chipping, breakage, contact with soil or other contaminating material. Deliver cementitious materials in the manufacturer's unbroken, labeled containers. Care shall be taken in transportation and handling of stone, so as not to scratch or damage the stone, particularly the naturally weathered surfaces.

1.8 Project Conditions

A. Hot Weather Conditions

Protect all masonry construction from direct exposure to wind and sun for 48 hours after installation when erected in an ambient air temperature of 99°F (37°C) in the shade with relative humidity less than 50%.

B. Cold Weather Conditions

Before erecting masonry during temperatures below 40°F, submit a written statement and receive approval on methods proposed to heat masonry materials and protect masonry from freezing as required hereafter. Keep masonry completely covered and free of frost, ice and snow at all times, maintain a minimum temperature of 40°F (4°C) when laid. Maintain temperature of mortar and grout between 70°F (21°C) and 100°F (43°C). Do not exceed 160°F (71°C) temperature of mixing water or of water and sand introduced to cement. Maintain air temperature on both side of masonry above 40°F (4°C) for at least 72 hours, 48 hours if high-early strength cement is used in the mortar in lieu of Portland cement or masonry cement. Do not build upon frozen work. Do not place concrete footings on muddy or frozen surfaces.

PART 2 - PRODUCTS

2.1 General

A. Boulders shall be tagged at the quarry by the landscape architect. Contractor shall arrange with quarry to have stone stockpiled. Stone Tags shall remain on the stones during delivery to the site.

B. Upon delivering the stone to the site, Owner's Representative will examine the stone and may reject any determined to be damaged or scratched on the desired exposed faces or unnaturally shaped. These stone shall be removed from the site at the Contractor's expense.

C. Stone features shall incorporate a mix of shapes and sizes with bedding planes and proportions of stone in different sizes resembling the elevations shown in the drawings.

Natural bedding planes of stone slab walls are to be laid horizontally; horizontal and vertical joints to be frequently interrupted. Stone shall appear naturally weathered; cut faces shall not be visible unless shown on the drawings; and sharp edges shall not be exposed.

D. The nominal sizes of boulders and stone slabs listed shall serve as the minimum acceptable dimension on any axis through the approximate center of mass of the stone. Stone with any dimension smaller than the nominal dimension stated shall be used as the next nominal size less.

E. Contractor shall notify the Owner's Representative at a minimum 48 hours in advance of stone placement.

2.2 Stone

A. Stone series 1 shall be native, red, have naturally rounded edges "Lyons Red, Round Sandstone Boulders" as supplied by Lyons Sandstone (T)303-823-5659, Lyons, Colorado, or approved equal. Select boulders with smooth face and avoid sharp edges.

a. Stone Type 1B, Seat Wall (Dimensional)
   i. Finish: Natural Cleft
   ii. Quantity: Per Plans
   iii. Size: Width: 1'-6" min. – 2'-0" Max
   Length: 3'-6" min. – 5'-0" Max.
   Height: 1'-8" Min. – 2'-2" Max.

b. Stone Type 1C – Landscape Boulder
   i. Finish: Natural Cleft
   ii. Quantity: Per Plans
   Size: Width: 4-0" min - 5'-0" max
   Length: 3-'0" min - 4'-6" max
   Height: 2'-0" min - 3'-0" max

c. Stone Type 1E – Flagstone
   i. Finish: Natural Cleft
   ii. Quantity: Per Plans
   iii. Size: Width: 2'-0" min - 6'-0" max
   Length: 2'-0" min - 6'-0" max
   Height: 1 3⁄4" min – 2 1⁄4" max

B. Stone series 2 shall be native, gray stone as supplied by Monarch Stone Company, Inc. (T) 303-933-9657, Brighton, CO, or approved equal. Select boulders with smooth face and with moss wherever possible, and avoid sharp edges.

a. Stone Type 2B, Seat Wall (Dimensional)
   i. Finish: Natural Cleft, "Granite"
   ii. Quantity: Per Plans
   iii. Size: Width: 1'-6" min. – 2'-0" Max
   Length: 3'-6" min. – 5'-0" Max.

Height: 1’-8” Min. – 2’-2” Max.

b. Stone Type 2C – Landscape Boulder
   i. Finish: Natural Blast, “Granite”
   ii. Quantity: Per Plans
   iii. Size: Width: 3-0” min - 5’-0” max
   Length: 3-’0” min - 5’-0” max
   Height: 2’-0” min - 3’-0” max

c. Stone Type 2E – Flagstone, “Charcoal”
   i. Finish: Natural Cleft
   ii. Quantity: Per Plans
   iii. Size: Width: 1’-0” min - 6’-0” max
   Length: 1’-0” min - 6’-0” max
   Height: 1 3⁄4” min – 2 1⁄4” max

d. Stone Type 2F – Water Feature Boulder
   i. Finish: Natural blast, “Granite”
   ii. Quantity: Per Plans
   iii. Size: Width: 2’-6” min – 3’-6” max
   Length: 3’-6” min - 4’-9” max
   Height: 1’-0” min – 2’3’ max
   iv. Stone to be selected at the quarry with landscape architect.

C. Stone Type 2D shall be native, gray “Sebastian Blue Snap Cut Step” as supplied by Colorado Materials (T) 303-682-2314, 1541 Boston Ave, Longmont, CO 80501, or approved equal. Select boulders with smooth face and avoid sharp edges.

a. Stone Type 2D - Steps (Dimensional)
   i. Finish: Snap Cut, color match to stone series 3
   ii. Quantity: Per Plans
   iii. Size: Width: 1’-6” min. – 2’-0” Max
   Length: 3’-6” min. – 4’-6” max.
   Height: 1’-6” min. – 2’-0” Max

b. Stone Type 2G – Stone Weir (Dimensional)
   i. Finish: Snap Cut, color match to stone series 3
   ii. Quantity: Per Plans
   iii. Size: Width: 6” Min. – 9” max.
   Length: 4’-6” min. – 5’-6” max.
   Height: 1’-6” min. – 2’-0” Max

D. Stone series 3 shall be native, buff/tan, have naturally rounded edges “Layered Sedimentary Sandstone” as supplied by Arkins Park Stone (T) (970) 663-1920, Loveland, CO, or approved equal. Select boulders with smooth face and avoid sharp edges.

a. Stone Type 3A – Large Seat Wall Stone (Dimensional)
   i. Finish: Natural Cleft

ii. Quantity: Per Plans
iii. Size: Width: 3’-0” min. – 4’-0” Max
Length: 2’-6” min. – 5’-0” Max.
Height: 1’-6” Min. – 2’-0” Max.

b. Stone Type 3B, Seat Wall (Dimensional)
i. Finish: Natural Cleft
ii. Quantity: Per Plans
iii. Size: Width: 1’-6” min. – 2’-0” Max
Length: 3’-6” min. – 5’-0” Max.
Height: 1’-8” Min. – 2’-2” Max.

c. Stone Type 3C – Landscape Boulder
i. Finish: Natural Cleft
ii. Quantity: Per Plans
Size: Width: 4-0” min - 5’-0” max
Length: 3-’0” min - 4’-6” max
Height: 2’-0” min - 3’-0” max

d. Stone Type 3D – Steps (Dimensional)
i. Finish: Natural Cleft
ii. Quantity: Per Plans
Size: Width: 1’-6”
Length: 4’-0” min. – 5’-6” max.
Height: 20”

e. Stone Type 3E – Flagstone
i. Finish: Natural Cleft
ii. Quantity: Per Plans
iii. Size: Width: 1’-0” min - 6’-0” max
Length: 1’-0” min - 6’-0” max
Height: 1 3⁄4” min – 2 1⁄4” max

f. Stone Type 3H – Memorial Stone
i. Finish: Natural Cleft
ii. Quantity: Per Plans
iii. Size: Width: 5’-0” min - 8’-0” max
Length: 5’-0” min - 8’-0” max
Height: 5’-0” min - 8’-0” max

E. Stone series 4 shall be native, gray/red, be naturally rounded with minimal edges “Zuni Blasted Granite” as supplied by High Plains Stone Company (T) 303-791-1862, Littleton, CO, or approved equal. Select boulders with rounded shape, smooth face, and no sharp edges.

a. Stone Type 4B, Seat Wall (Dimensional)
i. Finish: Natural Cleft
ii. Quantity: Per Plans
iii. Size: Width: 1’-6” min. – 2’-0” Max

Length: 3’-6” min. – 5’-0” Max.
Height: 1’-8” Min. – 2’-2” Max.

F. Stone Type 4C – Landscape Boulder
   i. Finish: River Smoothed
   ii. Quantity: Per Plans
   iii. Size: Width: 4-0” min - 5’-0” max
   Length: 3-’0” min - 4’-6” max
   Height: 2’-0” min - 3’-0” max

G. Stone series 5 shall be native, gray “Riprap” as supplied by Bedrock Landscaping Materials. (T) 303-432-7222, Denver, CO, or approved equal.

a. Stone Type 5A – Riprap
   i. Finish: Black Granite, Natural Blast Finish
   ii. Quantity: Per Plans
   iii. Size: Diameter 4” min - 18” max

b. Stone Type 5B – Small Riprap
   i. Type: Mountain Granite (VTR–Vehicle Tracking Rock)
   ii. Finish: Natural Blast Finish
   iii. Quantity: Per Plans
   iv. Size: Diameter 2” min - 4” max

H. Stone Type 6 shall be “Platte River Rock” as supplied by Bedrock Landscaping Materials. (T) 303-432-7222, Denver, CO, or approved equal by the Project Manager.

a. Stone Type 6 – Rounded River Cobble
   i. Finish: Natural Blast Finish
   ii. Quantity: Per Plans
   iii. Size: Diameter: 1-1/2”

I. Stone Type 7 shall be “tan squeegee” as supplied by Bedrock Landscaping Materials. (T) 303-432-7222, Denver, CO, or approved equal by the Project Manager. Stone shall be unused material free of shale, lay, friable materials, organics and debris.

a. Stone Type 7 - Squeegee
   i. Size Range: 1/4 inch maximum
   ii. Color: Shall be “Tan Squeegee”

J. Stone Type 8 shall be “Gray Granite Crushed” as supplied by Colorado Materials (T) 303-682-2314, 1541 Boston Ave, Longmont, CO 80501, or approved equal. Stone shall be unused material free of shale, lay, friable materials, organics and debris.

a. Stone Type 8: Crushed Stone
   i. Size: 3/8”
   ii. Color: Gray

K. Stone Type 9 shall be “Crushed Buff” as supplied by Colorado Materials (T) 303-682-2314, 1541 Boston Ave, Longmont, CO 80501, or approved equal. Stone shall be unused material free of shale, lay, friable materials, organics and debris.

a. Stone Type 9: Rock Mulch
   i. Size: 1 ½”
   ii. Color: Buff

2.3 Geotextile Fabric

A. Mirafi 140 N as supplied by TC Mirafi, 706-693-2226, or approved equal

PART 3 - EXECUTION

3.1 General

A. Stone shall be placed individually in a manner to avoid displacing underlying materials or placing undue impact force on the underlying materials. Stone shall not be dropped from a height of more than 2 inches.

B. Stone shall be placed in position by the use of a multi-prong grapple device or suitable equipment for handling material. Dayline buckets and skips shall not be used for placement of stone.

C. Stone shall be placed with weathered and most natural, rounded surface up, or as directed.

D. Stone shall be placed in the presence of the Owner’s Representative, and Owner’s Representative shall approve the placement before stone are backfilled and/or mortared. The contractor should anticipate that rehandling of individual stone after initial placement will be required to achieve required elevations and placements.

E. Backfill excavation around site boulder / stone as indicated on construction plans and in accordance with Section 02200 and 02260.

F. Excavate for placement of stone, such that top of stone slab will meet grade specified on grading plan and detail. Provide a firm, smooth, uniform surface. Contractor shall prepare subgrade as indicated in the construction plans and specifications.

G. Provide chases, reveals, reglets, openings and other spaces as shown or required for contiguous work. Close up openings in stonework after other work is in place. Use materials and set to match surrounding stonework.

H. During all seasons, protect partially completed stonework against weather when work is not in progress. Cover top of wall with strong, waterproof, non-staining membrane extending at least 2-feet down the stone face and anchor securely in place.

I. Do not build on frozen work; remove and replace stonework damaged by frost or freezing.

J. Do not use stone units with chips, cracks, voids, stains or other defects which might be visible in the finished work unless otherwise acceptable to the Owner's Representative.

A. Contractor shall cut stone slabs as required to meet desired lines, layout, and grades. Contractor shall place filler stones and grout to meet desired grades. Reference drawings for details for example of finish work.

K. Contractor shall place aggregate base course and stone slab in accordance with specifications and construction plans. Contractor shall minimize the appearance of cut stone faces. Contractor shall mortar stones in place as indicated in construction plans and as directed by Owner's Representative.

L. Set stone in accordance with drawings. Provide anchors, supports, fasteners and other attachments as shown or necessary to secure stonework in place. Adjust accessories for proper setting of stone. Completely fill slots for anchors, dowels, fasteners and supports with mortar during setting of stone. Stone walls over 3 feet high shall be mortared. Minimize appearance of all mortar.

M. Execute stonework by skilled mechanics and employ skilled stone fitters at the site to do necessary field cutting as stone is set.

3.2 Adjustment, Protection, And Clean-Up

A. Upon completion of work, remove from the premises all surplus materials, tools, equipment, rubbish, debris, and rejected stone resulting from the work.

B. Remove and replace stone units that are broken, chipped, stained or otherwise damaged. Where directed, remove and replace units that do not match adjoining stonework. Provide new matching units; install as specified and point-up to eliminate evidence of replacement. Repoint defective and unsatisfactory joints as required to provide a neat, uniform appearance.

C. Clean stonework not less than six days after completion. Thoroughly clean and scrub completed wall with fiber brushes, using a mild alkaline abrasive cleaner that contains no caustic or harsh fillers. Do not use wire brushes or acid type cleaning agents. Begin at top and work down. Clean stone thoroughly, leaving no mortar stains or traces of cleaning compound.

D. Protect the stonework from collapse, deterioration, discoloration or damage during subsequent construction and until acceptance of the work.

END OF SECTION 32 40 00

SECTION 32 84 00

PLANTING IRRIGATION

PART 1 - GENERAL

1.01 WORK INCLUDED - Work of this Section generally includes provisions for the installation of an underground landscape irrigation system including the following:

A. Static pressure verification and coordination of irrigation system installation with landscape material installation.

B. Trenching, stockpiling excavation materials, refilling and compacting trenches.

C. Complete irrigation system including but not limited to piping, backflow preventer assemblies, valves, fittings, heads, controllers and wiring, and final adjustments to insure complete coverage.

D. Water connections.

E. Replacement of unsatisfactory materials.

F. Clean-up, Consultant Reviews, and Project Acceptance.

G. Tests.

1.02 REFERENCES

A. Conform to requirements of reference information listed below except where more stringent requirements are shown or specified in Contract Documents.
   1. American Society for Testing and Materials (ASTM) - Specifications and Test Methods specifically referenced in this Section.
   2. Underwriters Laboratories (UL) - UL Wires and Cables.
   3. National Sanitation Foundation (NSF) – Piping and Backflow prevention.
   4. American Water Works Association - Piping and Backflow prevention.

1.03 QUALITY ASSURANCE

A. Installer Qualifications - Installer shall have had considerable experience and demonstrate ability in the installation of irrigation system(s) of specific type(s) in a neat, orderly, and responsible manner in accordance with recognized standards of workmanship. To demonstrate ability and experience necessary for this Project, and financial stability, submit if requested by Consultant, prior to contract award the following:
   1. List of 3 projects completed in the last 2 years of similar complexity to this Project. Description of projects shall include:
      a. Name of project.
      b. Location.
      c. Owner.
      d. Brief description of work and project budget.

B. Special Requirements:
   1. Work involving substantial plumbing for installation of copper piping, backflow preventer(s), and related work shall be executed by licensed and bonded plumber(s). Secure a permit at least 48 hours prior to start of installation.
   2. Tolerances - Specified depths of mains and laterals and pitch of pipes are minimums. Settlement of trenches is cause for removal of finish grade treatment, refilling, compaction, and repair of finish grade treatment.

3. Coordination with Other Contractors - Protect, maintain, and coordinate Work with Work under other Section.
4. Damage To Other Improvements - Contractor shall replace or repair damage to grading, soil preparation, seeding, sodding, or planting done under other Sections during Work associated with installation of irrigation system at no additional cost to Owner.

C. Pre-Construction Conference - Contractor shall schedule and conduct a conference to review in detail quality control and construction requirements for equipment, materials, and systems used to perform the Work. Conference shall be scheduled not less than 10 days prior to commencement of Work. All parties required to be in attendance shall be notified no later than 7 days prior to date of conference. Contractor shall notify qualified representatives of each party concerned with that portion of Work to attend conference, including but not limited to Architect, Consultant, Contractor's Superintendent, and Installer.
1. Minutes of conference shall be recorded and distributed by Contractor to all parties in attendance within five days of conference.

1.04 SUBMITTALS

A. See Section 01 3000 – Administrative Requirements, for submittal procedures.

B. Materials List - Submit five copies if submitting in hard-copy format or one full electronic set of a complete materials list indicating manufacturer, model number, and description of all materials and equipment to be used. Show appropriate dimensions and adequate detail to accurately portray intent of construction via cut sheets and/or shop drawings, as appropriate based on plans, details, and specification information contained within.

C. Record Drawings (As-Builts):
1. At onset of irrigation installation secure Autocadd files of original irrigation design from Owner. At the end of every day, revise as-built prints for work accomplished that day in red ink. As-built field prints and cadd files shall be brought up-to-date at the close of the working day every Friday by a qualified draftsperson. A print of record plan(s) shall be available at Project Site. Indicate zoning changes on weekly as-built drawings. Indicate non-pressure piping changes on as-built. Upon completion of Project, but prior to scheduling of substantial acceptance walk-through, submit for review a final set of as-built mylars and an Autocadd disk copy with all equipment symbols moved to actual locations in cadd file. Dimensions, from two permanent points of reference (building corners, sidewalk, road intersections or permanent structures), location of following items:
   a. Connection to existing water lines.
   b. Routing of sprinkler pressure lines (dimension maximum 100 feet along routing).
   c. Sprinkler control valves.
   d. Quick coupling valves.
   e. Manual drains and stop and waste valves.
   f. Drip line blow-out stubs.
   g. Control wire routing if not with pressure mainline.
   h. Gate valves.
   i. Control wire and communication cable splices
   j. Water meters
   k. Locations of all sleeving including size, quantity and depth of sleeve
   l. Flow sensors
   m. Pressure regulating valves
2. Owner’s Representative will not certify any pay request submitted by the Contractor if the as-built drawings are not current, and processing of pay request will not occur until as-builts are up-dated.

D. Operation Instructions - Submit 3 written operating instructions including winterization procedures and start-up, with cut sheets of products, and coordinate controller/watering operation instruction with Owner maintenance personnel.
1. Controller Charts:

a. Do not prepare charts until Consultant has reviewed record (as-built) drawings.
b. Provide one controller chart for each automatic controller installed.
    i. Chart may be reproduction of record drawing, if scale permits fitting of controller door. If photo reduction prints are required, keep reduction to maximum size possible to retain full legibility.
    ii. Chart shall be blueline print of actual "as-built" system, showing area covered by that controller.
c. Identify area of coverage of each remote control valve, using a distinctly different pastel color drawing over entire area of coverage.
d. Following review of charts by Consultant, they shall be hermetically sealed between two layers of 20-mm thick plastic sheet
e. Charts shall be completed and reviewed prior to final review of irrigation system.

E. Provide documentation of construction and demolition waste debris recycling / salvage rates. See Section 01 74 19 - Construction Waste Management and Disposal

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with General Conditions and Division 1 Section “Product Requirements”.

B. Deliver, unload, store, and handle materials, packaging, bundling, products in dry, weatherproof, condition in manner to prevent damage, breakage, deterioration, intrusion, ignition, and vandalism. Deliver in original unopened packaging containers prominently displaying manufacturer's name, volume, quantity, contents, instructions, and conformance to local, state, and federal law. Remove and replace cracked, broken, or contaminated items or elements prematurely exposed to moisture, inclement weather, snow, ice, temperature extremes, fire, or jobsite damage.

C. Handling of PVC Pipe - Exercise care in handling, loading and storing, of PVC pipe. All PVC pipe shall be transported in a vehicle that allows length of pipe to lie flat so as not to subject it to undue bending or concentrated external loads. All sections of pipe that have been dented or damaged shall be discarded, and if installed, shall be replaced with new piping.

1.06 JOBSITE CONDITIONS

A. Protection of Property:
1. Preserve and protect all trees, plants, monuments, structures, and paved areas from damage due to Work of this Section. In the event damage does occur, all damage to inanimate items shall be completely repaired or replaced to satisfaction of Owner, and all injury to living plants shall be repaired by Owner. All costs of such repairs shall be charged to and paid by Contractor.
2. Protect buildings, walks, walls, and other property from damage. Flare and barricade open ditches. Damage caused to asphalt, concrete, or other building material surfaces shall be repaired or replaced at no cost to Owner. Restore disturbed areas to original condition.

B. Existing Trees:
1. All trenching or other Work under limb spread of any and all evergreens or low branching deciduous material shall be done by hand or by other methods so as to prevent damage to limbs or branches.
2. Where it is necessary to excavate adjacent to existing trees use all possible care to avoid injury to trees and tree roots. Excavation, in areas where 2 inch and larger roots occur, shall be done by hand. Roots 2 inches or larger in diameter, except directly in the path of pipe of conduit, shall be tunneled under and shall be heavily wrapped with burlap to prevent scarring or excessive drying. Where a trenching machine is operated close to trees having roots smaller than 2 inches in diameter, wall of trench adjacent to tree shall be hand trimmed, making clean cuts through roots. Trenches adjacent to trees shall be closed within 24 hours,

and when this is not possible, side of trench adjacent to tree shall be kept shaded with moistened burlap or canvas.

C. Protection and Repair of Underground Lines:
   1. Request proper utility company to stake exact location (including depth) of all underground electric, gas, or telephone lines. Take whatever precautions are necessary to protect these underground lines from damage. If damage does occur, Utility Owner shall repair all damage. Contractor shall pay all costs of such repairs unless other arrangements have been made.
   2. Request Owner, in writing, to locate all private utilities (i.e., electrical service to outside lighting) before proceeding with excavation. If, after such request and necessary staking, private utilities that were not staked are encountered and damaged by Installer, Owner shall repair them at no cost to Installer. If Contractor damages staked or located utilities, they shall be repaired by Utility Owner at Contractor's expense unless other arrangements have been made.

D. Replacement of Paving and Curbs - Where trenches and lines cross existing roadways, paths, curbing, etc., damage to these shall be kept to a minimum and shall be restored to original condition.

1.07 WARRANTY/GUARANTY

A. Manufacturer shall warrant materials against defects for a period of one year from date of Substantial Completion. Installer(s) shall guaranty workmanship for similar period.

B. Settling of backfilled trenches that may occur during guaranty period shall be repaired at no expense to Owner, including complete restoration of damaged property.

C. Expenses due to vandalism before substantial completion shall be borne by Contractor.

D. Owner will maintain turf and planting areas during warranty period, so as not to hamper proper operation of irrigation system.

1.08 MAINTENANCE

A. Furnish the following maintenance items to Owner prior to final Acceptance:
   1. Two Sets of special tools required for removing, disassembling, and adjusting each type of sprinkler head and valve supplied on this Project.
   2. One eight foot valve key for operation of stop and waste valve.
   3. Two six foot valve keys for operation of gate valves.
   4. Two keys for each automatic controller.
   5. Two quick coupler keys and two matching hose swivels for each type of quick coupling valve installed.
   6. Two aluminum drain valve keys of sufficient length for operation of drain valves.

B. Winterization - include cost in bid for winterizing complete system at conclusion of sprinkling season (in which system received final acceptance) within 3 days notification by the Owner. System shall be voided of water using compressed air or similar method reviewed by Consultant. Reopen, operate, and adjust system malfunctions accordingly during April of following season within 3 days of notification by Owner.

1.09 EXTRA STOCK - In addition to installed system furnish the following items to Owner:

A. 10 Pop-up spray heads with nozzles of each type used.

B. 4 Rotor heads of each type used.

C. 30 Drip emitters of each type used.

D. 8 2-wire decoder –single station units

E. 1 Hand Held Programming unit for decoders.

F. 10 Bubbler heads of each type used.

G. 100’ roll in-line emitter tubing of each type used.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General Piping:
1. Pressure Supply Line (from tap on city mains to winterization tee or Stop and Drain valve prior to backflow prevention unit) – Type “K” Soft Copper (3/4” – 2 1/2”), and ductile iron (3” and larger).
2. Pressure Supply Line (from point of connection, winterization tee or Stop and Drain valve and through backflow prevention unit - Type "K" Hard Copper (3/4” – 2 1/2”), and ductile iron (3” and larger).
3. Pressure Supply Lines (downstream of backflow prevention units) Type "K" Hard Copper (3/4” – 2 1/2”), Class 200 PVC BE (1" - 2 1/2") and Class 200 PVC RT (3" and larger), HDPE DR11 as noted on plans and schedule.
4. Non-pressure Lines - Class 200 PVC BE 1” minimum size, as noted on plans.
5. Sleeving - Class 160 PVC, as noted on plans and schedule.
6. Drip Tubing - Toro Dura-Pol EHD 1645 3/4" with .050 inch wall thickness.
7. Emitter Tubing - As recommended by emitter manufacturer.

B. Copper Pipe and Fittings:
1. Copper Pipe - Type K, hard tempered or annealed coil.
2. Fittings - Wrought copper, solder joint type.
3. Joints - Soldered with solder, 45% silver, 15% copper, 16% zinc, and 24% cadmium and solidus at 1125~F and liquids at 1145~F.

C. Brass Pipe and Fittings:
1. Brass Pipe - 85% red brass, ANSI Schedule 40 screwed pipe.
2. Fittings - Medium brass, screwed 125-pound class.

D. Ductile Iron Pipe and Fittings:
1. Ductile Iron Pipe – Centrifugal cast ductile iron in metal molds for water pipe in accordance with ANSI C151 and AWWA A21.51 with asphaltic exterior coating and interior lining and coating in accordance with ANSI C151 and AWWA A21.
2. Fittings – Mechanical joint as supplied by the pipe manufacturer and rated for working pressures of 350 psi.
3. Gaskets – Furnish in accordance with ANSI C111 and AWWA A21.11.

E. Plastic Pipe and Fittings:
1. Identification Markings:
    a. Identify all pipe with following indelible markings:
        i. Manufacturer's name.
        ii. Nominal pipe size.
        iii. Schedule of class.
        iv. Pressure rating.
        v. NSF (National Sanitation Foundation) seal of approval.
        vi. Date of extrusion.
2. Solvent Weld Pipe - Manufactured from virgin polyvinyl chloride (PVC) compound in accordance with ASTM D2241 and ASTM D1784; cell classification 12454-B, Type 1, Grade 1.
    a. Fittings - Standard Weight, Schedule 40, injection molded PVC; complying with ASTM D1784 and D2466, cell classification 12454-B.
        i. Threads - Injection molded type (where required).
        ii. Tees and ells - Side gated.
    b. Threaded Nipples - ASTM D2464, Schedule 80 with molded threads.

c. Teflon Tape – All PVC male threaded fittings and nipples, excluding marlex fittings, shall receive wrapping of Teflon tape applied to threaded surfaces per pipe manufacturer's recommendations.
d. Joint Cement and Primer - Type as recommended by manufacturer of pipe and fittings.

3. HDPE Pipe - Pipe shall be manufactured from a pipe resin which meets ASTM D 3350-05 with a minimum cell classification of 445474C. Pipe shall be manufactured to the dimensions of ASTM F-714. The service factor to determine the pressure rating shall be 0.63. Pipe shall have a minimum pressure rating of: DR 11, 200 psi. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.
   HDPE FITTINGS:
   a. Butt Fusion Fittings - Fittings shall be made from HDPE pipe resin meeting ASTM D 3350-05 with a minimum cell classification of 445474C, Molded Butt Fusion Fittings shall have a manufacturing standard of ASTM D-3261. Molded & fabricated fittings shall have the same pressure rating as the pipe unless otherwise specified on the plans. Fabricated fittings must have the same pressure rating as the pipe; a DR less than the pipe shall be used. Fabricated fittings are to be manufactured using a Data Logger to record temperature, fusion pressure, and a graphic representation of the fusion cycle shall be part of the Quality Control records.
   b. Electrofusion Fittings - Fittings shall be made from resin or pipe meeting ASTM D 3350-05 with a minimum cell classification of 445474C; Electrofusion Fittings shall meet the manufacturing standard of ASTM F-1055. Fittings shall have the same pressure rating as the pipe or higher unless otherwise specified on the plans.
   c. Transition fittings shall be used for transition to other pipe materials (1/2" – 4", Male NPT x Butt Fusion) and meet dual standards 4710/3608 HDPE Resin, Black; Red Brass or 304 SS Stainless Steel.
   d. Flanged and Mechanical Joint Adapters - Flanged and Mechanical Joint Adapters (4" – 12") shall be made from materials containing resin that meets ASTM D 3350-05 with a minimum cell classification of 445474C.
   e. Transitional Stiffeners shall meet 304 SS Stainless Steel.
4. Gasketed End Pipe - Manufactured from virgin Polyvinyl Chloride compound in accordance with ASTM D2241 and ASTM D1784; cell classification 1254-B, Type 1,Grade 1.
   a. Fittings and Services Tees - Ductile iron, grade 70-55-05 in accordance with ASTM A-536. Fittings shall have deep slanted bell push-on joints with gaskets meeting ASTM F-477.
   b. Joint Restraint System – As recommended manufacturer of pipe fittings.
   c. Gaskets - Factory installed in pipe and fittings, having a metal or plastic support within gasket or a plastic retainer ring for gasket.
   d. Lubricant - As recommended by manufacturer of pipe fittings.
5. Flexible Plastic Pipe - Manufactured from virgin polyethylene in accordance with ASTM D2239, with a hydrostatic design stress of 630 psi and designated as PE 2306.
   a. Fittings – Insert type manufactured in accordance with ASTM D2609; PVC Type 1 cell classification 12454-B.
6. Pressure Supply Piping Locating Tape: Markline Tape, 3" wide detectable tape, NP purple in color with the words "CAUTION: RECYCLED/ RECLAIMED WATERLINE BELOW" printed every 36 inches. Place 12" below finish grade.

F. Drip, Sub-Surface Irrigation Systems and Bubblers:
1. Drip Tubing - Manufactured of flexible vinyl chloride compound conforming to ASTM D1248, Type 1, Class C, Category 4, P14 and ASTM D3350 for PE 122111C.
2. Fittings - Type and diameter recommended by tubing manufacturer.
3. Drip Valve Assembly - Type and size shown on Drawings.
   a. Wye Strainer - Plastic construction with 150 mesh nylon screen and 1/2 inch blowout assembly. 35-40 PSI discharge pressure device.

b. Control Valve - 2 way, solenoid pilot operated type made of synthetic, non-corrosive material; diaphragm activated and slow closing. Include freely pivoted seat seal; retained (mounted) without attachment to diaphragm.
c. Pressure Reducing Valve - Plastic construction as detailed.
d. Single station 2-wire decoder.

4. Emitters - Single port, pressure compensating, press on type.
5. Sub-Surface tubing - Size and type shown on Drawings; installed as detailed.
   a. Dripperline Tubing – Nominal sized one-half inch (1/2") low density, ultra-violet-resistant linear polyethylene tubing with internal pressure-compensating, continuous self-cleaning, integral drippers at specified intervals and with specified discharge rates. Emitter spacing and discharge specified on Drawings.
   b. Headers and footers – polyethylene or PVC pipe as shown on Drawings.
   c. Fittings - Type and diameter recommended by tubing manufacturer.
   d. Drip Valve Assembly - Type and size shown on Drawings.
      i. Wye Strainer - Plastic construction with 150 mesh nylon screen and 1/2 inch blowout assembly.
      ii. Control Valve - 2 way, solenoid pilot operated type made of synthetic, non-corrosive material; diaphragm activated and slow closing. Include freely pivoted seat seal; retained (mounted) without attachment to diaphragm.
      iii. Pressure Reducing Valve - Plastic construction as detailed.
      iv. Single station 2-wire decoder.
   e. Soil staples – install on all on-surface installations, spaced 3 feet on center for sandy soils, 4 feet on center for loam soils, and 5 feet on center for clay soils.
6. Bubblers - Rainbird 1400 Series or approved equal.

G. Gate Valves:
1. Gate Valves for 3/4 inch through 2-1/2 Inch Pipe - Brass construction; solid wedge, IPS threads, and non-rising stem with cross operating handle.
2. Gate Valves for 3 Inch and Larger Pipe - Iron body, brass or bronze mounted AWWA gate valves with a clear waterway equal to full nominal diameter of valve; rubber gasket or mechanical joint-type only. Valves shall be able to withstand a continuous working pressure of 200 psi and be equipped with a square operating nut and resilient wedge. Provide pipe restraints on gate valves 3 inches or larger as detailed.

H. Quick Coupling Valves - Brass two-piece body designed for working pressure of 125 PSI; operable with quick coupler. Equip quick coupler with locking NP purple rubber cover.

I. Valve Boxes:
1. Gate Valves, Quick Coupling Valves, Drain Valves, Drip Line Blow-out Stubs, and Wire Splice or Stub Box - Carson Brooks #910-10, Carson Brooks #H910-12 or approved equal (including bolt) box with lid and w/ Purple Bolt Down Cover as detailed.
2. 1 inch through 2 inch Control Valves, Master Valves, Pressure Regulating Valves and Communication Cable Splice box, Sub-meters - Carson Brooks #1419-12 box, w/ Purple Bolt Down Cover as detailed.
3. Drip Valve Assemblies and Flow Sensors - Carson Brooks #1220-12 box w/ Purple Bolt Down Cover Carson Brooks #1730-12 box, as detailed.

J. Electrical Control Wiring:
1. Low Voltage:
   a. Electrical Control Wire - AWG UFUL approved No. 14 direct burial copper wire or larger, if required to operate system as designed.
   b. Electrical Common Wire - AWG UFUL approved No. 14 direct burial copper wire or larger, if required to operate system as designed.
   c. Wire Colors:
      i. Control Wires - Red.
      ii. Common Wires - White.
      iii. Master Valve Wires - Blue.

iv. Drawing Spare Control Wires - Black.
v. Drawing Spare Common Wires - Yellow.
vi. Maintenance Spare Control Wires - Green.
vii. Maintenance Spare Common Wires - Brown.

d. If multiple controllers are utilized, and wire paths of different controllers cross each other, both common and control wires from each controller shall be different colors approved by Consultant.
e. Control Wire connections and splices shall be made with 3M DBY or King 600 DBY/R direct bury splice, or as required by the controller manufacturer.
f. Communication Cable – Paige PE-89, P7171D-A or approved equal with 3M Gel-type connections installed within Preformed Super Serviseal Splice Kit.

2. Low Voltage – (2-Wire Decoder Cable):
   a. Electrical Control Wire - UFUL approved, Paige Wire – P7072D 12/2 or as per manufactures requirements, direct burial copper wire to operate system as designed.
   b. If multiple controllers are utilized, refer to wire routing plan for individual wire runs. Each controller shall have a wire path of a different color. Refer to plan for any additional cable color requirements
   c. If multiple controllers are utilized, each controller shall have its own 2-wire decoder cable run, controllers cannot be connected with same 2-wire run.
   d. Loop five (5) feet minimum of 2-wire cable into all valve boxes.
   e. Control Wire connections and splices shall be made with 3M DBY or King 600 DBY/R direct bury splice, or as required by the controller manufacturer.
3. High Voltage - Type required by local codes and ordinances, of proper size to accommodate needs of equipment serviced.

K. Automatic Controller - Size and type shown on Drawings; mounted as detailed.
   1. Automatic Controller (2-Wire) - Size and type shown on Drawings; mounted as detailed.
      a. Single Station Decoders (2-Wire) - Size and type shown on Drawings; mounted as detailed.
      b. Install decoders and wire per manufacture recommendations and requirements.
      c. Grounding for all decoders and 2-wire decoder cable, to be per manufactures recommendations and requirements. Minimum one grounding assembly per every 500' of wire or every 8th decoder and at all ends of 2-wire decoder cable run.

L. Electric Control Valves - Size and type shown on Drawings having Purple manual flow adjustment, Purple solenoids, and manual bleed nut.
   1. Single station 2-wire decoder.

M. Master Valve – Size and type shown on Drawings.

N. Flow Sensor – Size and type shown on Drawings.

O. Sprinkler Heads - As indicated on Drawings. Fabricated riser units in accordance with details on Drawings - with fittings and nipples of equal diameter as riser inlet in sprinkler body.
   1. 6" to 12" Pop-up Spray Heads: Rainbird RD-XX-PXX Series with Rainbird 1800-NP purple cap covers on all spray heads.
   2. Gear Driven Rotors: Manufactured by Rain Bird or as indicated on Drawings with check valves and NP purple reclaimed identification caps and covers on all rotor heads.
   3. Sprinkler heads shall be Rotors or High-efficiency spray nozzles as indicated on plans. No substitution shall occur without written approval.

P. Backflow Preventer - Size and type indicated on Drawings; Brass or iron construction with 150 psi working pressure.

Q. Supply Pump - Size and type indicated on Drawings. Installed per manufactures recommendations.

R. Reclaimed Water Signage:

1. Sign shall state: “CAUTION: RECLAIMED WATER – DO NOT DRINK,” and display the international “do not drink” symbol.
2. Signs shall be installed and prominently displayed at: all points of ingress, restroom facilities, around all reclaimed lakes and water features, and a maximum spacing of 500 feet within the project.
3. Signs shall be visible and legible from all directions.

EXECUTION

2.02 SITE CONDITIONS, LANDSCAPE PLAN REVIEW AND COORDINATION

A. Contractor will be held responsible for coordination between landscape and irrigation system installation. Landscape material locations shown on the Landscape Plan shall take precedence over the irrigation system equipment locations. If irrigation equipment is installed in conflict with the landscape material locations shown on the Landscape Plan, the Contractor will be required to relocate the irrigation equipment, as necessary, at Contractor’s expense.

B. Contractor is responsible to notify Consultant of any field conditions that vary from the conditions shown on the Irrigation Construction Documents. If Contractor fails to notify Consultant of these conditions, Contractor will be held responsible for all costs associated with system adjustments required due to the change in field conditions.

C. Comply with the requirements of the TEMPORARY EROSION AND SEDIMENTATION CONTROL PLAN for preparation and protection of the site.

2.03 STATIC PRESSURE VERIFICATION

A. Contractor shall field verify the static pressure at the project site, prior to commencing work or ordering irrigation materials, and submit findings, in writing, to Consultant. If Contractor fails to verify static water pressure prior to commencing work or ordering irrigation materials, Contractor shall assume responsibility for all costs required to make system operational and the costs required to replace any damaged landscape material. Damage shall include all required material costs, design costs and plant replacement costs.

2.04 INSPECTION

A. Examine areas and conditions under which Work of this Section is to be performed. Do not proceed with Work until unsatisfactory conditions have been corrected.

B. Grading operations, with the exception of final grading, shall be completed and approved by Owner before staking or installation of any irrigation system begins.

C. Underground Utilities shall be installed prior to installation of irrigation system. If irrigation installation takes place prior to utility installation, Contractor shall notify Owner of this condition in writing prior to commencement of irrigation installation.

2.05 PREPARATION:

A. Staking shall Occur as Follows:
1. Mark, with powdered lime, routing of pressure supply line and flag heads for first few zones. Contact Consultant 48 hours in advance and request review of staking. Proposed locations of all trees shall be field staked by Contractor and approved by Owner/Landscape Architect prior to Consultant review of irrigation staking. Consultant will advise installer as to the amount of staking to be prepared. Consultant will review staking and direct changes if required. Review does not relieve installer from coverage problems due to improper placement of heads after staking.

2. Contractor shall contact Consultant if field spacing varies by +/- 10% of the spacing shown on the irrigation plans. If Contractor fails to notify Consultant of variances exceeding 10%, Contractor assumes full responsibility for the costs associated with any required system modifications deemed necessary by the Consultant or Owner.
3. If Project has significant topography, freeform planting beds, or other amenities, which could require alteration of irrigation equipment layout as deemed necessary by Consultant, do not install irrigation equipment in these areas until Consultant has reviewed equipment staking.

B. Install sleeving under asphalt paving and concrete walks, prior to concreting and paving operations, to accommodate piping and wiring. Compact backfill around sleeves to 95% Modified Proctor Density within 2% of optimum moisture content in accordance with STM D1557.

C. Trenching - Trench excavation shall follow, as much as possible, layout shown on Drawing. Dig trenches straight and support pipe continuously on bottom of trench. Trench bottom shall be clean and smooth with all rock and organic debris removed.
1. Clearances:
   a. Piping 3 Inches and Larger - Make trenches of sufficient width (14 inches minimum) to properly assemble and position pipe in trench. Minimum clearance of piping 3 inches or larger shall be 5 inches horizontally on both sides of the trench.
   b. Piping Smaller than 3 Inches - Trenches shall have a minimum width of 7 inches.
   c. Line Clearance - Provide not less than 6 inches of clearance between each line and not less than 12 inches of clearance between lines of other trades.
2. Pipe and Wire Depth:
   a. Pressure Supply Piping – 30 inches from top of pipe minimum or as noted on plans.
   b. PVC Sleeving – To match depth of sleeved material.
   c. Non-pressure Piping (rotor) - 18 inches from top of pipe.
   d. Non-pressure Piping (pop-up) - 14 inches from top of pipe.
   e. Non-pressure Piping (high-pop spray) – 18 inches from top of pipe
   f. Non-pressure Piping (high-pop rotor) - 24 inches from top of pipe.
   g. Control Wiring/Communication Cable - Side of pressure main or at 18 inch depth if installed in a separate trench with no mainline piping.
   h. Drip Tubing - 12 inches from top of pipe.
   i. Emitter Tubing (Micro-tubing) - 8 inches from top of pipe.
3. Boring will be permitted only where pipe must pass under obstruction(s) which cannot be removed. In backfilling bore, final density of backfill shall match that of surrounding soil. It is acceptable to use sleeves of suitable diameter installed first by jacking or boring, and pipe laid through sleeves. Observe same precautions as though pipe were installed in open trench.
4. Vibratory Plow - Non-pressure piping may be installed through use of vibratory plow method if consultant determines soil conditions are satisfactory for this method of installation. Vibratory plowing does not relieve installer of minimum pipe depths.

D. Pressure Supply Piping Locating Tape for Non-Potable Systems: Markline Tape, 3" wide detectable tape, NP purple in color with the words "CAUTION: RECYCLED/ RECLAIMED WATERLINE BELOW" printed every 36 inches. Place 12" below finish grade.

2.06 INSTALLATION - Locate other equipment as near as possible to locations designated. Consultant shall review deviations prior to installation.

A. PVC Piping - Snake pipe in trench as much as possible to allow for expansion and contraction. Do not install pipe when air temperature is below 40 degrees F. Place manual drain valves at low points and dead ends of pressure supply piping to insure complete drainage of system. When pipe installation is not in progress, or at end of each day, close pipe ends with tight plug or cap. Perform Work in accordance with good practices prevailing in piping trades.
1. Solvent Weld PVC Pipe - Lay pipe and make all plastic to plastic joints in accordance with manufacturer's recommendations.

2. HDPE Piping - Snake pipe in trench as much as possible to allow for expansion and contraction. Do not install pipe when air temperature is below 40 degrees F. Place manual drain valves at low points and dead ends of pressure supply piping to insure complete drainage of system. When pipe installation is not in progress, or at end of each day, close pipe ends with tight plug or cap. Perform Work in accordance with good practices prevailing in piping trades.
    a. Lay pipe and make all plastic to plastic, fusion joints in accordance with manufacturer's recommendations.
    b. Fusion: Sections of polyethylene pipe should be joined into continuous lengths on the jobsite above ground. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe supplier's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe supplier. The butt fusion joining will produce a joint weld strength equal to or greater than the tensile strength of the pipe itself. All field welds shall be made with fusion equipment equipped with a Data Logger. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the Quality Control records.
    c. Transition fittings shall be used for transition to other pipe materials (1/2" – 4") and utilize butt fusion.
    d. Mechanical joining will be used where the butt fusion method cannot be used. Mechanical joining will be accomplished by using a HDPE flange adapter with a Ductile Iron back-up ring.
    e. Hot gas fusion, threading, solvents, and epoxies will not be used to join HDPE pipe.
3. Gasketed End Pipes with Joint Restraint System:
    a. Lay pipe and make pipe-to-fitting or pipe-to-pipe joint, following the manufacturer's recommendations. Install joint restraint fittings and pipe restraints on all fittings and adjacent pipe runs per manufacturer's recommendations and as shown on plans.
    b. Prior to backfilling any joint restraints, the Project Manager shall be present to verify that the restraints were installed in the proper locations and that all bolts have been tightened to the manufacturer's recommendations. Any restraints that are buried prior to inspections shall be excavated to allow for review and inspection prior to approval.
4. Flexible Plastic (Polyethylene) Pipe - Lay pipe and assemble fittings following manufacturer's recommendations.

B. Drip Tubing:
1. Make all fitting connections as per manufacturer's recommendations.
2. Use only manufacturer provided or recommended hole punch when making penetrations in drip tubing for insert fittings. Use of any other hole punch shall be cause for immediate removal and replacement of all installed drip tubing.
3. Install drip line blow-out stubs at all dead ends of drip tubing.

C. Control Wiring:
1. Low Voltage Wiring:
    a. Install in conduit, as indicated on plans.
    b. Bury control wiring between controller and electric valves in pressure supply line trenches, strung as close as possible to main pipe lines with such wires to be consistently located below and to one side of pipe, or in separate trenches.
    c. Bundle all 24 volt wires at 10 foot intervals and lay with pressure supply line pipe to one side of the trench.
    d. Provide an expansion loop at every pressure pipe angle fitting, every electric control valve location (in valve box), and every 500 feet. Form expansion loop by wrapping wire at least 8 times around a 3/4 inch pipe and withdrawing pipe.
    e. Make all splices and E.C.V. connections using 3M DBY, King 600 DBY/R direct bury connectors, or similar dry splice method.
    f. Install all control wire splices not occurring at control valve in a separate splice valve box.
    g. Install one control wire for each control valve.

h. Maintenance spare wires - In addition to spare wires labeled on drawings, extend two spare #14 AWG UFUL control wires and one spare #14 AWG UFUL common wire from controller pedestal to the end of each and every leg of mainline. Label maintenance spare wires at controller and wire stub box.

2. Low Voltage Wiring– 2-Wire:
   a. Bury control wiring between controller and electric valves in pressure supply line trenches, strung as close as possible to main pipe lines with such wires to be consistently located below and to one side of pipe, or in separate trenches.
   b. Provide an expansion loop at every pressure pipe angle fitting, every electric control valve location (in valve box), and every 500 feet. Minimum 5 feet in every valve box, 2 feet at every angle fitting and 10 feet at every future phase line.
   c. Make all splices and E.C.V. connections using 3M DBY-6, King 600 DBR/Y connectors, or similar dry splice method.
   d. Install all control wire splices not occurring at control valve in a separate splice valve box.
   e. Install one decoder for each control valve or as indicated on plans.
   f. The wire paths shall be sized per distance requirements or as shown on plan. The two wire decoder cable shall be of the type indicated on the plans or per manufacturer recommendation.
   g. The two-wire paths may be spliced, or “teed”, permitting extensions of the path in multiple directions. In general, the distance from the controller to the end of any one end of a “tee” or wire run shall not exceed the maximum for the gauge of wire, even if the total of all wire exceeds that number. All wire splices must be made in a valve box with DBR-6 or equal direct-burial waterproof connectors.
   h. Grounding of decoders and decoder wire shall occur every of wire or every 8TH decoder and at all ends of 2-wire decoder cable run.
   i. Grounding shall occur at right angles to wire path and shall have an impedance of 10 Ohms or less, or shall meet the standards of the Earth Grounding Guidelines by ASIC.
   j. Where limits of work consist of narrow areas that make grounding rods installed at right angles a hardship, contractor shall utilize grounding plates installed at a minimum distance of 4’ offset and parallel to wire path. Avoid installing grounding near other electrical equipment.

3. High Voltage Wiring for Automatic Controller:
   a. Provide 120 volt power connection to automatic controller by contractor.
   b. All electric work shall conform to local codes, ordinances, and authorities having jurisdiction. All high voltage electrical work shall be performed by licensed electrician.

D. Automatic Controller:
   1. Install controller in accordance with manufacturer's instructions as detailed and where shown on Drawings.
   2. Connect remote control valves to controller in numerical sequence as shown on Drawings.
   3. Owner shall approve final location of controller prior to installation.
   4. Each controller shall have a dedicated separate ground wire and grounding rod as detailed. Earth grounding shall be connected via a factory supplied copper ground lug inside the controller, for connection to earth ground hardware via 6 AWG(4mm dia.) copper wire (see ASIC Earth Grounding Guideline 100-2002 for details of earth grounding irrigation control systems available online at www.asic.org). Ground wire shall be extended underground, at right angles to any communications wiring, to approved direct burial earth grounding hardware at least 6 ft./2m from the controller location. Earth Ground shall be have an impedance of 10 Ohms or less, or shall meet the standards of the Earth Grounding Guideline cited above.
   5. Connect remote control valves to controller in numerical sequence as shown on Drawings.
   6. All above ground conduit shall be rigid galvanized with appropriate fittings. All below ground conduit shall be schedule 40 PVC.

E. Electric Control Valves - Install cross-handle four inches below finished grade where shown on Drawings as detailed. When grouped together, allow minimum of 12 inches between valve box

sides. Install each remote control valve in a separate valve box. Install valve box flush with grade or when present flush with surfacing material (rock mulch). When parallel to roadway, sidewalk or other permanent element or structure, control valve and box to be installed perpendicular to element or structure, spaced equally.

1. All connections in the two-wire paths (outside the controller enclosure) shall be made with 3M DBR-6 waterproof, strain-relieving direct burial connectors, or exact equals. Decoder output to solenoid connections shall be made with 3M DBY waterproof, strain-relieving connectors, or exact equals. No substitution of wire or wire connector specifications is permissible. All connections, tees, and splices shall be positioned in valve boxes for future location and service.
2. The installer shall provide adequate earth ground (not to exceed 10 Ohms, or in compliance with practices as defined in American Society of Irrigation Consultants Earth Grounding Guideline 100-2002, available at www.asic.org) and connect it to one of the decoder ground 500', of wire or every 8TH decoder, whichever is shorter. Minimum ground hardware shall be a 4" x 36" (100 x 915mm) copper plate with at least 10AWG/2.5mm dia. copper wire. In high lightning areas, grounding may be increased to every 500 ft./150m or 10 decoders.
3. Ground connections from decoder ground lead to grounding hardware shall be made by joining the 12AWG (2mm dia.) decoder ground wire with a 10AWG (2.5mm dia.) solid copper lead in an approved wire nut of appropriate size, inserted in a DBR-6 waterproof direct burial connector, or with an approved wire clamp. Ground hardware shall extend at right angles from the two-wire path, and ground hardware shall be located at least 8ft./2m away from the two-wire path.
4. Where limits of work consist of narrow areas that make grounding rods installed at right angles a hardship, contractor shall utilize grounding plates installed at a minimum distance of 4' offset and parallel to wire path. Avoid installing grounding near other electrical equipment.

F. Quick Coupling Valves - Install quick couplers on swing-joint assemblies as indicated on construction details; plumb and flush to grade. Angled nipple relative to pressure supply line shall be no more than 45 degrees and no less than 10 degrees.

G. Drip and Sub-Surface Valve Assemblies - Install valve assembly as detailed.

H. Drip Emitters - Stake all surface emitters as detailed and staked with acceptable tubing stakes..

I. Drain Valves - Install one manual drain valve on pressure supply line directly downstream of backflow preventer and at all low points in pressure supply line as detailed. Provide a three cubic foot drainage sump for drain valve as detailed.

J. Valve Boxes:
   1. Install one valve box for each type of valve installed as detailed. Valve box extensions are not acceptable except for master valves and flow sensors. Install gravel sump after compaction of all trenches. Place final portion of gravel inside valve box after valve box is backfilled and compacted.
   2. Brand controller letter and station number on lid of each valve box. Letter and number size shall be no smaller than 1 inch and no greater in size than 1 1/2 inches. Depth of branding shall be no more than 1/8 inch into valve box lid.
   3. Concrete polymer boxes shall be labeled with branded inserts per manufacturer's recommendations.

K. Gate Valves - Install where shown on Drawings as detailed.

L. Sprinkler Heads - Install sprinkler heads where designated on Drawings or where staked. Set to finish as detailed. Spacing of heads shall not exceed the maximum indicated on Drawing unless re-staked as directed by Consultant. In no case shall the spacing exceed maximum recommended by manufacturer. Install heads on swing joints or riser assemblies as detailed. Adjust part circle heads for proper coverage. Adjust heads to correct height after sod is installed. Plant placement shall not interfere with intended sprinkler head coverage, piping, or other

equipment. Consultant may request nozzle changes or adjustments without additional cost to the Owner.

M. Backflow Preventer - Install as detailed at location designated on Drawings.

N. System Pump - Size and type required for project. Installed per manufacturers recommendations and as detailed.

O. Master Valve – Install as detailed at location designated on Drawings.

P. Flow Sensor - Install as detailed at location designated on Drawings.

Q. Backfilling - Do not begin backfilling operations until required system tests have been completed. Backfill shall not be done in freezing weather except with review by Consultant. Leave trenches slightly mounded to allow for settlement after backfilling is completed. Trenches shall be finish graded prior to walk-through of system by Consultant.
   1. Materials - Excavated material is generally considered satisfactory for backfill purposes. Backfill material shall be free of rubbish, vegetable matter, frozen materials, and stones larger than 1 inch in maximum dimension. Do not mix subsoil with topsoil. Material not suitable for backfill shall be hauled away. Contractor shall be responsible for providing suitable backfill if excavated material is unacceptable or not sufficient to meet backfill, compaction, and final grade requirements.
   2. Do not leave trenches open for a period of more than 48 hours. Open excavations shall be protected in accordance with OSHA regulations.
   3. Compact backfill to 90% maximum density, determined in accordance with ASTM D155-7 utilizing the following methods:
      a. Mechanical tamping.
      b. Puddling or ponding. Puddling or ponding and/or jetting is prohibited within 20’-0" of building or foundation walls.

R. Piping Under Paving:
   1. Provide for a minimum cover of 18 inches between the top of the pipe and the bottom of the aggregate base for all pressure and non-pressure piping installed under asphaltic concrete or concrete paving.
   2. Piping located under areas where asphalt or concrete paving will be installed shall be bedded with sand (a layer 6" below pipe and 6" above pipe).
   3. Compact backfill material in 6" lifts at 90% maximum density determined in accordance with ASTM D1557 using manual or mechanical tamping devices.
   4. Set in place, cap, and pressure test all piping under paving, in presence of Owner prior to backfilling and paving operations.
   5. Piping under existing walks or concrete pavement shall be done by jacking, boring, or hydraulic driving, but where cutting or breaking of walks and/or concrete is necessary, it shall be done and replaced at not cost to Owner. Obtain permission to cut or break walks and/or concrete from Owner.

S. Water Supply and Point of Connection - Water supply shall be extended as shown from water supply lines.

2.07 FIELD QUALITY CONTROL:

A. Flushing - After piping, risers, and valves are in place and connected, but prior to installation of sprinkler heads, quick coupler assemblies, and hose valves, thoroughly flush piping system under full head of water pressure from dead end fittings. Maintain flushing for 5 minutes through furthermost valves. Cap risers after flushing.

B. Pressure Testing - Conduct test in presence of Consultant. Arrange for presence of Consultant 48 hours in advance of testing. Supply force pump and all other test equipment. Compressed air shall not be used for pressure testing system.

1. After backfilling, and installation of all control valves, fill pressure supply line with water, and pressurize to 40 PSI over the designated static pressure or 120 PSI, whichever is greater, for a period of 2 hours.
2. Leakage, Pressure Loss - Test is acceptable if no loss of pressure is evident during the test period.
3. Leaks - Detect and repair leaks.
4. Retest system until test pressure can be maintained for duration of test.
5. Before final acceptance, pressure supply line shall remain under pressure for a period of 48 hours.
6. Pressure test shall be scheduled and passed prior to scheduling of Substantial Completion Walk-through.

C. Walk-Through for Substantial Completion:
1. Arrange for Consultant's presence 48 hours in advance of walk-through.
2. Entire system shall be completely installed and operational prior to scheduling of walk-through.
3. Operate each zone in its entirety for Consultant at time of walk-through and additionally, open all valve boxes if directed.
4. Generate a list of items to be corrected prior to Final Completion.
5. Furnish all materials and perform all work required to correct all inadequacies of coverage due to deviations from Contract Documents.
6. During walk-through, expose all drip emitters under operations for observation by Consultant to demonstrate that they are performing and installed as designed, prior to placing of all mulch material. Schedule separate walk-through if necessary.
7. Supply Consultant with prints of irrigation as-builts prior to scheduling substantial completion walk-through.

D. Walk-Through for Final Completion:
1. Arrange for Consultant’s presence 48 hours in advance of walk-through.
2. Show evidence to Consultant that Owner has received all accessories, charts, record drawings, and equipment as required before Final Completion walk-through is scheduled.
3. Operate each zone, in its entirety for Consultant at time of walk-through to insure correction of all incomplete items.
4. Items deemed not acceptable by Consultant shall be reworked to complete satisfaction of Consultant.
5. If after request to Consultant for walk-through for Final Completion of irrigation system, Consultant finds items during walk-through which have not been properly adjusted, reworked, or replaced as indicated on list of incomplete items from previous walk-through, Contractor shall be charged for all subsequent walk-throughs. Funds will be withheld from final payment and/or retainage to Contractor, in amount equal to additional time and expenses required by Consultant to conduct and document further walk-throughs as deemed necessary to insure compliance with Contract Documents.
6.

2.08 ADJUSTING - Upon completion of installation, fine-tune entire system by adjusting patterns and break-up pins, and setting pressure reducing valves at proper and similar pressure to provide optimum and efficient coverage. Flush and adjust all sprinkler heads for optimum performance and to prevent overspray onto walks, roadways, and buildings as much as possible. Heads of same type shall be operating at same pressure +/- 10%.

A. If it is determined that irrigation adjustments will provide proper coverage, and improved water distribution as determined by Consultant, contractor shall make such adjustments prior to Final Acceptance, as directed, at no additional cost to Owner. Adjustments may also include changes in nozzle sizes, degrees of arc, and control valve throttling.

B. All sprinkler heads shall be set perpendicular to finish grade unless otherwise noted on Construction Plans or directed by Consultant.

C. Areas which do not conform to designated operation requirements due to unauthorized changes or poor installation practices shall be immediately corrected at no additional cost to the Owner.

2.09 CLEANING - Maintain continuous cleaning operation throughout duration of work. Dispose of, off-site at no additional cost to Owner, all trash or debris generated by installation of irrigation system.

END OF SECTION 32 84 00

SECTION 32 91 13 SOIL PREPARATION

PART 1 GENERAL

1.1 SUMMARY

A. RELATED DOCUMENTS: The General Contract Conditions, Drawings and other Division - 1 Specification sections apply to Work of this section.

B. DESCRIPTION: The work of this section consists of ripping, fertilizing, soil conditioning and fine grading of topsoil in preparation for seeding, sodding or planting operations.

C. RELATED SECTIONS:

1. Earthwork - Section 310000
2. Sodding - Section 329223
3. Planting- Section 329300

1.2 SUBMITTALS:

A. Quality Control Submittals:

1. Existing Soil Testing: Contractor shall be responsible for providing and paying for three (3) soil tests from three (3) locations (to be determined in-field by Owner's Representative and Contractor) prior to any soil preparation work is to begin. Test results shall be provided to Owner's Representative as per Section 01 40 00. Costs to be calculated into seeding and soil preparation costs.
2. Certificates: State, federal and other inspection certificates shall accompany invoice for materials showing source or origin. Submit to Owner's Representative prior to acceptance of material.
3. Material Analysis: Provide soil conditioner analysis performed no more than 3months prior to delivery to site. Submit 0.5 cubic foot sample of soil conditioner at least 14 days prior to delivery to the site.

1.3 DELIVERY, STORAGE AND HANDLING:

A. Fertilizer: Deliver inorganic or chemical fertilizer to site in original unopened containers bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark and conformance to state law, bearing name and warranty or producer. If fertilizers are delivered in bulk, supplier shall provide the same certification as above.

B. Notify the Owner's Representative of delivery schedule in advance so material can be inspected upon arrival at project site. Immediately remove unacceptable material from project site.

1.4 PROJECT/SITE CONDITIONS:

A. General: Do not perform work when climate and existing site conditions will not provide satisfactory results.

B. Vehicular accessibility on site shall be as directed by the Owner's Representative. Repair damage to prepared ground and surface caused by vehicular movement during work under this section to original condition at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 SOIL MATERIALS:

A. Soil Conditioner:

1. Composted material meeting the following requirements – shall be adjusted accordingly dependent upon Contractor's soil test results (at no additional cost):

   a. Organic matter: 25% minimum
   b. Salt content: 4.0 mmhos/cm maximum
   c. pH: 8.5 maximum
   d. Carbon to nitrogen ratio of 10:1 to 25:1
   e. No live noxious weed seeds or plants shall be present

2. Mountain peat, aspen humus, gypsum, manure and sand will not be accepted.

2.2 OTHER MATERIALS:

A. Fertilizer: Diamonium phosphate (18-46-0). Shall be adjusted accordingly dependent upon Contractor's soil test results (at no additional cost).

B. Post Emergent Herbicide: Roundup (Glyphosate) as manufactured by Monsanto Company or approved equal.

C. Sand: Washed local sand with no deletrious materials.

PART 3 EXECUTION

3.1 EXAMINATION:

A. General: Verify that existing site conditions are as specified and satisfactory to perform the work in this section. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the installer. Starting installation constitutes acceptance of site conditions.

1. Grades: Inspect to verify rough grading is within +/- 0.1 foot of grades indicated and specified.
2. Damaged Earth: Inspect to verify that earth rendered unfit to receive planting due to concrete, water, mortar, limewater or any other contaminant dumped on it has been removed and replaced with clean earth from a source approved by the Owner's Representative.

B. Unsatisfactory Conditions: Report in writing to General Contractor with copy to Owner's Representative.

C. Acceptance: Beginning of installation means acceptance of existing conditions by installer.

3.2 PREPARATION

A. Protection

1. Locate sewer, water, irrigation, gas, electric, phone and other pipelines or conduits and equipment prior to commencing work.
2. Be responsible for proper repair to landscape, utilities, walls, pavements and other site improvements damaged by operations under this section.

B. Weed Control: Remove annual weeds by tilling. Remove perennial weeds by applying herbicide 1 week before soil preparation and as needed, but no sooner than 3 months before beginning work.

C. Surface Grade: Remove weeds, debris, clods and rocks larger than ½". Dispose of accumulated debris at direction of Owner's Representative.

D. Runoff: Take measures and furnish equipment and labor necessary to control the flow, drainage, and accumulation of water. Insure that all water will run off the grades.

E. Erosion Control: Take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind-deposited material on the site throughout duration of work.

3.3 INSTALLATION

A. Fine Grading in all Landscape Areas:

1. Do fine grading for all areas prior to seeding or planting.
2. For ground surface areas surrounding buildings to be landscaped, maintain required positive drainage away from buildings.
3. Establish finish grades to within 0.1 foot of grades indicated. Allow 1-1/2 inch for thickness of sod.
4. Finished grades of shrub, ground cover beds and planter pots shall be 4" below top of adjacent pavement, or cap, for thickness of mulch, unless otherwise specified on drawings.
5. Noxious weeds or parts thereof shall not be present in the surface grade prior to seeding.
6. Prior to acceptance of grades, hand rake to smooth, even surface, free of debris, clods, rocks and vegetable matter greater than 0.5 inch.

3.4 NOTIFICATION AND INSPECTION

A. Inspection: Provide notice to Owner's Representative requesting inspection at least seven (7) days prior to anticipated date of completion.

B. Deficiencies: Owner's Representative will specify deficiencies to Contractor who shall make satisfactory adjustments and shall again notify Owner's Representative for final inspection.

3.5 CLEANING

A. General: Remove debris and excess materials from site. Clean out drainage inlet structures. Clean paved and finished surfaces soiled as a result of work under this Section, in accordance with direction given by Owner's Representative.

3.6 PROTECTION

A. General: Provide and install barriers as required and as directed by Owner's Representative to protect completed areas against damage from pedestrian and vehicular traffic until acceptance by Owner. Contractor is not responsible for malicious destruction caused by others.

END OF SECTION 32 91 13

SECTION 32 91 19.13 TOPSOIL PLACEMENT AND GRADING

PART 1 GENERAL

1.1 SUMMARY

A. RELATED DOCUMENTS

1. The General Contract Conditions, Drawings and other Division - 1 Specification sections apply to Work of this section.

B. DESCRIPTION

1. The work of this section consists of furnishing, stockpiling and placing topsoil on a previously prepared subgrade.

C. RELATED WORK

1. Soil Preparation - Section 329113
2. Sodding – Section 329223
3. Planting- Section 329300

1.2 QUALITY ASSUARANCE

A. Contractor shall submit soil analysis report for on-site topsoil from the State University Agricultural Extension Service or other approved soil testing laboratory. Report shall cover soil textural classification (percentages of sand, silt, and clay), pH and include additive recommendations. Testing will be at the expense of the Contractor. Contractor to amend topsoil per test recommendations with approval of Owner's Representative.

1.3 DELIVERY, STORAGE AND HANDLING

A. Do not deliver or place topsoil in frozen, wet, or muddy condition.

PART 2 PRODUCTS

2.1 ON-SITE TOPSOIL

A. On-site Topsoil shall consist of loose friable loam free of subsoil, trash, stumps, roots, rocks, heavy clay or hard clods greater than 1" in size, toxic substances, brush, weed seeds and reproductive vegetative plant parts (such as Knapweed, Purple Loosestrife, and Canadian Thistle) and other material which would be deleterious to its use on the project. Strip from top 6" of existing topsoil where organic material is visible and as directed by the Project Manager. Verify depth and size of topsoil stockpile with Project Manager.

2.2 IMPORTED TOPSOIL

A. All topsoil shall be a loam or sandy loam. At least 10 days prior to topsoil delivery, notify Owner's Representative of the source(s) from which topsoil is to be furnished. Topsoil shall be furnished by the Contractor and shall be a natural, friable soil representative of productive soils in the vicinity. It shall be obtained from the top 6" of well drained areas

B. Fertile, friable, loamy soil, reasonably free from subsoil, refuse, roots, heavy or stiff clay, stones larger than 1 inch, coarse sand, noxious seeds, sticks, brush, litter, and other deleterious substances; suitable for the germination of seeds and the support of vegetative growth. The pH value shall be between 7.0 and 8.0 and the total salts maximum content shall be 3 MMHOS/CM

C. Soil Texture: Sand, 30 to 50 percent; silt, 30 to 50 percent; clay, 5 to 30 percent.

D. Additives: As determined by soil fertility tests.

E. % Organic Content: 2.9% minimum.

PART 3 EXECUTION

3.1 STOCKPILING

A. Stockpile topsoil within boundaries of staging areas within Limits of Construction as shown on drawings or as directed by the Project Manager. Topsoil stockpiles shall be separate from other soil and materials piles and protected with silt fence on the down-gradient side of the stockpile. Contractor shall construct storage piles to freely drain surface water. Seed or cover storage piles to prevent erosion.

3.2 PLACING TOPSOIL

A. Scarify compacted subgrade to a 6-inch depth to bond topsoil to subsoil. Place topsoil to a minimum depth of 4-inches after settlement. Topsoil shall be free from weeds, sod, clods and stones larger than 1-inch, toxic substances, litter or other deleterious material. Spread evenly and grade to elevations and slopes shown. Hand rake areas inaccessible to machine grading.

B. Utilize salvaged topsoil as the top layer to the extent available.

END OF SECTION 32 91 13.13

SECTION 32 92 20 NATIVE SEEDING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes requirements for the installation of native seed, mulch, erosion control material (if applicable), and maintenance of the seeded areas, to be achieved as outlined in the "Maintenance" section below.

B. Related Sections:
1. Division 01 Section "Erosion and Sedimentation Control".
2. Division 01 Section "Tree Retention and Protection".
3. Division 31 Section "Earth Moving".
4. Division 31 Section "Watering".
5. Division 32 Section "Irrigation System".
6. Division 32 Section "Soil Preparation".
7. Division 32 Section "Topsoil".
8. Division 32 Section "Trees, Plants, and Groundcovers".

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, herbicide, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

E. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

F. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

G. Weeds: Including but not limited to Puncturevine, Field Bindweed, Twitch, Dandelion, Jimsonweed, Diffuse, Spotted and Russian Napweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Prickly Lettuce, Lambsquarter, Chickweed, Cress, Crabgrass, Canada Thistle, Nutgrass, Blackberry, Tansy Ragwort, Bermuda Grass, Johnsongrass, Poison Ivy, Nut Sedge, Nimble Weed, Bent Grass, Garlic

Mustard, Perennial Sorrel, and Broom Grass or any weed listed on Colorado Noxious Weed List and Watch List.

1.4 REFERENCES

A. Comply with U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act and be equal to or better in quality than the standards for Certified Seed.

B. Colorado Department of Transportation (CDOT) – Standards Specifications for Road and Bridge Construction.

1.5 SUBMITTALS

A. See Division 01 Section "Submittals" for submittal requirements.

B. Materials: The Contractor shall submit to the Project Manager for approval a complete list of all materials to be used during this portion of the work prior to delivery of any materials to the site. Include complete data on source, amount and quality. This submittal shall in no way be construed as permitting substitution for specific items described on the plans or in these specifications unless approved in writing by the Project Manager.
   1. Certification of Seed: From seed vendor for each seed mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
   2. Native Grass Species (supplied as pure live seed): Submit lab germination test results for all grass species. Submit an affidavit that describes estimated purity for all forb species that are not typically tested.
   3. Pesticides: Include product label and manufacturer's application instructions specific to this Project.
   4. Product Certificates: For soil amendments and fertilizers, from manufacturer.

C. Qualification Data: For qualified landscape Installer.

D. Material Test Reports: For existing in-place surface soil.
   1. Soil Analysis: See Division 32 Section "Soil Preparation"
   2. Analysis for each soil amendment.
   3. Analysis for each amended planting soil.

E. Analysis and standards: Wherever applicable, for non-packaged materials, provide two copies of analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists.

F. Seeding schedule: Submit, in writing, two (2) copies of proposed seeding schedule, indicating dates for site preparation, seeding, mulching, erosion control, and coordination with plant procurement, planting soil preparation, plant delivery and planting. Schedule all Work during specified planting seasons. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.

G. Maintenance Instructions: Recommended procedures for maintenance of non-irrigated native seed areas during a calendar year. Submit before expiration of required initial maintenance periods.

H. Contract Closeout Submittals:
   1. Operating and Maintenance Data: At completion of work, submit one (1) digital copy and two (2) hard copies to the Project Manager in accordance with Division 01 Section "Contract Closeout". Include directions for irrigation, aeration, mowing, fertilizing, and spraying as required for continued and proper maintenance through full growing season and dormant period.

2. Warranty for Native Seed Areas: At completion of work, furnish written warranty to Project Manager based upon specified requirements.

I. The Project Manager reserves the right to reject the seed at any time prior to acceptance and that fails to meet specification requirements. Promptly remove rejected seed from the site.

1.6 QUALITY CONTROL

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful native grass establishment.
   1. Experience: Five years' experience in native seed installation in addition to requirements in Division 01 Section “Quality Control”.
   2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   3. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

B. Pre-installation Conference: Conduct conference at Project site to coordinate the process with other trades, to coordinate equipment movement within planting areas and to avoid soil compaction, to review proposed methods of installation, performance criteria, and maintenance procedures. Review underground utility location maps and plans. This meeting shall be coordinated by the Contractor, and comply with requirements in Division 01.

C. Standards: All materials and methods used during this portion of the work shall meet or exceed applicable federal, state, county, and local laws and regulations. All seed shall be free from insects and disease. Species shall be true to their scientific name as specified.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed: Shall be furnished in bags or containers clearly labeled to show the name and address of the supplier, the seed name, the lot number, net weight, origin, the percent of weed seed content, the guaranteed percentage of purity and germination, pounds of pure live seed (PLS) of each seed species, and the total pounds of PLS in the container. Seed that has become wet, moldy or damaged in transit or in storage will not be acceptable.

B. Other Packaged Materials: Deliver packaged materials in original unopened containers bearing weight, analysis and name of supplier.

C. Fertilizer: Deliver organic or chemical fertilizer to site in original unopened container bearing manufacturer’s guaranteed chemical analysis, name, trade name, trademark and conformance to state law, and bearing name and warranty of producer.

D. Bulk Materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.
   4. Seed: Deliver seed materials in original unopened containers, showing bearing weight, analysis and name of supplier.

5. Fertilizer: Deliver inorganic or chemical fertilizer to site in original unopened container bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark and conformance to state law, and bearing name and warranty of producer.

E. Material will be inspected upon arrival at project site. Project Manager will reject any opened or unacceptable materials as described above. Store all materials in a manner to prevent wetting and deterioration.

F. Immediately remove unacceptable material from job site.

1.8 PROJECT/SITE CONDITIONS

A. Work scheduling: Proceed with and complete landscape work rapidly, as portions of the site become available, working within the specified planting season and approved schedule.

B. Planting Restrictions: Planting is preferred in fall and winter months but may be performed during one of the periods noted below. Variance from the schedule shall be permitted only with written approval from the Project Manager. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.

C. Vehicular accessibility on site shall be as directed by Project Manager. Repair damage to prepared topsoil and existing surfaces, caused by vehicular access and movement during work under this section, to original condition at no additional cost to the Town.

D. Do not drill or sow seed during windy, rainy weather or when ground is frozen or otherwise unable to be tilled.

E. Seeding Season: Seeding shall generally occur during the specified windows below. Seeding dates may be modified when temperature and moisture conditions are favorable. Verify with local producers and contractors prior to finalizing.

Seed Type	Non-Irrigated Areas
Native Grasses	November 15-April 15

1. Dormant Seeding: Upon approval of the Project Manager, dormant seeding for Non-irrigated areas may be accomplished between November 15 and April 15. No seeding shall be done when the ground is frozen, muddy, covered with snow, or otherwise in a condition unsuitable for seeding. Dormant seeding will not relieve the Contractor from the warranty or the acceptance requirements specified elsewhere in this specification.

F. Existing conditions:
1. Existing Plants: Install sod only after all other landscape and irrigation items have been installed and accepted by the Project Manager.
2. Utilities: Determine location of underground utilities. Perform work in a manner to avoid possible damage. Hand excavate, as required.
3. Excavation: Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, noxious materials or obstructions, notify Project Manager before planting.
4. If weeds are present on site, treat with pesticide prior to preparing soil for installing seed or sod as specified below.

G. Coordination:

1. Coordinate with construction of utilities on site. Do not begin placing topsoil until underground work is completed in the area.
2. Coordinate with seeding and landscape Contractor(s) approved schedule. Limit construction access to areas where topsoil has been placed if placement is completed more than three (3) days prior to commencement of landscaping in the area. Limit fine grading to areas that can be prepared for planting within twenty-four (24) hours after fine grading.
3. Coordinate with Contractors work requiring access to site over seeded areas.
4. Coordinate with installation of underground irrigation system.

PART 2 PRODUCTS

1.9 MATERIALS

A. Topsoil: See Division 32 Section "Topsoil".

B. General:
1. The selected seed mix must be approved by the Town Project Manager and the Project Landscape Architect or Ecologist prior to its incorporation into the project.
2. All seed brands shall be free from Colorado prohibited noxious weed seeds, including but not limited to Canada Thistle, Field Bindweed, Johnsongrass, and Leafy Spurge. The Contractor shall furnish to the Project Manager a signed statement certifying that the seed is from a lot that has been tested by a recognized laboratory for seed testing within six months prior to the date of delivery.
3. Computation for quantity of seed required on the project is based on Pure Live Seed (PLS).
4. The formula used for determining the quantity of PLS shall be:
Pounds of Seed x (Purity x Germination) = Pounds of PLS.
5. If seed available on the market does not meet the minimum purity and germination specified, the Contractor must compensate for a lesser percentage of purity or germination by furnishing sufficient additional seed to equal the specified product. Product comparison shall be made on the basis of PLS in pounds, stated on each seed bag.

C. Seed Mixes:

1. Pond Perimeter Wetland Seed Mix at Pond

1. Pond Perimeter Wetland Mix (With Tall & More Aggressive Bulrushes)

Scientific Name	Common Name	PLS Lbs./acre	Seeds/Ft2	Percentage of Mix
Graminoids				
Acorus americanus	Sweetflag	2.5	4.8	4.5%
Eleocharis palustris	Creeping spike rush	0.5	7.1	6.5%
Carex pellita	Woolly sedge	1.5	8.1	7.5%
Deschampsia caespitosa	Tufted hairgrass	0.125	7.2	6.6%
Glyceria striata	Fowl mannagrass	0.25	6.9	6.3%
Juncus longistylis	Longstyle rush	0.0125	4.6	4.2%
Juncus torreyi	Torrey's rush	0.025	7.1	6.5%
Scirpus acutus	Hardstem bulrush	0.5	4.6	4.2%
Scirpus americanus	Threesquare bulrush	0.5	3.4	3.2%
Scirpus maritimus	Alkali bulrush	0.5	4.9	4.5%
Sorghastrum nutans	Indiangrass	2	6.1	5.6%
Sparganium eurycarpum	Giant burreed	1	0.5	0.5%
Triglochin maritima	Arrowgrass	0.5	5.4	4.9%
	TOTAL GRASSES	**9.91**	**70.8**	**65.1%**
Forbs				
Asclepias incarnata	Swamp milkweed	2	3.5	3.2%
Asclepias speciosa	Showy milkweed	2	3.3	3.0%
Eutrochium maculatum	Spotted joe pye weed	0.125	4.1	3.8%
Helianthus nuttalii	Marsh sunflower	1.5	4.3	4.0%
Iris missouriensis	Western blue flag	2	1.0	0.9%
Lobelia siphilitica	Blue lobelia	0.03125	5.6	5.1%
Rudbeckia ampla	Goldenglow	1	5.5	5.1%
Solidago gigantea	Giant goldenrod	0.0325	3.0	2.7%
Solidago canadensis	Canada goldenrod	0.0325	3.4	3.2%
Verbena hastata	Blue vervain	0.125	4.3	3.9%
	TOTAL FORBS	**8.85**	**38.0**	**34.9%**
	GRAND TOTAL	**18.76**	**108.8**	**100.0%**

*Broadcast seed at a rate of ~109 seeds per square foot.

2. Recirculating Creek Wetland Seed Mix

2. Recirculating Creek Wetland Mix (Shorter With No Aggressive Bulrushes)

Scientific Name	Common Name	PLS Lbs./acre	Seeds/Ft2	Percentage of Mix
Graminoids				
Acorus americanus	Sweetflag	2.5	4.8	4.8%
Eleocharis palustris	Creeping spike rush	0.5	7.1	7.0%
Carex pellita	Woolly sedge	1	5.4	5.3%
Deschampsia caespitosa	Tufted hairgrass	0.125	7.2	7.1%
Glyceria striata	Fowl mannagrass	0.25	6.9	6.8%
Juncus longistylis	Longstyle rush	0.0125	4.6	4.5%
Juncus torreyi	Torrey's rush	0.025	7.1	7.0%
Sorghastrum nutans	Indiangrass	2.5	7.6	7.5%
Triglochin maritima	Arrowgrass	0.5	5.4	5.3%
	TOTAL GRASSES	**7.41**	**56.0**	**55.3%**
Forbs				
Asclepias incarnata	Swamp milkweed	2	3.5	3.5%
Asclepias speciosa	Showy milkweed	2	3.3	3.3%
Eutrochium maculatum	Spotted joe pye weed	0.125	4.1	4.1%
Helianthus nuttalii	Marsh sunflower	2	5.7	5.7%
Iris missouriensis	Western blue flag	2	1.0	1.0%
Lobelia siphilitica	Blue lobelia	0.03125	5.6	5.5%
Rudbeckia ampla	Goldenglow	1	5.5	5.4%
Solidago gigantea	Giant goldenrod	0.0625	5.7	5.7%
Solidago canadensis	Canada goldenrod	0.0625	6.6	6.5%
Verbena hastata	Blue vervain	0.125	4.3	4.2%
	TOTAL FORBS	**9.41**	**45.4**	**44.7%**
	GRAND TOTAL	**16.82**	**101.4**	**100.0%**

*Broadcast seed at a rate of ~101 seeds per square foot.

3. Riparian Seed Mix

3. Riparian Mix

Scientific Name	Common Name	PLS Lbs./acre	Seeds/Ft2	Percentage of Mix
Graminoids				
Andropogon gerardii	Big blustem	2	8.3	8.3%
Bouteloua curtipendula	Sideoats grama	2	8.7	8.7%
Bouteloua gracilis	Blue grama	0.375	7.1	7.1%
Elymus canadensis	Canada wildrye	2	5.2	5.2%
Panicum virgatum	Switchgrass	1.75	8.0	8.1%
Pascopyrum smithii	Western wheatgrass	0.75	2.2	2.2%
Schizachyrium scoparium	Little bluestem	3	9.0	9.0%
Sorghastrum nutans	Indiangrass	3	9.1	9.1%
	TOTAL GRASSES	**14.88**	**57.6**	**57.8%**
Forbs				
Asclepias speciosa	Showy milkweed	2	3.3	3.3%
Echinacea angustifolia	Narrow-leaved cone flower	1	4.7	4.7%
Liatris ligulostylis	Rocky Mountain gayfeather	1	3.7	3.7%
Monarda fistulosa	Bee balm	0.25	7.3	7.3%
Rudbeckia ampla	Goldenglow	1	5.5	5.5%
Solidago canadensis	Canada goldenrod	0.075	7.9	7.9%
Symphyotrichum laeve var. geyeri	Smooth blue aster	0.375	8.7	8.8%
Thalictrum dasycarpum	Purple meadow rue	0.125	0.5	0.5%
Vicia americana	Amercian vetch	0.5	0.4	0.4%
	TOTAL FORBS	**6.33**	**42.1**	**42.2%**
	GRAND TOTAL	**21.20**	**99.7**	**100.0%**

*Broadcast seed at a rate of ~100 seeds per square foot.

1.

4. Wildflower Meadow Seed Mix

4. Wildflower Meadow Mix

Scientific Name	Common Name	PLS Lbs./acre	Seeds/Ft2	Percentage of Mix
Shrubs				
Ericameria nauseosa	Rubber rabbitbrush	0.0625	0.6	0.5%
	TOTAL SHRUBS	**0.13**	**0.6**	**0.5%**
Grasses				
Aristida purpurea	Purple threeawn	0.75	4.3	3.7%
Oryzopsis hymenoides	Indian ricegrass	0.75	2.4	2.1%
Bouteloua curtipendula	Sideoats grama	0.75	3.3	2.8%
Bouteloua gracilis	Blue grama	0.125	2.4	2.1%
Festuca idahoensis	Idaho fescue	0.25	2.6	2.2%
Hesperostipa comata	Needle and Thread	1.25	3.3	2.9%
Hesperostipa neomexicana	New Mexico feathergrass	2	4.1	3.6%
Koeleria macrantha	Junegrass	0.0625	3.3	2.9%
Schizachyrium scoparium	Little bluestem	1	3.0	2.6%
Stipa tenuissima	Mexican feather grass	0.125	3.9	3.3%
	TOTAL GRASSES	**7.06**	**32.5**	**28.2%**
Forbs				
Agastache foeniculum	Anise hyssop	0.125	4.4	3.8%
Asclepias speciosa	Showy milkweed	3	5.0	4.3%
Asclepias tuberosa	Butterfly milkweed	2	5.0	4.3%
Cleome serrulata	Rocky Mountain beeplant	1.5	2.2	1.9%
Coreopsis tinctoria	Plains coreopsis	0.0625	4.6	4.0%
Dalea purpurea	Purple prairie clover	0.75	5.2	4.5%
Delphinium nuttallii	Nuttal's larkspur	0.5	7.5	6.5%
Echinacea angustifolia	Narrow-leaved cone flower	1.5	7.1	6.1%
Erysimum capitatum	Western wallflower	0.25	2.1	1.9%
Gaillardia aristata	Blanket flower	1	4.3	3.7%
Heliomeris multiflora	Showy goldeneye	0.25	6.9	6.0%
Liatris punctata	Gayfeather	1	1.4	1.3%
Linum lewisii	Blue flax	1	6.8	5.9%
Lupinus argenteus	Silvery lupine	2	0.8	0.7%
Monarda fistulosa	Bee balm	0.1825	5.3	4.6%
Penstemon strictus	Rocky Mountain penstemon	0.75	4.9	4.3%
Ratibida columnifera	Prairie coneflower	0.25	4.2	3.7%
Rudbeckia hirta	Gloriosa daisy	0.125	4.5	3.9%
	TOTAL FORBS	**16.25**	**82.2**	**71.3%**
	GRAND TOTAL	**23.43**	**115.3**	**100.0%**

*Broadcast seed at a rate of ~115 seeds per square foot.

5. Tallgrass Prairie Seed Mix

5. Tallgrass Prairie Mix

Scientific Name	Common Name	PLS Lbs./acre	Seeds/Ft2	Percentage of Mix
Grasses				
Andropogon gerardii	Big bluestem	2	8.3	7.9%
Bouteloua curtipendula	Sideoats grama	1	4.4	4.2%
Bouteloua gracilis	Blue grama	0.375	7.1	6.8%
Hesperostipa comata	Needle and Thread	3	7.9	7.6%
Hesperostipa neomexicana	New Mexico feathergrass	3	6.2	6.0%
Panicum virgatum	Switchgrass	1.5	6.9	6.6%
Pascopyrum smithii	Western wheatgrass	1.5	4.5	4.3%
Schizachyrium scoparium	Little bluestem	1	3.0	2.9%
Sorghastrum nutans	Indiangrass	2.5	7.6	7.3%
	TOTAL GRASSES	**15.88**	**55.8**	**53.6%**
Forbs				
Artemisia ludoviciana	White sage	0.03125	2.7	2.6%
Coreopsis tinctoria	Plains coreopsis	0.05	3.7	3.6%
Dalea purpurea	Purple prairie clover	0.5	3.4	3.3%
Echinacea angustifolia	Narrow-leaved coneflower	1	4.7	4.5%
Gaillardia aristata	Blanket flower	1	4.3	4.1%
Heliomeris multiflora	Showy goldeneye	0.125	3.4	3.3%
Linum lewisii	Blue flax	0.5	3.4	3.3%
Monarda fistulosa	Bee balm	0.125	3.7	3.5%
Ratibida columnifera	Prairie coneflower	0.25	4.2	4.1%
Rudbeckia hirta	Gloriosa daisy	0.125	4.5	4.3%
Solidago canadensis	Canada goldenrod	0.05	5.3	5.1%
Verbena stricta	Hoary vervain	0.5	4.9	4.7%
	TOTAL FORBS	**4.26**	**48.2**	**46.4%**
	GRAND TOTAL	**20.13**	**104.0**	**100.0%**

*The tallgrass prairie species found in this mix require irrigation
*Broadcast seed at a rate of ~104 seeds per square foot.

6. Prairie/Midgrass Seed Mix

6. Midgrass Prairie Mix

Scientific Name	Common Name	PLS Lbs./acre	Seeds/Ft2	Percentage of Mix
Grasses				
Aristida purpurea	Purple threeawn	1.5	8.6	8.4%
Bouteloua curtipendula	Sideoats grama	2	8.7	8.5%
Bouteloua dactyloides	Buffalograss	4	5.1	5.0%
Bouteloua gracilis	Blue grama	0.5	9.5	9.3%
Koeleria macrantha	Junegrass	0.125	6.6	6.4%
Pascopyrum smithii	Western wheatgrass	1	3.0	2.9%
Schizachyrium scoparium	Little bluestem	3	9.0	8.7%
Sporobolis heterolepis	Prairie dropseed	0.25	6.9	6.7%
Stipa tenuissima	Mexican feather grass	0.25	7.7	7.5%
	TOTAL GRASSES	**12.63**	**65.1**	**63.6%**
Forbs				
Artemisia frigida	Fringed sage	0.015625	1.6	1.6%
Artemisia ludoviciana	White sage	0.03125	2.7	2.6%
Castilleja integra	Whole leaf indian paintbrush	0.03125	3.1	3.1%
Coreopsis tinctoria	Plains coreopsis	0.0625	4.6	4.5%
Dalea purpurea	Purple prairie clover	0.75	5.2	5.0%
Echinacea angustifolia	Narrow-leaved cone flower	0.5	2.4	2.3%
Gaillardia aristata	Blanket flower	1	4.3	4.2%
Liatris punctata	Gayfeather	4	5.8	5.7%
Linum lewisii	Blue flax	0.5	3.4	3.3%
Ratibida columnifera	Prairie coneflower	0.25	4.2	4.1%
	TOTAL FORBS	**7.14**	**37.3**	**36.4%**
	GRAND TOTAL	**19.77**	**102.4**	**100.0%**

*Broadcast seed at a rate of ~102 seeds per square foot.

7. Arid Seed Mix

7. Arid Mix

Scientific Name	Common Name	PLS Lbs./acre	Seeds/Ft2	Percentage of Mix
Shrubs				
Artemisia vaseyana	Mountain big sagebrush	0.0325	1.5	1.9%
Chrysothamnus viscidiflorus	Green rabbitbrush	0.025	0.4	0.6%
Krascheninnikovia lanata	Winterfat	0.25	0.7	0.9%
	TOTAL SHRUBS	**0.31**	**2.6**	**3.4%**
Grasses				
Aristida purpurea	Purple threeawn	1	5.7	7.6%
Elymus elymoides	Squirreltail	1	4.4	5.8%
Koeleria macrantha	Junegrass	0.125	6.6	8.7%
Nassella tenuissima	Mexican feathergrass	1	4.2	5.5%
Oryzopsis hymenoides	Indian ricegrass	2.5	8.1	10.7%
Poa secunda	Sandberg bluegrass	0.125	3.0	4.0%
Pseudoroegneria spicata	Bluebunch wheatgrass	1.25	4.3	5.7%
Hesperostipa comata	Needle and Thread	2	5.3	7.0%
	TOTAL GRASSES	**9.00**	**41.6**	**55.1%**
Forbs				
Artemisia frigida	Fringed sage	0.025	2.6	3.4%
Asclepias asperula	Antelope horn	0.015	0.0	0.0%
Balsamorhiza sagittata	Arrowleaf balsamroot	2	2.7	3.6%
Castilleja integra	Whole leaf indian paintbrush	0.03125	3.2	4.3%
Delphinium nuttalianum	Nuttal's larkspur	0.0005	0.0	0.0%
Erysimum capitatum	Wallflower	0.015625	0.4	0.5%
Heliomeris multiflora	Showy goldeneye	0.125	3.4	4.6%
Heterotheca villosa	Halse hairy goldenaster	0.5	3.9	5.1%
Ipomopsis aggregata	Scarlet gilia	0.25	3.1	4.1%
Mirabilis multiflora	Wild four o' clock	0.5	0.1	0.2%
Oenothera caespitosa	Fragrant evening primrose	0.001	0.0	0.0%
Oxytropis lambertii	Purple locoweed	0.0625	0.3	0.4%
Penstemon eatonii	Firecracker penstemon	0.125	1.1	1.5%
Penstemon palmeri	Palmer penstemon	0.25	5.6	7.4%
Sphaeralcea coccinea	Scarlet globemallow	0.375	4.3	5.7%
Stanleya pinnata	Prince's plume	0.125	0.5	0.7%
	TOTAL FORBS	**4.40**	**31.4**	**41.7%**
	GRAND TOTAL	**13.71**	**75.5**	**100.0%**

*This mix has been designed to have a lower seeding rate to mimic arid landscapes of Colorado. We suggest also supplementing this area with containerized co
*Broadcast seed at a rate of ~75 seeds per square foot.

8. High Elévation Seed Mix

8. High Elevation Mix

Scientific Name	Common Name	PLS Lbs./acre	Seeds/Ft2	Percentage of Mix
Grasses				
Bromus ciliatus	Fringed brome	1.5	2.8	2.8%
Deschampsia caespitosa	Tufted hairgrass	0.125	7.2	7.4%
Elymus glaucus	Blue wildrye	2	5.1	5.2%
Festuca saximontana	Rocky Mountain Fescue	0.25	7.5	7.7%
Festuca thurberi	Thurber's fescue	0.25	4.3	4.4%
Muhlenbergia montana	Mountain muhly	0.25	8.6	8.9%
Phleum commutatum	Alpine timothy	0.125	3.7	3.8%
Poa alpina	Alpine bluegrass	0.25	5.7	5.9%
	TOTAL GRASSES	**4.75**	**44.8**	**46.1%**
Forbs				
Achillea millefolium	Yarrow	0.25	1.9	2.0%
Agastache urticifolia	Nettle leaf giant hyssop	0.25	4.9	5.0%
Aquilegia coerulea	Blue columbine	0.75	6.9	7.1%
Aquilegia elegantula	Western red columbine	0.001	0.0	0.0%
Chamerion angustifolium	Fireweed	0.025	4.9	5.0%
Delphinium barbeyi	Subalpine larkspur	0.001	0.0	0.0%
Erigeron speciosus	Aspen daisy	0.125	3.3	3.4%
Geum triflorum	Prairie smoke	0.0625	0.4	0.4%
Heliomeris multiflora	Showy goldeneye	0.25	6.9	7.1%
Hymenoxys hoopesii	Sneezeweed	1.5	6.3	6.4%
Lupinus argenteus	Silvery lupine	1	0.4	0.4%
Penstemon strictus	Rocky Mountain penstemon	1.5	9.8	10.1%
Penstemon whippleanus	Whipple's penstemon	0.0001	0.0	0.0%
Polemonium foliosissimum	Tall Jacob's ladder	0.125	1.5	1.5%
Senecio atratus	Tall blacktip ragwort	0.125	4.0	4.2%
Thermopsis divaricarpa	Golden banner	2	1.2	1.2%
	TOTAL FORBS	**7.9646**	**52.4**	**53.9%**
	GRAND TOTAL	**12.7146**	**97.2**	**100.0%**

*Broadcast seed at a rate of ~97 seeds per square foot.

9. Alpine Seed Mix

9. Alpine Mix (Intended to Complement Live Plantings)

Scientific Name	Common Name	PLS Lbs./acre	Seeds/Ft2	Percentage of Mix	Notes
GRAMINOIDS					
Festuca saximontana	Rocky Mountain Fescue	0.25	7.5	15.5%	
Festuca thurberi	Thurber's fescue	0.5	8.6	17.9%	
Muhlenbergia montana	Mountain muhly	0.25	8.6	17.9%	
Phleum commutatum	Alpine timothy	0.25	7.5	15.5%	
Poa alpina	Alpine bluegrass	0.375	8.6	17.9%	
	TOTAL GRAMINOIDS	**1.625**	**40.7**	**84.7%**	
	Difficult to find large quantities of alpine-like forb seed. We recommend primarily using live plants in this area, which can be overseeded with this mix.				
	Many of these species are available in small quantities from Western Native Seed, Prairie Moon Nursery, as well as other online retailers.				
FORBS					
Aster alpinus	Alpine aster	0.052085	0.2	0.5%	
Aquilegia elegantula	Western red columbine	0.001	0.0	0.0%	Can sub with *A. canadensis* or *A. formosa.*
Aquilegia flabellata	Fan-leaved columbine	0.001	0.0	0.0%	
Aquilegia scopulorum	Utah columbine	0.001	0.0	0.0%	
Alyssum montanum	Creeping basket of gold	0.003937	0.1	0.2%	
Antennaria neglecta	Field pussytoes	0.03125	3.2	6.6%	
Antennaria parvifolia	Small-leaf pussytoes	0.015625	0.4	0.8%	
Armeria maritima	Sea thrift	0.03	0.2	0.4%	
Arenaria montana	Mountain sandwort	0.029396	0.2	0.5%	
Delphinium barbeyi	Subalpine larkspur	0.0001	0.0	0.0%	Can sub with other short-statured *Delphinium*
Eriogonum umbellatum	Sulfur-flower buckwheat	0.015625	0.1	0.2%	Can sub with, *E. arcuatum, E. flavum, E. jamesii ssp. jamesii, E. ovalifolium, E. subalpinum.*
Geum triflorum	Prairie smoke	0.0625	0.4	0.9%	
Hymenoxys hoopesii	Sneezeweed	0.125	0.5	1.1%	
Myosotis alpestris	Forget me not	0.0615	1.0	2.1%	
Penstemon crandallii	Matt penstemon	0.03125	0.9	1.9%	
Penstemon davidsonii	Davidson's penstemon	0.0005	0.0	0.0%	
Penstemon virens	Blue mist penstemon	0.0001	0.0	0.0%	
Phlox subulata	Creeping phlox	0.001	0.0	0.0%	
Saxifraga bronchialis ssp. austromontana	Matted saxifrage	0.0001	0.0	0.0%	
	TOTAL FORBS	**0.462968**	**7.3**	**15.3%**	
	GRAND TOTAL	**2.087968**	**48.1**	**100.0%**	

*Broadcast seed at a rate of ~48 seeds per square foot.

U. Hydromulch: Comply with Section 213 – Mulching of the CDOT Standards and Specifications for Road and Bridge Construction.

V. Tackifier: Comply with Section 213 – Mulching of the CDOT Standards and Specifications for Road and Bridge Construction.

1.10 SUBSTITUTIONS

A. All substitutions shall be submitted to and approved by the Project Manager prior to construction.

PART 3 EXECUTION

1.11 EXAMINATION

A. Examine areas to be seeded for compliance with requirements and other conditions affecting performance.
   1. Verify that finished grades are consistent with the slopes and grades indicated on the Contract Drawings. Verify grades are in conformance with Division 31 Section "Earth Moving". Obtain the Project Manager's approval of finished grade prior to proceeding with seeding operations.
   2. Verify soil prepare of all areas to be seeded is in accordance with the requirements of Division 32 Section "Soil Preparation". When completed, the soil shall be firmed by float dragging, followed by steel raking, to provide for the proper seeded surface. The seed bed shall be totally free from rock or clay clods over one inch (1") in diameter.
   3. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a seeding area. If contamination is present in soil, remove the soil and contamination as directed by the Project Manager and replace with new soil.

B. Proceed with seeding only after unsatisfactory conditions have been corrected and approved by the Project Manager.

C. Acceptance: Beginning of installation means acceptance of existing conditions by the Contractor.

1.12 PREPARATION

A. Notify the Project Manager at least seven (7) working days prior to start of seeding operations.

B. Protect existing utilities, paving, planting and other facilities from damage caused by seeding operations. Contractor shall repair any damage at no additional cost to the Town.

C. Utilize equipment having low unit pressure ground contact within seeding areas.

D. Limit preparation to areas that can be seeded within twenty-four (24) hours of preparation.

E. Moisten prepared area before seeding if soil is dry. Water thoroughly and allow surface to dry before seeding. Do not create muddy soil.

F. Erosion Control: Take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind-deposited materials on the site throughout the duration of work.

1.13 SEEDING

A. Seed within twenty-four (24) hours after preparation of seed bed. Seeding at other times may only be done if approved by the Project Manager.

B. Areas outside Contract Limits disturbed as a result of construction operations shall be restored at Contractor's expense.

C. Seed shall be uniformly applied at the specified rate, (half in one direction and the other half perpendicular to the first application). Seed shall be installed at a depth between one-quarter inch (1/4") and one-half inch (1/2").

D. Seeds shall be placed with 12" spacing when using a drill seeder.

E. Areas that are too small or steep for mechanical seeding may be hand seeded. Seed shall be uniformly applied at the specified rate utilizing a broadcast spreader and then hand raked in to a depth of no more than one-half inch (1/2"), then roll seed bed to ensure proper contact to the soil.

1.14 EROSION CONTROL MATERIALS

A. Review erosion control measures with the Project Manager prior to installation.

1.15 MULCHING

A. Hydromulch and Tackifier Application: Utilize an approved hydromulcher to apply cellulose fiber at a rate of two-thousand (2,000) pounds per acre and applied evenly across all seeded areas. Apply tackifier to comply with CDOT Section 213.02 – Mulching. Contractor shall provide verification of application rates in the form of ship tickets.

B. Mulching shall not be installed when surface water is present resulting from rain, melting snow, irrigation, or other causes.

C. Areas not properly mulched, or any damage that may occur during construction is the responsibility of the Contractor and shall be repaired and re-mulched in an acceptable manner at the Contractor's expense. Mulching removed by wind, rain, or other causes prior to acceptance shall be re-established by the Contractor at their own expense.

D. The seeded area shall be mulched within eight (8) hours of seeding. Areas not mulched within twenty-four (24) hours after seeding must be re-prepped and re-seeded with the specified seed mix at the Contractor's expense.

E. Contractor shall remove all hydromulch from surface areas not specified for seeding, including but not limited to plant materials, fences, paved areas, signs, mulch beds, irrigation components and all other objects as directed by the Project Manager.

1.16 CLEANING

A. Perform cleaning during installation of the work and upon completion of the work. Remove from all excess materials, debris and equipment from site. Repair any damage resulting from seeding operations.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove non-degradable erosion-control measures after grass establishment period.

1.17 PROTECTION

A. Restrict vehicular and pedestrian traffic from seeded areas until vegetation is established. Erect signs and barriers as required or directed by the Project Manager at no additional cost to the Town.

1.18 MAINTENANCE

A. Refer to Landscape Maintenance section 32 97 00

B. If no native seed maintenance is required per the contract, then the native seed warranty is per the Acceptance sub-section. Maintenance of the native seed area is the responsibility of the Contractor until Final Acceptance.

1.19 ACCEPTANCE

A. Substantial Completion shall be granted when the seeded areas have a uniform plant growth establishing over the entire seeded area. Refer to the Contract General Conditions, Title 19 – Substantial Completion of the Work.

B. Final Acceptance will be granted when native seed areas are in a healthy, vigorous growing condition, and for consistency and completion of coverage for a minimum period of one (1) year from date of Substantial Completion or until the Project Manager and Project Landscape Architect and/or Ecologist are satisfied with germination.

C. Non-irrigated native seed areas shall be established when the following criteria are met:
   1. Total vegetation cover in all zones seeded with cover crop shall exceed fifty percent (70%) by aerial cover and twenty-five percent (50%) of all species present shall be native. Native seed shall be free of weeds, foreign grasses, disease and harmful insects.
   2. At any time during the contract period no more than ten percent (10%) by aerial cover of the seeded area should be dominated by aggressive exotic species such as, but not limited to, red clover (*Trifolium* spp.), white or yellow sweet clover (*Melilotus* spp.), Canada thistle (*Cirsium arvense*), tall fescue (*Festuca elatior*), field bindweed *(Convolvulus arvensis*) etc.
   3. During the original warranty period, reseed at once with comparable blend/mix, those areas that have failed to achieve a stand of grass or which in the Project Manager's opinion are unhealthy.
   4. Reseeding will not be allowed in any season considerable unfavorable by the Project Manager.
   5. Reseed in a manner to achieve quality as originally specified.

END OF SECTION 32 92 00

SECTION 32 92 23 SODDING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes requirements for furnishing and installation of bluegrass sod, and maintenance of sodded areas as outlined in Maintenance Section 1.8.B. until Final Acceptance.

B. Related Sections:
1. Division 01 Section “Erosion and Sedimentation Control”.
2. Division 31 Section “Earth Moving”.
3. Division 31 Section “Watering”.
4. Division 32 Section “Irrigation System”.
5. Division 32 Section “Automatic Irrigation Controllers”
6. Division 32 Section “Soil Preparation”.
7. Division 32 Section “Topsoil”.
8. Division 32 Section “Trees, Plants, and Groundcovers”.

1.3 DEFINITIONS

A. Finished Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, pesticides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, herbicide, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

F. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

G. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

H. Weeds: Including but not limited to Goathead, Bindweed, Twitch, Dandelion, Jimsonweed, Knapweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress,

Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Weed, Bent Grass, Wild Garlic, Perennial Sorrel, and Broom Grass.

1.4 SUBMITTALS

A. See Division 01 Section “Submittals” for submittal requirements.

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

C. Sod Certificates:
1. State, Federal and other inspection certificates for sod shall be provided to the Project Manager a minimum of 10 working days prior to anticipated date of sod delivery.
2. Submit a list of varieties contained in the sod, and include the source and origin for approval by the Project Manager.

D. Analysis and standards: Wherever applicable, for non-packaged materials, provide two copies of analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists.

E. Planting schedule: Submit in writing two copies of proposed planting schedule, indicating dates for topsoil placing, site preparation, pesticide treatments, soil preparation, sodding, seeding, and coordination with plant procurement, planting soil preparation, plant delivery and planting. Schedule all Work during specified planting seasons. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.

F. Contract Closeout Submittals:
1. Operating and Maintenance Data: At completion of work, submit one digital copy and two hard copies to the Project Manager in accordance with Division 01 Section “Contract Closeout’. Include directions for irrigation, aeration, mowing, fertilizing and spraying as required for continued and proper maintenance through full growing season and dormant period.
2. Warranty for Turfgrass Sod Areas: At completion of work, furnish written warranty to Project Manager based upon specified requirements.

1.5 QUALITY CONTROL

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five years' experience in turf installation in addition to requirements in Division 01 Section "Quality Control."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Sod Producer: Company specializing in sod production and harvesting with minimum five (5) years’ experience, and certified by the State of Colorado Department of Agriculture.
5. Personnel Certifications: Installers shall have certification the following categories from the Professional Landcare Network:
   a. Certified Landscape Technician - Exterior, with installation maintenance irrigation specialty area(s), designated CLT-Exterior.
6. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
7. Pesticide Applicator: State licensed, commercial.

B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: See Division 32 Section “Soil Preparation”.

D. Preinstallation Conference: Conduct conference at Project site to coordinate the process with other trades, to coordinate equipment movement within planting areas and to avoid soil compaction, to review proposed methods of installation, performance criteria, and maintenance procedures. Review underground utility location maps and plans. This meeting shall be coordinated by the Contractor, and comply with requirements in Division 1.

E. Standards: All materials and methods used during this portion of the work shall meet or exceed applicable federal, state, county, and local laws and regulations. All sod shall be free from insects and disease. Species shall be true to their scientific name as specified.

F. Materials: The Contractor shall submit to the Project Manager for approval a complete list of all materials to be used during this portion of the work prior to delivery of any materials to the site. Include complete data on source, amount and quality. This submittal shall in no way be construed as permitting substitution for specific items described on the plans or in these specifications unless approved in writing by the Project Manager.

G. Source Quality Control:
   1. Sod Materials: Subject to inspection and acceptance. The Project Manager reserves the right to reject at any time or place prior to acceptance, any work and sod which in the Project Manager’s opinion fails to meet these specification requirements.
   2. Inspection will be made periodically during sodding, at completion and at end of warranty period by the Project Manager. Primarily for quality; however, other requirements are not waived even though visual inspection results in acceptance.
   3. Promptly remove rejected sod from site.

H. Sod Standards:
   1. Sod shall consist of healthy, thick turf having undergone a program of regular fertilization, mowing and weed control; free of weeds; uniform in green color, leaf texture and density; healthy, vigorous root system; inspected and found free of disease, nematodes, pests and pest larvae by the State Department of Agriculture.
   2. Each piece of Sod shall consist of a sandy-loam soil base that will not break, crumble or tear during sod installation.
   3. Sod thickness shall be a minimum three quarters inch (3/4”) thick, excluding top growth and thatch.
   4. Thatch layer shall not exceed one half inch (1/2”), uncompressed.
   5. Sod shall be delivered and installed within twenty four (24) hours of being cut.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver on pallets properly loaded on vehicles with root system protected from exposure to sun, wind, and heat in accordance with standard practice. Sod that has been damaged by poor handling or improper storage is subject to rejection by the Project Manager.
   1. Protect from dehydration, contamination, freezing and heating at all times. Keep stored sod moist and under shade or covered with moistened burlap.
   2. Do not drop sod rolls from carts, trucks or pallets.

3. Do not deliver more sod than can be installed within twenty four (24) hours.

B. Fertilizer: Deliver inorganic or chemical fertilizer to site in original unopened container bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark, warranty and conformance to state law.

C. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.
4. Fertilizer: Deliver inorganic or chemical fertilizer to site in original unopened container bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark and conformance to state law, and bearing name and warranty of producer.

D. Material will be inspected upon arrival at project site. Project Manager will reject any opened or unacceptable materials as described above.

E. Immediately remove unacceptable material from job site.

1.7 PROJECT/SITE CONDITIONS

A. Work scheduling: Proceed with and complete landscape work as rapidly as portions of the site become available, working within the specified planting season and approved schedule.

B. Vehicular accessibility on site shall be as directed by Project Manager. Repair damage to prepared topsoil and existing surfaces, caused by vehicular access and movement during work under this section, to original condition at no additional cost to the Town.

C. Install sod between April 15 and October 1 or when irrigation is available for twenty one (21) days for sod establishment.

D. Schedule work for periods of favorable weather. Do not install sod on saturated or frozen soil. The Project Manager reserves the right to deny sod installation on days that are deemed to be unfavorable for installation.

E. Existing conditions:
1. Existing Plants: Install sod only after all other landscape and irrigation items have been installed and accepted by the Project Manager.
2. Utilities: Determine location of underground utilities. Perform work in a manner to avoid possible damage. Hand excavate, as required.
3. Excavation: Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, noxious materials or obstructions, notify Project Manager before planting.
4. If weeds are present on site, treat with pesticide prior to preparing soil for installing sod as specified in this or other Sections.

F. Coordination:
1. Coordinate with construction of utilities on site. Do not begin placing topsoil and sod until underground work is completed in the area.

2. Coordinate sodding with Contractor(s) approved schedule. Limit construction access to areas where topsoil has been placed if placement is completed more than 3 days prior to commencement of landscaping in the area. Limit fine grading to areas that can be prepared for planting within twenty four (24) hours after fine grading.
3. Coordinate with Contractors work requiring access to site over sodded areas.
4. Coordinate with installation of underground irrigation system.

1.8 WARRANTY

A. Warrant sod areas to be in a healthy, vigorous growing condition, and for consistency and completion of coverage for a period of one (1) year from date of Substantial Completion as a full stand of grass. Re-sod any areas where sod has failed due to disease or other inadequate installation, as defined in this Section.
1. During the original warranty period, immediately replace the sod with a comparable sod blend/mix in the areas that have failed to achieve a stand of grass or which are unhealthy in the Project Manager's opinion.
2. Re-sodding will not be allowed in any season considerable unfavorable for sod installation by the Project Manager.

PART 2 PRODUCTS

2.1 MATERIALS

A. Topsoil: See Division 32 Section "Topsoil".

B. Soil Preparation: See Division 32 Section "Soil Preparation.

C. Sod:
1. Product shall be High Performance Blue supplied by Graff's Turf, contact (970)-867-8873, or approved equal.
2. Sod to be produced in accordance with requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding."
3. Harvesting: Sod shall be fertilized 2–3 weeks prior to harvesting. Mow sod to a height of one and one-half inches (1-1/2") before the sod is lifted. Sod shall be harvested in rolls, and shall not be cut more than 24 hours prior to planting.
4. Size: Machine cut to a minimum pad thickness of three quarters inch (3/4), excluding top growth and thatch. Provide sod of uniform pad sizes eighteen inches (18") maximum width by twenty four (24") minimum length, with maximum five percent (5%) deviation in either length or width. Broken pads or pads with uneven ends will not be acceptable. Sod pads incapable of supporting their own weight when suspended vertically from upper ten percent (10%) of pad will be rejected. Sod which has dried out, sod with adhering soil which breaks, tears, or crumbles away will not be accepted. Sod cut for more than twenty-four (24) hours will not be accepted.
5. Plastic netting: Sod to be free of plastic netting used during establishment by sod grower.

D. Fertilizer: Inorganic mixture with following chemical composition: (20-5-10) with fifty percent (50%) sulfur coated urea (no iron), or as recommended by testing lab based on soil sample results.

2.2 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and

application. Do not use restricted pesticides unless authorized in writing by Project Manager and authorities having jurisdiction.

1. Pre-Emergent Herbicide (Selective and Non-Selective): Use only with approval by Project Manager. Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
2. Post-Emergent Herbicide: Glyphosate or 2,4-D, or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that finish grades are consistent with the slopes and grades indicated on the Contract Drawings. Verify grades are in conformance with Division 31 Section "Earth Moving".
2. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
3. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
4. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
5. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected and approved by the Project Manager.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Engineer and replace with new planting soil.

D. Beginning of installation means acceptance of existing conditions by the Contractor.

3.2 PREPARATION

A. Work notification: Notify the Project Manager at least seven (7) working days prior to start of sodding operations.

B. Limit turf subgrade preparation to areas that can be sodded within twenty four (24) hours.

C. Newly Graded Subgrades: Prepare soil as required by Division 32 Section "Soil Preparation".

D. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 8 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top six inches (6") of soil. Till soil to a homogeneous mixture of fine texture.
3. Remove stones larger than one-half (½") inch in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Town property.

E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Verify that all areas are graded to drain at a minimum of two percent (2%) or as indicated on the Contract Drawings. Verify that subsurface drainage system and drain inlets if any, are operative.

G. Verify that irrigation system is operable and provides adequate coverage prior to planting.

H. Adjustment: Adjust irrigation heads to proper watering height according to depth of sod material but lower than compacted blade height to enable lawn mowers to cut grass freely without damage to the sprinkler system.

I. When completed, the soil shall be firmed by float dragging, followed by steel raking, to provide for the proper sodded subgrade. The sod bed shall be totally free from rock or clay clods over one-half inch (1/2") inch in diameter.

J. Repair: Re-establish grade and specified conditions to damaged sod areas prior to placing sod.

3.3 INSTALLATION

A. Sodding:
1. Sod within twenty-four (24) hours after preparation of bed.
2. If plastic netting is present within sod, remove all netting during sod installation and discard from site.
3. Subgrade on which sod is laid shall be slightly moist during installation.
4. Lay sod with longest dimension parallel to contours and in continuous rows.
5. Tightly butt ends and sides of sod together. Stagger and compact vertical joints between sod strips.
6. Sod shall not be overlapped or stretched during placement. Exposed joints due to shrinkage will require replacement of sod in affected areas.

B. Topsoil: Where new sod abuts an existing turf area topsoil shall be placed along seams and or joints to provide a smooth transition.

C. Rolling: Sod shall be rolled after installation to ensure proper contact with the subgrade, and to ensure tight joints between adjacent pieces. Sod shall be moist prior to rolling. Once rolling is complete additional watering shall occur. Roller shall weigh one-hundred (100) pounds.

D. Drainage: Contractor shall ensure that finished areas are graded so that positive drainage of storm and irrigation water is achieved.

E. Water: Contractor to utilize the existing irrigation system and or quick coupler(s) when available. If irrigation or quick coupler(s) are not available then the contractor is responsible for watering. Refer to Division 31 Section "Watering". Water shall be free of substances that may be harmful to sod growth. Hoses and other watering equipment necessary to water the sod to be furnished by Contractor.
1. Water thoroughly with a fine spray as laying progresses and immediately after planting. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches (1-1/2 ") below sod.

F. After sod and soil have dried, roll sodded areas to ensure a good bond between sod and soil and to remove minor depressions and irregularities. Roller shall not exceed one hundred (100) pounds.

3.4 CLEANING

A. Perform cleaning during installation of the Work and upon completion of the Work to the satisfaction of the Project Manager. Remove all excess materials, debris, and equipment from site. Repair any damage resulting from sodding operations.

3.5 PROTECTION

A. Protect existing utilities, paving and other facilities from damage caused by sodding operations, the Contractor shall repair any damage at no additional cost to the Town.

B. Restrict vehicular and pedestrian traffic from sodded areas until grass is established. Erect signs and barriers as required or directed by the Project Manager at no additional cost to the Town.

C. Locate, protect and maintain the irrigation system during sodding operations. Repair irrigation system components damaged during sodding operations shall be replaced or repaired to current Town of Erie irrigation standards at the Contractor's expense.

D. Erosion Control: Take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind-deposited materials on the site throughout the duration of work.

3.6 MAINTENANCE

A. General: The maintenance period shall begin immediately after each area is sodded and continue for Sixty (60) days or as determined by the Project Manager. During this time, the Contractor is responsible for watering, mowing, spraying, weeding, fertilizing and all related work as necessary to ensure that sodded areas are in a vigorous growing condition. Provide all supervision, labor, material and equipment to develop and maintain sodded areas from time of installation.

B. Mowing and Trimming: When turfgrasses reach three and one-half inches (3-1/2") in height, begin weekly mowing program to maintain turf at two and one-half inches (2-1/2") to three inches (3") in height. Do not remove more than 1/3 the height of the grass blade in single mowing. Do not mow when grass is wet. All clippings from adjacent paved areas shall be removed and clippings from mowed turf areas shall be removed to the satisfaction of Project Manager.

C. Fertilizing: Within thirty (30) days of sodding and every sixty (60) days thereafter until Acceptance, apply specified fertilizer to maintain optimal turf vigor or per the direction of the Project Manager.

D. Weed Control: Control annual weeds by mowing. Do not use pesticides unless approved by the Project Manager.

E. Insect and Disease Control: As needed, apply insecticide and fungicide approved by the Project Manager and the Parks Operations Supervisor.

3.7 ACCEPTANCE

A. Substantial Completion of sod areas will not be given until the Project Manager is satisfied with establishment and a full stand of grass, in a vigorous growing condition, and thoroughly rooted to the soil and absence of visible joints. The sodded areas shall be accepted on the basis of having a healthy, uniform stand of turf over the entire sodded area.
   1. Sixty (60) days after sodding, the sodded areas shall be reviewed by the Project Manager and the Contractor. Any areas as determined by the Project Manager where the sod has failed to establish shall be re-sodded.

B. Final Acceptance will be defined as a healthy uniform turf that does not contain any stressed or bare spots greater than one (1) square foot.

END OF SECTION 32 92 23

SECTION 32 92 43 TREES

PART 1 GENERAL

1.01 DESCRIPTION

A. The work of this section consists of providing, installing, and maintaining plant material.

1.02 SUBMITTALS

A. See Section 01 3000-Administrative Requirements, for submittal procedures.
B. Delivery tickets for all bulk materials with Owner's Representative's approval or acknowledgment that materials were received in satisfactory condition.

B. Product certificates signed by manufacturers certifying that their products comply with specified requirements.
   1. Manufacturer's certified analysis for standard products, where applicable.
   2. Analysis for other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

B. Samples: 1 cubic foot of mulch required for the project, in labeled plastic bags, boxes, or buckets.

C. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and address of Landscape Architects and Owners, and other information specified.

D. Material test reports from qualified independent testing agency, indicating and interpreting test results relative to compliance of the following materials with requirements indicated.

E. Analysis of existing surface soil for plant growth per Section 329113 – Soil Preparation.

F. Planting schedule indicating anticipated dates and locations for each type of planting.

G. Copy of a written warranty stating all items included in the warranty, conditions of the warranty, and beginning and ending of warranty period(s).

H. Contractor to provide representative photographs, or physical samples of all trees under 1" caliper for deciduous trees to Landscape Architect for approval. Photographs must have a person or measuring stick to establish relative size. When approved, photographed or tagged will be maintained as representative samples for final installed plant materials. Contractor to coordinate tree tagging with landscape architect for all trees over 1" caliper for deciduous trees and 6'-0" tall for evergreens.

1.03 INSPECTION

A. All plants shall be subject to inspection and approval by the Landscape Architect. Trees required for the work may be inspected and tagged at the place of growth before being dug. Inspection and tagging at the place of growth shall not affect the Landscape Architects' right to reject such trees on or after delivery thereof to the Site.

B. Inspection of trees over 1" caliper for deciduous trees and 6'-0" tall for evergreen trees by the Landscape Architect at the place of growth or upon delivery will be for quality and size. Variety, color, and all other requirements shall be the responsibility of the Subcontractor. Inspection for

size of ball of roots, latent defects and for other requirements shall be made at the site during progress of the work by the Landscape Architect.

C. Tagged plants shall be delivered to the site and planted in locations as shown on the Drawings, or as designated by the Landscape Architect. These tagged samples shall be maintained, protected and used as standards for comparison with plants furnished for the work.

D. The Landscape Architect will accompany the Subcontractor on selection trip(s) to the Nursery. The Landscape Architect will select plants for proper visual formation. Subcontractor shall inspect the selected plants for disease and other requirements of the Contract Documents. Prior to this trip, the Subcontractor shall have preselected the Nursery(s) to ascertain that sufficient plants in size and species required are available for proper selection. If trees are not available contractor to supply list of substitutions prior to tree selection trip to the nursery.

E. The Landscape Architect will tag all trees. Trees or delivered without tags to the site will be rejected.

F. The Subcontractor shall make a written request to the Landscape Architect ten (10) working days in advance for all inspections at the various nurseries and collecting grounds and shall list the particular plants which are to be inspected.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful landscape establishment.

B. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during times that landscaping is in progress.

C. Testing Agency Qualifications: To qualify for acceptance, an independent testing agency must demonstrate to Owner's Representative's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.

D. Provide quality, size, genus, species, and variety of trees indicated, complying with applicable requirements of ANSI Z60.1 "American Standard for Nursery Stock", and all applicable state and local rules and regulations.

E. Inspection: Owner's Representative may inspect plants either at place of growth or at site before planting, for compliance with requirements for name, variety, size, and quality.

1. The Owner's Representative reserves the right to reject at any time or place prior to final acceptance all plant materials, which in the Owner's Representative's opinion fail to meet specifications. Inspection of materials is primarily for quality, size, and variety, but other requirements are not waived even though visual inspection results in approval. Plants are to be inspected where available; however, inspection at the places of supply shall not preclude the right of rejection at the site or at a later time prior to final acceptance. Rejected material shall be removed from the site within 24 hours.
2. The Contractor shall schedule inspection of the plants, at either the supplier or on-site, to be completed in one visit. Any further inspection required due to plants being unavailable or rejected as not meeting specifications shall be charged to the Contractor.

F. Measurements: Measure trees according to ANSI Z60.1 with branches and trunks in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches (150 mm) above ground for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above ground for larger sizes. Measure main body of tree for height and spread; do not measure branches or roots tip-to-tip.

G. Pre-installation Conference: Contractor shall attend pre-installation conference at location specified by Owner's Representative.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery and while stored at site. The Owner's Representative reserves the right to inspect containers before or after installation to verify compliance with Specifications.

B. Trees: Deliver nursery stocked or freshly dug trees. Do not prune before delivery, except as approved by Owner's Representative. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees in such a manner as to destroy natural shape. Provide protective covering during delivery. Plant materials delivered without protective covering may be rejected. Do not drop trees during delivery. Label at least one tree of each variety with a securely attached waterproof tag bearing a legible plant name. Remove all tags and flagging as directed by Owner's Representative.

C. Handle balled and burlapped stock by the root ball only.

D. Deliver trees after preparations for planting have been completed and install immediately. If planting is delayed more than 6 hours after delivery, set planting materials in shade, protect from weather and mechanical damage, and keep roots moist.
1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
2. Do not remove container-grown stock from containers before time of planting.
3. Water root systems of trees stored on site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.05 PROJECT CONDITIONS

A. Utilities: Determine location of above grade and underground utilities and perform work in a manner that will avoid damage. Hand excavate, as required. Maintain grade stakes until their removal is mutually agreed upon by parties concerned. Contractor shall be responsible for utility locating, repair of utilities damaged by Contractor, and establishment of grade controls.

B. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Owner's Representative before planting.

C. Protection: Erect and maintain barricades, warning signs and lights, and provide guards as necessary or required to protect all persons on the site.

1.06 COORDINATION AND SCHEDULING

A. Coordinate installation of planting materials during normal planting seasons for each type of plant material required. Planting materials should be planted between April 15 and October 1. If irrigation is not available at the time of planting, then the Contractor is responsible for watering of all plant material at no additional cost.

B. Plant trees after final grades have been accepted and prior to planting turf, unless otherwise authorized by Owner's Representative.

1.07 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in

addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Replace planting materials that do not meet product requirements, that may be excessively pruned, more than 20% dead, or in an unhealthy or declining condition immediately upon notice from the Owner's Representative.

C. All plants shall be true to name and meet all conditions of these specifications. Any plant that is not true to name as indicated by form, leaf, flower, or fruiting characteristics shall be replaced at the Contractor's expense.

D. The warranty shall not be enforced should any plant die due to vandalism after Final Acceptance.

1.08 FINAL ACCEPTANCE

A. Planted areas will be inspected upon completion and accepted subject to compliance with specified materials and installation requirements. At this time Contractor shall receive a Final Acceptance from the Owner's Representative. The warranty period will begin upon notification of Final Acceptance.

1.09 TREE MAINTENANCE DURING CONSTRUCTION PERIOD

A. Maintain trees by pruning, cultivating, watering, winter watering, weeding, restoring planting saucers, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray as required to keep trees free of insects and disease. Restore or replace damaged tree wrappings. Trees shall be maintained until Final Acceptance of the entire project.

PART 2 PRODUCTS

2.01 PLANT MATERIALS

A. General: Furnish nursery-grown trees and shrubs conforming to ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully-branched, healthy, vigorous stock free of disease, insects, eggs, larvae, girdling, and defects such as sun scald, injuries, abrasions, and disfigurement. Trees of a larger size may be used if acceptable to Owner's Representative with a proportionate increase in size of roots and balls.

B. Label at least 1 plant of each variety and caliper with a securely attached waterproof tag bearing legible designation of botanical and common name.

C. All plants shall be the species designated on the Drawings. No substitutions will be accepted without the prior written approval of the Owner's Representative. Contractor must provide proof of non-availability.

2.02 TREES

A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, conforming to ANSI Z60.1 for type of trees required.
   1. Branching Height: 1/3 to ½ of tree height.

B. Provide balled and burlapped trees. Container-grown trees will be acceptable in lieu of balled and burlapped trees subject to meeting ANSI Z60.1 limitations for container stock.

C. All deciduous trees of one species used in formal rows or groupings shall exhibit cultural uniformity, i.e. “matched” in height, crown width and shape, height to first branch, and trunk taper. For this reason it is desired that these trees be produced by a single grower.

2.03 MULCH

A. Organic Mulch: Organic Mulch: Organic non-dyed mulch, free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of chipped or shredded wood material not larger than three inches (3”) in length and one-half inch (1/2”) in diameter. The following materials are not acceptable as mulch: bark, elm, redwood, newspaper, and plastic. Submit 1.0 CF sample for approval.

2.04 PLANT BACKFILL MATERIAL

A. The plant pit backfill material shall consist of the following, thoroughly mixed:
1. Soil originally excavated from the pit (two thirds portion of total mix)
2. Compost material as specified in Section 329113 – Soil Preparation, 2.01A.1.

B. Topsoil shall meet the requirements specified in Section 329113 – Soil Preparation.

2.05 WATER

A. Water will be available from on-site quick couplers during the irrigation season (generally May through September). Contractor shall supply water when system is not charged.

B. Water shall not contain any substances injurious to plant growth.

2.06 MISCELLANEOUS MATERIALS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's instructions.

B. Pre-Emergent Herbicide: Treflan as manufactured by Elanco Company, or an approved substitution.

C. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, 4 inches (102 mm) wide minimum, with stretch factor of 33 percent.

D. Herbicides and Pesticides: EPA registered and approved, of type recommended by manufacturer.

E. Tree Stakes: 6’ steel T-posts, color green, or 2” x 2” wood posts, min. 6’ long.

F. Anchor System: Rootball Fixing System - Plati-Mat, as manufactured by Platipus Earth Anchoring Systems, England.

G. Tree Ties: Grommeted nylon straps, 1 ½” wide.

H. Staking Wire: Fourteen (14) or sixteen (16) gauge or larger galvanized steel.

I. Steel Edger and Steel Edger in Lawn: Steel edger shall be commercial type roll-top steel edging. 3/16” x 4" height x 16' length with tapered steel stakes supplied by the manufacturer (Ryerson, or approved substitute). The color of the steel edging should be the following: Black. Submit a 1-foot-long sample to Landscape Architect for approval prior to installation.

J. Steel Angle Tree Frame – Steel angle frame shall be commercial type steel 3/16” x 4" height x 2 1/2' length. Submit a 1-foot-long sample to Landscape Architect for approval prior to installation.

K. Gravel Mulch – 1 ½” Commanche Tan from Pioneer Sand and Gravel, contact Michael Ford (720)-250-7879, or approved equal.

L. Geotextile Fabric - Mirafi 140 N as supplied by TC Mirafi, 706-693-2226, or approved equal

M. Tree Tag Type A - National Band & Tag Company. (T) 1-859-261-2035, or Landscape Architect approved alternate.
   1. Model: Style #14 Custom Rectangle, Stainless Steel Tags
   2. Size: Tag height: 1-1/2", Tag length: 3"
   3. Hole: (1) 1/8" hole
   4. Text Justification: Left Centered. Text Line 1: Scientific Name, Text Line 2: Common Name
   5. Color/Finish: Stainless Steel
   6. Install per details, manufacturers details and recommendations
   7. Quantity: Per plans

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to receive landscaping for compliance with requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Cooperate with any other contractors and trades which may be working in and adjacent to the landscape work areas. Examine drawings which show the development of the entire site and become familiar with the scope of all work required.

3.02 FINISH AND FINE GRADING

A. Tillable Soil: Mechanically rip or disk subsoil in all areas to be planted to minimum depth of 6 inches prior to placing topsoil and soil amendments. Except within the driplines of existing trees.

B. Positive Surface Drainage: Finish and fine grade the project area to establish an even and well matched gradient over the entire surface. Provide positive surface drainage, with no depressions, settling, or irregularities in the finished grade.

C. Transitional Areas: At any transitional point or line where one plane intersects another, such as from a sloping area or berm to a level area, a smooth and gentle transition shall be made. There shall be no abrupt changes in grade unless specifically noted otherwise. Match the grades of new work with existing areas outside the project area.

D. Finish Grade Tolerance: The finish grade elevation shall not vary above or below the proposed grade more than 0.05 foot.

3.03 PREPARATION

A. Lay out individual tree locations and areas for multiple plantings. Stake locations, outline areas, and secure Owner's Representative's acceptance before the start of planting work. Make adjustments as directed at no additional cost to the Owner.

3.04 WEED CONTROL

A. In areas that have been regraded and/or have existing weed growth, weed control measures appropriate to the amount of growth and/or species shall be provided. Submit weed control plan to Owner's Representative for approval.

B. Clear and grub, apply pre-emergent herbicide, and/or apply post emergent herbicide as necessary to eliminate weeds. Do not proceed with landscape work until weed growth has been controlled.

3.05 TOPSOIL PLACEMENT

A. Place topsoil to a depth of 4" below top of wall or top of curb on all planter beds.

3.06 EXCAVATION FOR PLANT MATERIAL

A. Planting Pits: Excavate with vertical sides and with bottom of excavation slightly raised at center to assist drainage. Roughen sides of planting pit.

1. Balled and Burlapped Trees: Excavate approximately 2 times as wide as ball diameter. The depth of the plant pit shall be 2 inches less than the depth of the ball in well drained soils and 4 inches less than the ball depth in poorly drained soils.
2. Container-Grown Trees and Shrubs: Excavate approximately 2 times as wide as container diameter. The depth of all plant pits shall be 1 inch less than depth of container.
3. Where drain tile is shown or required under planted areas, excavate to top of porous backfill over tile.

B. Obstructions: Notify Owner's Representative if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavation.

C. Drainage: Notify Owner's Representative if subsoil conditions show evidence of water seepage or retention in tree or shrub pits.

1. Fill the pit with water and allow it to completely drain before planting occurs.
2. If water does not drain out of pit within 24 hours, notify Owner's Representative.

3.07 PLANTING MATERIAL

A. Balled and Burlapped Stock:

1. Set balled and burlapped stock plumb and in center of pit with top of ball raised above adjacent finish grades as indicated.
2. Remove burlap from tops of balls and partially from sides, but do not remove from under balls. Remove wire baskets entirely. Remove pallets, if any, before setting. Do not use planting stock if ball is cracked or broken before or during planting operation.
3. Place backfill around ball in layers, tamping to settle backfill and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing and tamping final layer of backfill. Create 48” diameter saucer around tree and fill with 4” specified wood mulch.

B. Container Grown Stock:

1. Carefully remove containers so as not to damage root balls.
2. Lightly scratch sides of exposed root ball to loosen surface roots.
3. Set plants plumb and in center of pit or trench with top of ball raised above adjacent finish grades as indicated.
4. Place backfill around ball in layers, tamping to settle backfill and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing and tamping final layer of backfill.
5. Mulch at planting bed as shown on drawings.

3.08 PRUNING OF PLANTS

A. Prune, thin, remove injured or dead branches, and shape plants as directed by Owner's Representative.

3.09 MULCHING

A. Mulch backfilled surfaces of pits, planted areas, non-irrigated zones, and other areas indicated.

B. Pre-Emergent Herbicide: Apply pre-emergent herbicide to all shrub bed areas at the rate recommended by the manufacturer. Do not apply to annual, perennial, or ground cover areas.

C. Mulch in shrub bed areas: Apply 4” thick layer of mulch and finish level with adjacent finish grades. Do not place mulch against trunks or stems.

3.10 INSTALLATION OF MISCELLANEOUS MATERIALS

A. Apply antidesiccant using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage.

1. When deciduous trees or shrubs are moved in full-leaf, spray with antidesiccant at nursery before moving and again 2 weeks after planting.

3.11 CLEANUP AND PROTECTION

A. During landscaping, keep pavements clean and work area in an orderly condition.

B. Protect landscaping from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

C. At the time of the final inspection of the work, clean all paved areas by sweeping and washing. Remove construction equipment, excess materials, debris or rubbish from the site.

3.12 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of it off the Owner's property.

END OF SECTION 32 92 43

SECTION 32 93 00 PLANTS

PART 1 GENERAL

1.01 DESCRIPTION

A. The work of this section consists of providing, installing, and maintaining plant material.

1.02 SUBMITTALS

A. See Section 01 3000-Administrative Requirements, for submittal procedures.
B. Delivery tickets for all bulk materials with Owner's Representative's approval or acknowledgment that materials were received in satisfactory condition.

B. Product certificates signed by manufacturers certifying that their products comply with specified requirements.
   1. Manufacturer's certified analysis for standard products, where applicable.
   2. Analysis for other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

B. Samples: 1 cubic foot of mulch required for the project, in labeled plastic bags, boxes, or buckets.

C. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and address of Landscape Architects and Owners, and other information specified.

D. Material test reports from qualified independent testing agency, indicating and interpreting test results relative to compliance of the following materials with requirements indicated.

E. Analysis of existing surface soil for plant growth per Section 329113 – Soil Preparation.

F. Planting schedule indicating anticipated dates and locations for each type of planting.

G. Copy of a written warranty stating all items included in the warranty, conditions of the warranty, and beginning and ending of warranty period(s).

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful landscape establishment.

B. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during times that landscaping is in progress.

C. Testing Agency Qualifications: To qualify for acceptance, an independent testing agency must demonstrate to Owner's Representative's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.

D. Provide quality, size, genus, species, and variety of trees indicated, complying with applicable requirements of ANSI Z60.1 "American Standard for Nursery Stock", and all applicable state and local rules and regulations.

E. Inspection: Owner's Representative may inspect plants either at place of growth or at site before planting, for compliance with requirements for name, variety, size, and quality.

1. The Owner's Representative reserves the right to reject at any time or place prior to final acceptance all plant materials, which in the Owner's Representative's opinion fail to meet specifications. Inspection of materials is primarily for quality, size, and variety, but other requirements are not waived even though visual inspection results in approval. Plants are to be inspected where available; however, inspection at the places of supply shall not preclude the right of rejection at the site or at a later time prior to final acceptance. Rejected material shall be removed from the site within 24 hours.
2. The Contractor shall schedule inspection of the plants, at either the supplier or on-site, to be completed in one visit. Any further inspection required due to plants being unavailable or rejected as not meeting specifications shall be charged to the Contractor.

F. Measurements: Measure trees according to ANSI Z60.1 with branches and trunks in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches (150 mm) above ground for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above ground for larger sizes. Measure main body of tree for height and spread; do not measure branches or roots tip-to-tip.

G. Pre-installation Conference: Contractor shall attend pre-installation conference at location specified by Owner's Representative.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery and while stored at site. The Owner's Representative reserves the right to inspect containers before or after installation to verify compliance with Specifications.

B. Trees: Deliver nursery stocked or freshly dug trees. Do not prune before delivery, except as approved by Owner's Representative. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees in such a manner as to destroy natural shape. Provide protective covering during delivery. Plant materials delivered without protective covering may be rejected. Do not drop trees during delivery. Label at least one tree of each variety with a securely attached waterproof tag bearing a legible plant name. Remove all tags and flagging as directed by Owner's Representative.

C. Handle balled and burlapped stock by the root ball only.

D. Deliver trees after preparations for planting have been completed and install immediately. If planting is delayed more than 6 hours after delivery, set planting materials in shade, protect from weather and mechanical damage, and keep roots moist.
1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
2. Do not remove container-grown stock from containers before time of planting.
3. Water root systems of trees stored on site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.05 PROJECT CONDITIONS

A. Utilities: Determine location of above grade and underground utilities and perform work in a manner that will avoid damage. Hand excavate, as required. Maintain grade stakes until their removal is mutually agreed upon by parties concerned. Contractor shall be responsible for utility locating, repair of utilities damaged by Contractor, and establishment of grade controls.

B. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Owner's Representative before planting.

C. Protection: Erect and maintain barricades, warning signs and lights, and provide guards as necessary or required to protect all persons on the site.

1.06 COORDINATION AND SCHEDULING

A. Coordinate installation of planting materials during normal planting seasons for each type of plant material required. Planting materials should be planted between April 15 and October 1. If irrigation is not available at the time of planting then the Contractor is responsible for watering of all plant material at no additional cost.

B. Plant trees after final grades have been accepted and prior to planting turf, unless otherwise authorized by Owner's Representative.

1.07 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Replace planting materials that do not meet product requirements, that may be excessively pruned, more than 20% dead, or in an unhealthy or declining condition immediately upon notice from the Owner's Representative.

C. All plants shall be true to name and meet all conditions of these specifications. Any plant that is not true to name as indicated by form, leaf, flower, or fruiting characteristics shall be replaced at the Contractor’s expense.

D. The warranty shall not be enforced should any plant die due to vandalism after Final Acceptance.

1.08 FINAL ACCEPTANCE

A. Planted areas will be inspected upon completion and accepted subject to compliance with specified materials and installation requirements. At this time Contractor shall receive a Final Acceptance from the Owner’s Representative. The warranty period will begin upon notification of Final Acceptance.

1.09 TREE MAINTENANCE DURING CONSTRUCTION PERIOD

A. Maintain trees by pruning, cultivating, watering, winter watering, weeding, restoring planting saucers, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray as required to keep trees free of insects and disease. Restore or replace damaged tree wrappings. Trees shall be maintained until Final Acceptance of the entire project.

PART 2 PRODUCTS

2.01 PLANT MATERIALS

A. General: Furnish nursery-grown trees and shrubs conforming to ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully-branched, healthy, vigorous stock free of disease, insects, eggs, larvae, girdling, and defects such as sun scald, injuries, abrasions, and disfigurement. Trees of a larger size may be used if acceptable to Owner's Representative with a proportionate increase in size of roots and balls.

B. Label at least 1 plant of each variety and caliper with a securely attached waterproof tag bearing legible designation of botanical and common name.

C. All plants shall be the species designated on the Drawings. No substitutions will be accepted without the prior written approval of the Owner's Representative. Contractor must provide proof of non-availability.

2.02 TREES

A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, conforming to ANSI Z60.1 for type of trees required.
   1. Branching Height: 1/3 to ½ of tree height.

B. Provide balled and burlapped trees. Container-grown trees will be acceptable in lieu of balled and burlapped trees subject to meeting ANSI Z60.1 limitations for container stock.

C. All deciduous trees of one species used in formal rows or groupings shall exhibit cultural uniformity, i.e. “matched” in height, crown width and shape, height to first branch, and trunk taper. For this reason it is desired that these trees be produced by a single grower.

2.03 MULCH

A. Organic Mulch: Organic Mulch: Organic non-dyed mulch, free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of chipped or shredded wood material not larger than three inches (3”) in length and one-half inch (1/2”) in diameter. The following materials are not acceptable as mulch: bark, elm, redwood, newspaper, and plastic. Submit 1.0 CF sample for approval.

2.04 PLANT BACKFILL MATERIAL

A. The plant pit backfill material shall consist of the following, thoroughly mixed:
   1. Soil originally excavated from the pit (two thirds portion of total mix)
   2. Compost material as specified in Section 329113 – Soil Preparation, 2.01A.1.

B. Topsoil shall meet the requirements specified in Section 329113 – Soil Preparation.

2.05 WATER

A. Water will be available from on-site quick couplers during the irrigation season (generally May through September). Contractor shall supply water when system is not charged.

B. Water shall not contain any substances injurious to plant growth.

2.06 MISCELLANEOUS MATERIALS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's instructions.

B. Pre-Emergent Herbicide: Treflan as manufactured by Elanco Company, or an approved substitution.

C. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, 4 inches (102 mm) wide minimum, with stretch factor of 33 percent.

D. Herbicides and Pesticides: EPA registered and approved, of type recommended by manufacturer.

E. Tree Stakes: 6’ steel T-posts, color green, or 2” x 2” wood posts, min. 6’ long.

F. Anchor System: Rootball Fixing System - Plati-Mat, as manufactured by Platipus Earth Anchoring Systems, England.

G. Tree Ties: Grommeted nylon straps, 1 ½" wide.

H. Staking Wire: Fourteen (14) or sixteen (16) gauge or larger galvanized steel.

I. Steel Edger and Steel Edger in Lawn: Steel edger shall be commercial type roll-top steel edging. 3/16" x 4" height x 16' length with tapered steel stakes supplied by the manufacturer (Ryerson, or approved substitute). The color of the steel edging should be the following: Black. Submit a 1-foot-long sample to Landscape Architect for approval prior to installation.

J. Gravel Mulch – 1 ½" Commanche Tan from Pioneer Sand and Gravel, contact Michael Ford (720)-250-7879, or approved equal.

K. Crushed Stone or Gravel: Color: shall be "Black Granite Chips 3/8'" as supplied by Bedrock Landscaping Materials. (T) 303-432-7222, Denver, CO, or approved equal by the Project Manager.

L. Geotextile Fabric - Mirafi 140 N as supplied by TC Mirafi, 706-693-2226, or approved equal

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to receive landscaping for compliance with requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Cooperate with any other contractors and trades which may be working in and adjacent to the landscape work areas. Examine drawings which show the development of the entire site and become familiar with the scope of all work required.

3.02 FINISH AND FINE GRADING

A. Tillable Soil: Mechanically rip or disk subsoil in all areas to be planted to minimum depth of 6 inches prior to placing topsoil and soil amendments. Except within the driplines of existing trees.

B. Positive Surface Drainage: Finish and fine grade the project area to establish an even and well matched gradient over the entire surface. Provide positive surface drainage, with no depressions, settling, or irregularities in the finished grade.

C. Transitional Areas: At any transitional point or line where one plane intersects another, such as from a sloping area or berm to a level area, a smooth and gentle transition shall be made. There shall be no abrupt changes in grade unless specifically noted otherwise. Match the grades of new work with existing areas outside the project area.

D. Finish Grade Tolerance: The finish grade elevation shall not vary above or below the proposed grade more than 0.05 foot.

3.03 PREPARATION

A. Lay out individual tree locations and areas for multiple plantings. Stake locations, outline areas, and secure Owner's Representative's acceptance before the start of planting work. Make adjustments as directed at no additional cost to the Owner.

3.04 WEED CONTROL

A. In areas that have been regraded and/or have existing weed growth, weed control measures appropriate to the amount of growth and/or species shall be provided. Submit weed control plan to Owner's Representative for approval.

B. Clear and grub, apply pre-emergent herbicide, and/or apply post emergent herbicide as necessary to eliminate weeds. Do not proceed with landscape work until weed growth has been controlled.

3.05 TOPSOIL PLACEMENT

A. Place topsoil to a depth of 4" below top of wall or top of curb on all planter beds.

3.06 EXCAVATION FOR PLANT MATERIAL

A. Planting Pits: Excavate with vertical sides and with bottom of excavation slightly raised at center to assist drainage. Roughen sides of planting pit.

1. Balled and Burlapped Trees: Excavate approximately 2 times as wide as ball diameter. The depth of the plant pit shall be 2 inches less than the depth of the ball in well drained soils and 4 inches less than the ball depth in poorly drained soils.
2. Container-Grown Trees and Shrubs: Excavate approximately 2 times as wide as container diameter. The depth of all plant pits shall be 1 inch less than depth of container.
3. Where drain tile is shown or required under planted areas, excavate to top of porous backfill over tile.

B. Obstructions: Notify Owner's Representative if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavation.

C. Drainage: Notify Owner's Representative if subsoil conditions show evidence of water seepage or retention in tree or shrub pits.

1. Fill the pit with water and allow it to completely drain before planting occurs.
2. If water does not drain out of pit within 24 hours, notify Owner's Representative.

3.07 PLANTING MATERIAL

A. Balled and Burlapped Stock:

1. Set balled and burlapped stock plumb and in center of pit with top of ball raised above adjacent finish grades as indicated.
2. Remove burlap from tops of balls and partially from sides, but do not remove from under balls. Remove wire baskets entirely. Remove pallets, if any, before setting. Do not use planting stock if ball is cracked or broken before or during planting operation.
3. Place backfill around ball in layers, tamping to settle backfill and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing and tamping final layer of backfill. Create 48” diameter saucer around tree and fill with 4” specified wood mulch.

B. Container Grown Stock:

1. Carefully remove containers so as not to damage root balls.
2. Lightly scratch sides of exposed root ball to loosen surface roots.
3. Set plants plumb and in center of pit or trench with top of ball raised above adjacent finish grades as indicated.
4. Place backfill around ball in layers, tamping to settle backfill and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing and tamping final layer of backfill.

5. Mulch at planting bed as shown on drawings.

3.08 PRUNING OF PLANTS

A. Prune, thin, remove injured or dead branches, and shape plants as directed by Owner's Representative.

3.09 MULCHING

A. Mulch backfilled surfaces of pits, planted areas, non-irrigated zones, and other areas indicated.

B. Pre-Emergent Herbicide: Apply pre-emergent herbicide to all shrub bed areas at the rate recommended by the manufacturer. Do not apply to annual, perennial, or ground cover areas.

C. Mulch in shrub bed areas: Apply 4” thick layer of mulch and finish level with adjacent finish grades. Do not place mulch against trunks or stems.

3.10 INSTALLATION OF MISCELLANEOUS MATERIALS

A. Apply antidesiccant using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage.

1. When deciduous trees or shrubs are moved in full-leaf, spray with antidesiccant at nursery before moving and again 2 weeks after planting.

3.11 CLEANUP AND PROTECTION

A. During landscaping, keep pavements clean and work area in an orderly condition.

B. Protect landscaping from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

C. At the time of the final inspection of the work, clean all paved areas by sweeping and washing. Remove construction equipment, excess materials, debris or rubbish from the site.

3.12 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of it off the Owner's property.

END OF SECTION 32 93 00

THE GARDEN SPOT – Berthoud Arboretum

TECHNICAL SPECIFICATIONS

SECTION 33 1100 – WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Additional information concerning water distribution systems may be found on the Civil Drawings. In case of conflict between the drawings and the information specified herein, the more stringent requirements shall govern.

1.2 SUMMARY

A. Work Included: Excavation, trenching, exploratory excavation (pothole), backfill, bedding, soil stabilization, ground water removal, connection to existing mains, and installation of pipe, fire hydrants, taps, valves, fittings, valve boxes, and all necessary appurtenances. Also includes removal and replacement of existing paving or concrete where required, haul and import of adequate backfill material to meet compaction requirements and removal of existing thrust blocks where necessary.

B. Related Sections:

1. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2. Division 31 Section “Earth Moving” for soil materials, site excavating, filling and grading.
3. Division 31 Section “Temporary Erosion and Sedimentation Control” for erosion and sediment mitigation.
4. Division 31 Section “Trenching and Backfilling” for excavating and backfilling of utilities.
5. Division 32 Section “Asphalt Paving” for asphalt pavement removal, replacement, materials and testing.
6. Division 32 Section “Concrete Paving” for concrete pavement removal, replacement, materials and testing.

C. Permits and Fees: Contractor to obtain and pay for all permits required for work in this Section. Pay all fees for inspections by local authorities and utility agency for work specified in this Section.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Piping specialties.
2. Fittings.
3. Valves, valve boxes and accessories.

4. Water meters and accessories.
5. Protective enclosures.
6. Fire hydrants.

B. Shop Drawings: For the following:

1. Precast concrete vaults, including frames and covers, ladders, and drains.

C. Field Quality-Control Test Reports: From Contractor.

D. Test Reports: Submit two (2) copies of laboratory gradation tests for bedding and trench stabilization materials, concrete mix design, asphalt mix designs, and compression test.

E. Permits: Submit copies of all permits issued for project. Contractor is responsible for obtaining all applicable utility agency, City, County, and State Permits for the project.

F. Certificates: Submit two (2) copies of acceptance from Health Department prior to placing water system in service.

G. Locates: Contractor must submit two (2) copies of utility locate drawings/receipts prior to beginning construction.

H. As-Builts: Provide Engineer with copies of redlined, as-built plans upon completion of construction. Horizontal and vertical information is to be certified by a Professional Land Surveyor.

I. Product Requirements:

1. Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.
2. Preference shall be given to materials that are manufactured, harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

1.4 REFERENCE TO TOWN OF BERTHOUD STANDARDS AND SPECIFICATIONS

All work of this section shall be performed in conformance to the current published Town of Berthoud and as subsequently revised, which are incorporated into these specifications by reference. Supplementary requirements may be developed by the Engineer to address project-specific conditions, which may supersede the above-referenced specification.

END OF SECTION 33 1100

THE GARDEN SPOT – Berthoud Arboretum

TECHNICAL SPECIFICATIONS

SECTION 33 3100 – SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Additional information concerning the sanitary sewer distribution systems may be found on the Civil Drawings. In case of conflict between the drawings and the information specified herein, the more stringent requirements shall govern.

1.2 SUMMARY

A. Work Included: Excavation, trenching, removal of existing manholes and piping, backfill, compaction, bedding, soil stabilization, groundwater removal, connection to existing manholes, and installation of pipe, manholes, aggregate base course and gravel where required, service wyes, service lines, asphalt removal and replacement, and all necessary appurtenances and safety precautions. Also includes removal and replacement of existing paving, concrete, topsoil and landscaping where required.

B. Related Sections:

1. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2. Division 31 Section “Earth Moving” for soil materials, site excavating, filling and grading.
3. Division 31 Section “Temporary Erosion and Sedimentation Control” for erosion and sediment mitigation.
4. Division 31 Section “Trenching and Backfilling” for excavating and backfilling of utilities.
5. Division 32 Section “Asphalt Paving” for asphalt pavement removal, replacement, materials and testing.
6. Division 32 Section “Concrete Paving” for concrete pavement removal, replacement, materials and testing.

C. Permits and Fees: Contractor to obtain and pay for all permits required for work in this Section. Pay all fees for inspections by local authorities and utility agency for work specified in this Section.

1.3 SUBMITTALS

A. Submit shop drawings or product data showing specific dimensions and construction materials for pipe, fittings, and manholes or certifications that products conform with specifications.

B. Test Reports: Submit all field quality control test reports.

C. Permits: Contractor is responsible for obtaining all applicable utility agency, City, County and State permits for the project. Submit copies of all permits issued for project.

D. Product Requirements:

1. Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.
2. Preference shall be given to materials that are manufactured, harvested, extracted, mined, quarried, etc. within a 500-mile radius of the project site.

1.4 REFERENCE TO TOWN OF BERTHOUD STANDARDS AND SPECIFICATIONS

All work of this section shall be performed in conformance to the current published Town of Berthoud and as subsequently revised, which are incorporated into these specifications by reference. Supplementary requirements may be developed by the Engineer to address project-specific conditions, which may supersede the above-referenced specification.

END OF SECTION 33 3100

THE GARDEN SPOT – Berthoud Arboretum

TECHNICAL SPECIFICATIONS

SECTION 33 4100 – STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Additional information concerning storm water distribution systems may be found on the Civil Drawings. In case of conflict between the drawings and the information specified herein, the more stringent requirements shall govern.

1.2 SUMMARY

A. Work Included: Excavation, trenching, removal of existing manholes and piping, backfill, compaction, bedding, soil stabilization, ground water removal, connection to existing manholes, and installation of pipe, manholes, inlets, outfalls, aggregate base course and gravel where required, asphalt removal and replacement, and all necessary appurtenances and safety precautions. Also includes removal and replacement of existing paving, concrete, topsoil and landscaping where required.

B. Related Sections:

1. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2. Division 31 Section “Earth Moving” for soil materials, site excavating, filling and grading.
3. Division 31 Section “Temporary Erosion and Sedimentation Control” for erosion and sediment mitigation.
4. Division 31 Section “Trenching and Backfilling” for excavating and backfilling of utilities.
5. Division 32 Section “Asphalt Paving” for asphalt pavement removal, replacement, materials and testing.
6. Division 32 Section “Concrete Paving” for concrete pavement removal, replacement, materials and testing.

C. Permits and Fees: Contractor to obtain and pay for all permits required for work in this Section. Pay all fees for inspections by local authorities and utility agency for work specified in this Section.

1.3 SUBMITTALS

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

1. Special pipe fittings.
2. Backwater valves.
3. Cleanouts, inlets and area drains.

4. Channel drainage systems.
5. Trench drainage systems.
6. Manholes.
7. Pipes or conduits.
8. Frames and grates.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments for the following:

1. Precast concrete manholes and other structures, including frames, covers and grates.
2. Cast-in-place concrete manholes and other structures, including frames, covers and grates.
3. Catch Basins and Storm Water Inlet. Include plans elevations, sections, details and frames, covers and grates.
4. Storm Water Detention Structures: Include plans, elevations, sections, details, frames, orifice plates, and covers.
5. Design Mix Reports and Calculations: For each class of cast-in-place concrete.

C. Field Quality-Control Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.4 REFERENCE TO TOWN OF BERTHOUD STANDARDS AND SPECIFICATIONS

All work of this section shall be performed in conformance to the current published Town of Berthoud and as subsequently revised, which are incorporated into these specifications by reference. Supplementary requirements may be developed by the Engineer to address project-specific conditions, which may supersede the above-referenced specification.

END OF SECTION 33 4100

SECTION 33 56 00.01 SUBDRAINAGE SYSTEMS – PLAY AREAS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes requirements for furnishing and installation of sub-drainage systems as shown on the Contract Drawings, as specified herein, or as required to complete the work.

B. Related Work:
1. Division 01 Section “Layout of Work and Surveys”.
2. Division 01 Section “Contractor Quality Control”.
3. Division 01 Section “Erosion and Sedimentation Control”.
4. Division 01 Section “Tree Retention and Protection”.
5. Division 31 Section “Earth Moving”.
6. Division 31 Section “Excavation and Backfilling of Trenches”.
7. Division 32 Section “Sodding”.
8. Division 33 Section “Storm Sewerage”.

1.3 SUBMITTALS

A. See Division 01 Section “Submittals” for submittal requirements.

B. Product Data: For each type of product for approval prior to construction.
1. Geotextile Fabric: Submit twelve inch (12”) by twelve inch (12”) sample.
2. Gravel Sump material: Submit one (1) quart sample.

1.4 QUALITY CONTROL

A. Installer Qualifications: Engage an experienced Installer who has completed subdrainage work similar in material, design, and extent to that indicated for this Project and with a record of successful project completion and operation.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Materials: Deliver materials in original containers. Protect materials from damage during delivery and while stored at site. The Project Manager reserves the right to inspect containers before or after installation to verify compliance with Specifications.

B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk materials with appropriate certificates.
4. Protect piping and geotextile fabric from damage or contamination with soil or other construction materials from time of deliver to installation.

1.6 PROJECT/SITE CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and related construction contiguous with proposed subdrainage installations by field measurements before proceeding with planting work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Geotextile Fabric: Non-woven fabric "140N" by Tencate-Mirafi or acceptable substitution.

B. Gravel Sump: Three quarters inch (3/4") to one inch (1") washed river rock.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine areas where the Work of this Section will be performed for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within the work area.
2. Verify that final grades are completed in accordance with the drawings.

B. Proceed with installation only after unsatisfactory conditions have been corrected and approved by Project Manager.

C. PVC under drain: Install pipe under drains as shown on the Contract Drawings. Pitch shall be a minimum of one half of one percent (0.5%) or as shown on Contract Drawings. Contractor is responsible to immediately notify the Project Manager of any discrepancies.

D. Geotextile fabric used for the pipe under drains system shall be placed in the trench once pipe trench is prepared to receive pipe. The fabric shall be placed in full contact with the trench bottom and sides. The fabric shall be secured to the trench sides or top edge in a manner which does not damage the integrity of the fabric. The fabric shall be protected from damage during the placement of the pipe and granular fill. Install granular fill and pipe in trench to dimensions specified on Contract Drawings. Contractor is responsible to ensure that no debris, sediment or foreign material enters the granular fill that inhibit drainage. Any installation that does not meet these standards shall be replaced at the direction of the Project Manager at no additional cost to the Town. Upslope fabric sheet shall lap over downslope sheet at least 6-inches for the full width of the trench.

3.2 CLEANING

A. Clean and flush out lines before covering. Remove and legally dispose of all waste material and debris offsite.

3.3 RESTORATION

A. Restore all fences, ditches, yards, lawns, and other structures or surfaces to condition equal to or better than before work began.

END OF SECTION 33 46 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes impermeable geomembrane pond liners.

B. Related Sections include the following:

1. Division 2 Sections for earthwork, special subsurface bedding and geotextiles related to liner work.

1.3 DEFINITIONS

A. Plastics Terminology: Refer to ASTM D 1600 for definition of abbreviated terms for plastics not otherwise defined in this Section.

B. PVC: Polyvinyl chloride.

1.4 SUBMITTALS

A. Product Data: For each type of the following:

1. Geomembrane liner.

2. Geotextile fabric.

3. Seaming adhesive, solvent, and extrusion.

4. Penetration assembly.

5. Batten assembly

B. Shop Drawings: Show fabrication and installation details for geomembrane liner. Show panel layout, seams, penetrations, perimeter anchorage, and methods of sealing to other construction. Differentiate between factory and field seams and joints.

C. Samples for Verification: For each geomembrane, not less than one 12-inch seam length of factory-bonded sheets and one 12-inch seam length of field-bonded sheets.

D. Installer Certificates: Signed by manufacturer certifying that installers comply with requirements.

E. Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.

F. Qualification Data: Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

G. Material and Product Test Reports: Indicating materials, geomembrane, and seams comply with requirements, based on comprehensive testing of current product formulations and products.

H. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

I. Maintenance Data: For geomembrane system to include in maintenance manuals specified in Division 1.

J. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Installer shall have been in the business of installing project of similar complexity and size for a minimum of 10 years and have installed no less than 5 million square feet.

B. Manufacturer Qualifications: A firm experienced in manufacturing geomembrane liner panels similar to those indicated for this Project and with a record of successful in-service performance.

C. Source Limitations: Obtain geomembrane liner panels, accessories, and required seaming materials, solvents, and adhesives through one source from a single manufacturer.

D. Preinstallation Conference: Conduct conference at Project site. Review methods and procedures related to product including, but not limited to, the following:

1. Inspect and discuss condition of substrate and other preparatory work performed by other trades.

2. Review structural load limitations.

3. Review limitations on equipment and Installer's personnel.

4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

5. Review required testing, inspecting, and certifying procedures.

6. Review weather and forecasted weather conditions and procedures for unfavorable conditions.

1.6 DELIVERY, STORAGE, AND HANDLING

A. PROJECT CONDITIONS

1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit placement and seaming of geomembrane to be performed according to manufacturers' written instructions and warranty requirements. Do not place or seam geomembrane during conditions of precipitation, excessive atmospheric moisture, blowing dust, strong wind, or at temperatures outside manufacturers' recommended range.

1.7 COORDINATION

A. Coordinate pond mechanical system components that interface with the liner such as pipe penetrations, electrical connections and utility structures as described on the plans.

1.8 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, signed by geomembrane manufacturer, liner manufacturer, and liner Installer agreeing to repair or replace geomembrane liner that fails in materials and workmanship or that deteriorates under conditions of normal weather within specified warranty period. Warranty does not include deterioration or failure of geomembrane liner due to exposure to harmful chemicals, gases or vapors, abnormal and severe weather phenomena, fire, earthquakes, floods, vandalism, or abuse by persons, animals, or equipment. Failures include, but are not limited to, the following:

1. Leaks.

C. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Firestone Specialty Products

2.2 MATERIALS

A. General: Provide impervious geomembrane liner fabricated from sheet material indicated, complying with specified product characteristics.

2.3 GEOMEMBRANE LINER MATERIALS

A. The geomembrane liner material should consist of ethylene propylene diene monomer (EPDM). Liner shall confirm to the specifications for “Firestone PondGard Rubber Liners & Firestone EPDM Geomembrane with nominal thickness indicated:

1. Nominal Thickness: 45 mils.

2.4 MICELLANEOUS MATERIALS

A. Adhesives: Provide types of adhesive compounds, solvents, and tapes recommended in writing by liner manufacturer for bonding to structures (if required), for sealing of seams in geomembrane, and for sealing projections through liner.

B. Penetration Assemblies: Provide manufacturer's standard factory-fabricated assemblies for sealing penetrations. Include joint sealant, recommended in writing by liner manufacturer, compatible with geomembrane and containment conditions and materials.

C. Battens: Long-length strips of material indicated, size as shown on Drawings. Fabricate battens with sharp projections removed, and edges eased and predrilled or punched for anchors. Provide anchors, or other type of attachment, of type and spacing recommended in writing by liner manufacturer for attaching geomembrane liner system to substrate and as indicated.

1. Batten Material: Stainless steel; with stainless-steel anchors, complete with gasket and sealant compatible with geomembrane and containment conditions and materials. Batten system shall be approved by liner manufacturer.

D. Liner Ballast: Washed gravel.

E. Geotextile: As manufactured by Mirafi or equivalent.

1. Non woven polypropylene needle punched geotextile.

2. 8 oz per sq. yard per ASTM D 5261

3. Model S800.

2.5 FABRICATION

1. Fabricate geomembrane liner panels from sheets in sizes as large as possible with factory-sealed seams, consistent with limitations of weight and installation procedures. Minimize field seaming.

2.6 SOURCE QUALITY CONTROL

A. General: Test for bonded seam strength and peel adhesion every 1000 feet or once per panel, whichever is more frequent, per NSF 54, Table 14.

B. Liner: Test and inspect factory seams for peel adhesion not less than 10 lbf/in of seam width, according to ASTM D 413, as modified by NSF 54, Annex A, and for bonded seam strength indicated according to ASTM D 3083, as modified by NSF 54, Annex A.

1. Bonded Seam Strength: Not less than indicated for seam constructed from two sheets, each with nominal sheet thickness of not less than 40 mils.

a. 58.4 lbf/in. of seam width.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for freedom from sharp projections and voids; for compliance with requirements for soil compaction and grading; for subgrade free from angular

rocks, rubble, roots, vegetation, debris, voids, protrusions, and ground water; and for other conditions affecting performance of liner.

1. Examine anchor trench excavation, where liner is to be secured, for substrate conditions indicated above and for correct location and configuration.

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

3.2 PREPARATION

A. Provide temporary ballast that does not damage geomembrane liner or substrate, to prevent uplift of liner in areas with prevailing winds, until edges are permanently secured.

B. Prepare surfaces of construction penetrating through liner according to liner manufacturer's written instructions.

C. Remove curing compounds and coatings from concrete surfaces to be sealed to geomembrane liner.

3.3 INSTALLATION

A. General: Place geomembrane liner over prepared surfaces to ensure minimum handling. Install according to Shop Drawings and to comply with liner manufacturer's written instructions. In areas with prevailing winds, begin placing liner at Project's upwind direction and proceed downwind. Install liner in a relaxed condition, free from stress and tension. Fit closely and seal around inlets, outlets, and other projections through geomembrane liner. Permanently secure edges.

B. Field Seams: Comply with liner manufacturer's written instructions. Form lapped seams by lapping edges of panels 4 to 6 inches unless instructions require a larger overlap. Wipe contact surfaces clean and free of dirt, dust, moisture, and other foreign materials. Use solvent-cleaning methods and grind geomembrane seam surfaces if recommended by liner manufacturer. Proceed with seaming at required temperatures for materials and ambient conditions. Continuously bond sheet to sheet to construct single or double seams of width recommended for method of seaming used. Seal or fuse free seam edges as instructed. Inspect seams and reseal voids.

C. Adhesive Bonding: Apply bonding cement to both contact surfaces in seam area and press together immediately, or use other seaming methods as instructed by liner manufacturer. Roll to press surfaces together, to distribute adhesive to leading edges of panels, and to remove wrinkles and fishmouths. Remove excess adhesive.

D. Liner Attached to Concrete: Use liner manufacturer's standard system to suit project conditions. Support adhesive and liner fabric on not less than 8-inch-wide concrete substrate, unless otherwise indicated.

E. Install batten strips over bonded liner as shown on Drawings.

F. Liner Repairs: Repair tears, punctures, and other imperfections in liner field and seams using patches of liner material, liner-to-liner bonding materials, and bonding methods according to liner manufacturer's written instructions. Apply bonding solvent or weld to contact surfaces of both patch and liner and press together immediately. Roll to remove wrinkles.

G. After liner is installed, place geotextile material on liner and anchor until permanent ballast is installed. Protect all work during placement of ballast with utmost care at all battens.

3.4 FIELD QUALITY CONTROL

A. Nondestructive Testing: Visually inspect all seams and patches. Comply with ASTM D 4437 for Air Lance Test, Vacuum Box Testing, or Ultrasonic (High Frequency) Pulse Echo Testing or with GRI Test Method GM6, as applicable to geomembrane and seam construction. Record locations of failed seams and patches. For the record, individually number and date occurrences and details of leak and remedial action. Repair leaking seams and patches.

3.5 PROTECTION

A. Protect installed geomembrane liner according to liner manufacturer's written instructions. Repair or replace areas of liner damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.

B. Protect installed geomembrane with an additional layer of geotextile fabric at all locations where concrete, compacted fill, rip rap or pipe penetrations will bear on membrane.

C. Before initial filling of pond, or placement of earth or other cover, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged membrane and seams and reinspect repaired work.

END OF SECTION 33 47 14