

COLORADO
 DEPARTMENT OF TRANSPORTATION
 SPECIAL PROVISIONS

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 STANDARD SPECIAL PROVISIONS

Name	Date	No. of Pages
Revision of Section 202 – Removal of Bridge <i>Projects with bridge removal operations. Always use with Revision of Section 107 - Safety Critical Work.</i>	(March 30, 2021)	5
Revision of Section 206 – Excavation and Backfill for Structures <i>All projects.</i>	(January 20, 2021)	1
Revision of Section 207 – Topsoil <i>Projects having earthwork disturbances that will be stabilized with vegetation.</i>	(July 7, 2020)	6
Revision of Section 208 – Erosion Control 208.10 (b) <i>All projects.</i>	(January 20, 2021)	1
Revision of Section 212 – Soil Amendments, Seeding, and Sodding <i>Projects having earthwork disturbances that will be stabilized with vegetation.</i>	(July 7, 2020)	18
Revision of Section 214 – Nursery Stock Containers and Uprooted Cuttings <i>Projects having earthwork disturbances that will be stabilized with vegetation.</i>	(July 7, 2020)	10
Revision of Section 250 – Environmental Safety and Health <i>All projects.</i>	(January 20, 2021)	1
Revision of Section 412 – Dowel Bar for Joints <i>Projects with concrete pavement.</i>	(October 19, 2020)	3
Revision of Section 412 – Portland Cement Concrete Pavement <i>Projects with Portland Cement Concrete Pavement.</i>	(September 3, 2020)	1
Revision of Section 503 – Drilled Shafts <i>All projects.</i>	(January 20, 2021)	1
Revision of Section 504 and 606 – Precast Concrete <i>Projects having precast concrete.</i>	(September 3, 2020)	1
Revision of Section 518 – Waterstops and Expansion Joints <i>All projects.</i>	(January 20, 2021)	1
Revision of Section 601 – Concrete Mix Designs <i>Projects with structural concrete.</i>	(March 30, 2021)	1
Revision of Section 601 – Structural Concrete <i>Projects with structural concrete.</i>	(October 4, 2019)	17
Revision of Section 601 – Structural Concrete (601.05) <i>All projects.</i>	(January 20, 2021)	1
Revision of Sections 601 & 701 – Structural Concrete <i>Projects with structural concrete.</i>	(Dec. 28, 2020)	3
Revision of Section 602 – Reinforcing steel <i>Projects with reinforcing steel.</i>	(September 3, 2020)	4
Revision of Section 613 – Lighting <i>Projects with roadway lighting.</i>	(Sept. 18, 2020)	10
Revision of Section 614 – Pedestrian Push Buttons	(January 23, 2020)	4

Projects with Pedestrian Push Buttons, Accessible Pedestrian Signals, and Pedestrian Push Button Assembly Posts.

Revision of Section 625 – Construction Surveying (e-sealing) <i>All projects.</i>	(January 20, 2021)	1
Revision of Section 629 – Survey Monumentation <i>All projects.</i>	(January 20, 2021)	1
Revision of Section 630 – Barrier (Temporary) <i>Projects with temporary barrier.</i>	(October 4, 2019)	1
Revision of Section 630 – Construction Zone Traffic Control <i>All projects.</i>	(Dec. 28, 2020)	1
Revision of Section 709 – Reinforcing Steel and Wire Rope <i>Projects with reinforcing steel and wire rope.</i>	(Sept. 3, 2020)	1
Revision of Section 710 – Fence and Guardrail <i>Projects with cable barrier and/or fencing.</i>	(March 30, 2021)	1
Revision of Section 715 – Lighting and Electrical Materials <i>Projects with roadway lighting.</i>	(Sept. 18, 2020)	10

March 30, 2021

REVISION OF SECTION 202
REMOVAL OF BRIDGE

NOTICE

This is a project special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Construction Engineering Services Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects with bridge removal operations. Use the 107 standard special provision, Safety Critical Work, with this specification at all times.

1
REVISION OF SECTION 202
REMOVAL OF BRIDGE

Revise Section 202 of the Standard Specifications as follows:

Subsection 202.01 shall include the following:

This work consists of removal of the existing bridge(s) at the locations shown in the plans. Bridge removal shall consist of the complete removal of all superstructure and substructure elements including caissons and piling to a depth of at least two (2) feet below finished grade unless otherwise shown on the plans. Time limitations for the work shall be as shown in the contract and/or plans.

Subsection 202.02 shall include the following:

Perform the removal of the existing bridges in accordance with the requirements in this specification and Standard Specification 107.06. The Construction Plan requirements shown in Revision of Section 107-Performance of Safety Critical Work shall be included in the Bridge Removal Plan.

When removal operations are located over or in proximity to a railroad or any live water way, additional coordination including potential incident emergency/risk management notifications with the railroad or other agency (United States Army Corps of Engineers (USACE), US Fish and Wildlife Service, US Forest Service, etc.) shall be required.

The Contractor shall submit a Bridge Removal Plan to the Engineer for review and acceptance at least 2 weeks prior to the Pre-removal Conference. This Plan shall detail procedures, sequences, and all features required to perform the removal in a safe and controlled manner. The Bridge Removal Plan shall be prepared by the Contractor's Engineer and contain the Seal of a Professional Engineer registered in the State of Colorado. The Contractor's Engineer shall stamp and sign the Bridge Removal Plan "Approved for Construction". Submit the Bridge Removal Plan to the Engineer of Record, the corresponding CDOT Region Bridge Unit Leader and the Engineer for review and concurrence with general specification compliance, but it will not be approved. Submit comments from the referenced reviewers of the Bridge Removal Plan in writing to the Contractor within seven calendar days from receipt of the plan and prior to the Pre-removal Conference. Acceptance of the Bridge Removal Plan will be contingent upon the Contractor adequately addressing all written comments to the satisfaction of the Engineer.

The Bridge Removal Plan shall provide complete details of the bridge removal process, including:

- (1) The removal sequence corresponding to the construction phasing shown on the plans, including calculations and analysis of the Contractor's removal equipment as related to loading capacity and any crane bearing during the removal operations. Sequence of operation shall include a detailed schedule that complies with the working hour limitations.
- (2) Equipment descriptions including size, number, type, capacity, backup/standby need, and location of equipment during removal operations.
- (3) Roles, responsibilities, and positioning of all CDOT project management, construction supervision, and critical workers during removal activities. Include instructions for communicating and managing a 'safe-all stop' scenario in this section, if unexpected hazards are discovered during the activity.
- (4) Shoring that exceeds 5 feet in height, all falsework and bracing. Shoring design shall follow the AASHTO Guide Design Specifications for Bridge Temporary Works, or other design standard as approved by the Engineer.

2
REVISION OF SECTION 202
REMOVAL OF BRIDGE

- (5) Shoring construction, including verification and proof testing shall be in accordance with Section 206. Shoring will not be measured and paid for separately, but shall be included in the cost of item 202 – Removal of Bridge, unless otherwise provided on the plans or as directed by the Engineer.
- (6) Details, locations, and types of protective coverings to be used. The protective covering shall prevent materials, equipment, and debris from falling onto the property below. When removal operations are located over or in proximity to a live waterway, railroad, or pedestrian/bicycle path, additional width of protective covering sufficient to protect these facilities shall be required. Include detailed methods of protection of the existing roadway facilities, including measures to assure that people, property, utilities, and improvements will not be endangered. Consider a catastrophic, unplanned failure of the structure during demolition as worst-case scenario.
- (7) Detailed methods for protection of live waterways including minimization of turbidity and sedimentation, and protection of existing wetlands.
- (8) Detailed methods for mitigation of fugitive dust resulting from the demolition.
- (9) Details for dismantling, removing, loading, and hauling steel elements.
- (10) Locations of railroad tracks, roadways, utilities (overhead and underground), structures or facilities located within the area of the bridge removal operations.
- (11) Detailed methods of fire suppression.
- (12) Methods of Handling Traffic, including bicycles and pedestrians, in a safe and controlled manner.
- (13) Details for managing project communications, media, and on-looking public during demolition as needed.
- (14) Contingency planning for unexpected weather.
- (15) Details for emergency and post-incident management in a catastrophic failure or other serious incident or worker injury.

The Contractor's Engineer shall be responsible for the stability of the existing "in service" structure for any deviation from the bridge removal limits shown on the construction phasing plans. The Contractor is also responsible for the protection of any portion of the structure to remain in place for later phases, including protection from the Contractor's construction activities.

Use the more stringent criteria of the design guidelines, when a temporary works or demolition guideline is provided by a railroad or local agency

Hold a Pre-removal Conference at least seven days prior to the beginning of removal of the bridge. The Engineer, Staff Bridge, the Contractor, the subcontractor performing the removal(s), the Contractor's Engineer, the Traffic Control Supervisor (TCS), and CDOT/Project Communications Staff shall attend the Pre-removal Conference. Finalize the Bridge Removal Plan at this Conference. Record meeting minutes and the attendance list.

The Contractor's Engineer shall seal items (1) and (4) listed above in the final Bridge Removal Plan. Demonstrate with adequate calculations that the loads and impact of the Contractor's demolition equipment do not impose detrimental effects on the stability of the structure remaining after the end of each phase of removal. Review these calculations before traffic is allowed to resume in its normal configuration.

3
REVISION OF SECTION 202
REMOVAL OF BRIDGE

The final Bridge Removal Plan shall be stamped “Approved for Construction” and sealed by the Contractor’s Engineer. The Contractor shall address all written comments from the Engineer and submit a final Bridge Removal Plan to the Engineer. The Contractor shall not begin the removal operations without the Engineer’s written acceptance of the final Bridge Removal Plan.

Submittal of the final Bridge Removal Plan to the Engineer, and field inspection performed by the Engineer, will in no way relieve the Contractor and the Contractor’s Engineer of full responsibility for the removal plan and procedures.

Work within Railroad right-of-way shall be in accordance with Section 107. For bridge removal over railroads, including overhead wires, tunnels and underground facilities, approval of the bridge removal plans will be contingent upon the drawings being satisfactory to the railroad company involved.

The Contractor’s Engineer shall be onsite during safety critical removal operations considered to have a high degree of safety risk. At or before the Pre-removal Conference, the Contractor and the Engineer shall agree if the Bridge removal operations are of high safety risk. Document said agreement in writing. The Contractor’s Engineer shall inspect and provide written approval of each phase of the removal operations corresponding to the construction phasing shown on the plans prior to allowing vehicles or pedestrians on, below, or adjacent to the structure. The Contractor’s Engineer shall certify in writing that the falsework, bracing, and shoring conform to the details of the final Bridge Removal Plan. Submit a copy of the certification to the Engineer. If any part of the adjacent structure designated to remain in place is damaged during removal operations, the Contractor’s Engineer shall perform a full and complete engineering evaluation of the structure and submit a written report to the Engineer. This evaluation, as well as any additional costs to stabilize the structure due to or resulting from the Contractor’s actions or inactions, shall be borne solely by the Contractor. Do not permit further work involving the bridge until the report and any subsequent remedial stability measures are complete and satisfactory to the Engineer and Staff Bridge.

The Contractor shall have all necessary workers, materials, and equipment at the site prior to closing any lanes to traffic to accommodate bridge removal operations. Pursue work promptly and without interruption until reopening the roadway to traffic.

Removal of hazardous material shall be in accordance with Section 250.

The Contractor shall take all necessary steps to avoid contaminating state waters, in accordance with subsection 107.25.

If an unplanned event occurs or the bridge removal operation deviate from the submitted Bridge Removal Plan, the bridge removal operations shall immediately cease. Perform all necessary work to ensure worksite safety. The Contractor shall submit to the Engineer the procedure or operation proposed by the Contractor’s Engineer to correct or remedy the occurrence of this unplanned event or to revise the final Bridge Removal Plan. The Contractor’s Engineer shall submit a written report to the Engineer within 24 hours of the event summarizing the details of the event and the procedure for correction. The Engineer shall review the information submitted regarding the unplanned event and provide written acceptance of the corrective action or remedy procedure prior to resuming operations.

Before removal of the protective covering, the Contractor shall clean the protective covering of all debris and fine material.

REVISION OF SECTION 202
REMOVAL OF BRIDGE

The Engineer may be suspend bridge removal for the following reasons:

- (1) Final Bridge Removal Plan has not been submitted, or written acceptance has not been provided by the Engineer to begin the removal.
- (2) The Contractor is not proceeding in accordance with the final Bridge Removal Plan, procedures, or sequence.
- (3) The Contractor's Engineer is not onsite to conduct inspection for the written approval of the work.
- (4) Safety precautions are deemed to be inadequate.
- (5) Existing neighboring facilities are damaged because of bridge removal.

Suspension of bridge removal operations shall in no way relieve the Contractor of their responsibility under the terms of the Contract. A suspension ordered as a direct result of (1) through (5) above, shall be considered a non-excusable delay. Bridge removal operations shall not resume until modifications have been made to correct the conditions that resulted in the suspension, as approved in writing by the Engineer.

The Contractor shall notify all emergency response agencies of the proposed removal work and any detours a minimum of three days in advance of the work. This shall include the Colorado State Patrol, local Police Department, local Fire Department, all local ambulance services, and the Sheriff's Department, as appropriate.

All required traffic control devices, nighttime flagging stations, barricades and VMS signs shall be in place, with detours in operation, prior to the beginning of removal operations each day. Night work shall conform to the requirements of the MUTCD, Parts 1, 5, and 6.

Prior to reopening the roadway to public traffic, remove all debris, protective pads, materials, and devices and sweep the roadways clean. The Contractor shall install any restriping necessary to achieve full compliance pavement markings prior to reopening. All costs related to pavement marking replacement shall be included in the work.

Do not use explosives for removal work without the written approval of the Engineer.

Removal shall include the superstructure, the substructure, which includes the piers, abutments and wingwalls, the bridge rail, and any approach slabs and sleeper slabs.

During removal of the substructure, take it down to at least 2 feet below the natural existing or future ground surface at the lowest point of interface with the abutment, unless otherwise approved by the Engineer. Holes resulting from substructure removal shall be backfilled with Structure Backfill (Class 2) to the adjacent existing grades.

All other materials removed from the existing structure shall become the property of the Contractor and shall be properly disposed of offsite at the Contractor's expense, unless otherwise stated on the plans.

The Contractor shall not damage the existing structures, facilities, and surrounding roadways during the removal operations. Repair damage that occurs immediately, at the Contractor's expense.

5
REVISION OF SECTION 202
REMOVAL OF BRIDGE

Subsection 202.03 shall include the following:

Protect and remove all brass bridge plaques prior to demolition of the bridge. Deliver plaques to the Region Environmental group or Staff Bridge.

In Subsection 202.08: Replace the first paragraph with:

Unless otherwise directed, remove the substructures of removed structures to 2 feet below the natural stream bottom and remove those parts outside of the stream down 2 feet below natural ground or finished surface. Remove such portions of existing structures, which lie wholly or in part within the limits of a new structure, as necessary to accommodate the construction of the proposed structure.

In Subsection 202.12 include the following:

Make payment under:

Pay Item	Unit
Removal of Bridge	Each

Payment for Removal of Bridge will be full compensation for all labor and materials required to complete the work, including, preparation and implementation of the Bridge Removal Plan, Engineering work, inspection, equipment, debris handling and disposal, salvaging, handling and storage of salvable materials, handling and disposal of all hazardous materials and disposal of non-salvable materials.

Lighting required for nighttime operations will not be measured and paid for separately, but shall be included in the work.

January 20, 2021

REVISION OF SECTION 206
EXCAVATION AND BACKFILL
FOR STRUCTURES

NOTICE

This is a standard special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Construction Engineering Services Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects.

REVISION OF SECTION 206
EXCAVATION AND BACKFILL
FOR STRUCTURES

Section 206 of the Standard Specifications is hereby revised for this project as follows:

Delete the 2nd paragraph in Subsection 206.09 and replace with the following:

When the height of shoring exceeds five feet above the base of the excavation, the Contractor shall submit working drawings in accordance with subsection 105.02. The drawings shall be submitted to the Engineer for information only. The drawings shall be electronically sealed by the Contractor's Engineer. The Contractor shall design for internal and external stability of temporary shoring such as but not limited to bearing capacity, settlement, sliding, overturning, internal compound stability, and global stability. All proof and verification testing of the shoring elements shall be the responsibility of the Contractor and results shall be reported to the Engineer the day after the testing was performed.

Delete the 5th paragraph in Subsection 206.09 and replace with the following:

The Contractor shall have performed and documented an independent review of their shoring design and drawings at designated areas prior to submittal. The Contractor's Engineer shall electronically seal the independent review shoring design and drawings.

Delete the 11th paragraph in Subsection 206.09 and replace with the following:

The Contractor's Engineer may assign an on-site representative, to perform construction field oversight, by submitting documentation of experience to the Engineer ten days prior to starting shoring construction for review and the Engineer's acceptance. Prior to placing construction or traffic loads on or immediately adjacent to the supported earth, the Contractor's Engineer for the shoring shall certify in an electronically sealed letter that shoring materials and construction have been inspected and that all shoring, materials, and construction are in conformity with the shoring drawings. A copy of this certification shall be submitted to the Engineer.

July 9, 2020

REVISION OF SECTION 207
TOPSOIL

NOTICE

This is a standard special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Project Development Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use in projects having earthwork disturbances that will be stabilized with vegetation.

REVISION OF SECTION 207
TOPSOIL

Section 207 of the Standard Specifications is hereby deleted for this project and replaced with the following:

DESCRIPTION

207.01 This work consists of salvaging topsoil from onsite locations, stockpiling, maintaining, and preparing the subsoils for the placement of the topsoil at locations shown on the plans. It also includes creating seeding media by amending subsoils, and importing offsite topsoil when shown on the plans.

Substitutions from this specification will not be allowed unless submitted in writing to the Engineer and approved by the Region or Headquarters Landscape Architect.

MATERIALS

207.02 General. Topsoil shall be salvaged onsite, imported, or produced as shown on the plans. Topsoil shall be free of refuse and litter along with noxious weed seed and reproductive plant parts, as listed in current State of Colorado A and B Noxious Weed List and local agency weed lists. Topsoil shall not include heavy clay, hard clods, toxic substances, pathogens, or other material, which would be detrimental to growing native vegetation. All required amendments shall be thoroughly incorporated to parent material, onsite. All amendments shall conform to Section 212. Topsoil and parent material shall be free of clods, sticks, stones, debris, concrete, and asphalt in excess of 4 inches in any dimension for all material used within the designed clear zone for the project. Topsoil outside of the clear zone may contain rock larger than 4 inches in any dimension. For slopes with no structures being used to protect areas from falling rocks the Contractor shall remove or secure any rocks deemed unstable and could pose a safety hazard.

Topsoil shall be generated from one or more of the following as shown on the plans:

- (a) *Topsoil (Onsite)*. Topsoil shall consist of the upper 6-inch layer of the A horizon, as defined by the Soil Science Society of America, or at the depths and locations shown on the Stormwater Management Plan (SWMP). It shall consist of loose friable soil, salvaged from onsite and stockpiled or windrowed. Litter and duff (layer of partially decomposed plant material) shall be collected as part of the salvaging of topsoil unless specified to be removed and hauled offsite on the plans.
- (b) *Topsoil (Wetland)*. Wetland topsoil shall consist of moist, organic soil obtained from delineated wetlands, including any existing wetland vegetation and seeds. Wetland topsoil shall be extracted from the project site at locations shown on the plans or as directed, to a minimum depth of 12 inches or at the depths as shown on the plans.
- (c) *Seeding Media*. Seeding Media shall consist of one or all of the following approved materials: sub-soil, overburden, or material generated from rock. Contractor shall select onsite or offsite locations to generate material that meet the requirements of Table 207-1. The Contractor shall provide a Certified Test Report (CTR) in accordance with subsection 106.13, excluding lot, heat, and batch confirming that the excavated material conforms to Table 207-1.
- (d) *Topsoil (Offsite)*. The Contractor shall submit a CTR for Topsoil (Offsite) for approval a minimum of 60 days prior to import in accordance with subsection 106.13. The Contractor shall include with the CTR a complete Soil Nutrient Analysis for the properties listed in Table 207-2 from an independent laboratory that participates in the National Association for Proficiency Testing (NAPT). If topsoil nutrient analysis is deficient, an Amendment Protocol shall be submitted by the Contractor for approval. The Amendment Protocol shall contain a complete list of amendments and associated quantities to produce topsoil that conforms to Table 207-2.

2
 REVISION OF SECTION 207
 TOPSOIL

The Contractor shall submit a Certificate of Compliance (COC) for Topsoil (Offsite) for approval a minimum of 60 days prior to import that the source has controlled noxious weeds in accordance with the State of Colorado Noxious Weed Act 35-5.5-115.

**Table 207-1
 PHYSICAL PROPERTIES OF SEEDING MEDIA**

Property	Range	Test
Soil pH (s.u.)	5.6 – 7.5	ASA Mono. #9, Part 2, Method 10-3.2 or TMECC 04.11-A
Soil Electrical Conductivity (EC) (mmhos/cm or ds/m)	< 5.0	ASA Mono. #9, Part 2, Method 10-3.3
Soil SAR (s.u.)	0 - 10	ASA Mono. #9, Part 2, Method 10-3.4
Rock Content (%)	≤ 25	USDA NRCS Rock Fragment Modifier Usage
Trace Contaminants (Arsenic, Cadmium, Copper, Mercury, Selenium, Zinc, Nickel, and Lead)	Meets US EPA, 40 CFR 503 Regulations	TMECC 04.06 or EPA6020/ASA (American Society of Agronomy)
Rock Content (%) greater than 3” diameter	≤ 25	USDA NRCS Rock Fragment Modifier Usage
USDA Soil Texture	No more than 70% clay, silt, and sand by percentage volume of topsoil.	ASA Monograph #9, Part 1, Method 15-4 or ASA 1 43-5
All Particle Sizes	< 6 Inches	
Physical contaminants (man-made inerts) (%)	< 1	TMECC 03.08-C
C:N ratio	<20	TMECC 05.02-A
* Fines % when manufacturing material from rock	>25% material passing through #4 sieve	ASTM D6913

Amendments to the base imported material shall have the quantities of material verified onsite prior to incorporation into parent material, either at the stockpiles or after placement of parent material. Topsoil amended at the stockpiles shall be distributed to the site within seven days. * Substitute this requirement for USDA Soil Texture requirement when project are approved to use material manufactured from native rock material on site.

3
REVISION OF SECTION 207
TOPSOIL

**Table 207-2
TOPSOIL (OFFSITE) PROPERTIES**

Property	Range	Test Methods
Soil pH (s.u)	5.6 – 7.5	ASA Mono. #9, Part 2, Method 10-3.2 or TMECC 04.11-A
Salt by Electrical Conductivity (EC) (mmhos/cm or ds/m)	< 2.0	ASA Mono. #9, Part 2, Method 10-3.3
Soil SAR (s.u.)	0 – 10	ASA Mono. #9, Part 2, Method 10-3.4
Soil OM (%)	3 – 5	Methods of Soil Analysis, Part 3, Method 34
Soil N (NO ₃ -n, ppm)	≥ 20.0	Methods of Soil Analysis, Part 3. Chemical Methods. Ch. 38 Nitrogen – Inorganic Forms
Soil P (ppm)	≥ 13.0	ASA Mono. #9, Part 2, Method 24-5.4 or others as required based on soil pH
Soil K (ppm)	≥ 80	ASA Mono. #9, Part 2, Method 13-3.5
Rock Content (%) greater than 3” diameter	≤ 25	USDA NRCS Rock Fragment Modifier Usage
Bioassay (seedling emergence and relative vigor)	> 80% of control	TMECC 05.05-A or Approved Germination Test
Soil Texture	No more than 70% clay, silt and sand by percentage volume of topsoil	ASA Mono. #9, Part 1, Method 15-4
Physical contaminants (man-made inerts) (%)	< 1	TMECC 03.08-C
Trace Contaminants (Arsenic, Cadmium, Copper, Mercury, Selenium, Zinc, Nickel, and Lead)	Meets US EPA, 40 CFR 503 Regulations	TMECC 04.06 or EPA6020/ASA (American Society of Agronomy)
All Particle Sizes	< 6 Inches	
C:N ratio	<20	TMECC 05.02-A

The Contractor shall utilize a rod penetrometer for determining subgrade soil preparation and determining looseness of soil after ripping. The penetrometer shall have a psi pressure gage, and shall meet the following requirements:

- (1) Steel rod with a minimum diameter of ½ inch with graduations (tick marks) every 6 inches.
- (2) The rod shall be made of stainless steel or other metal that will not bend when weight is applied.
- (3) The end of the rod shall have a 30-degree cone tip.
- (4) The diameter of the cone at its tip shall be no more than 0.1 inch.
- (5) The top of the rod shall be a T-handled configuration.

REVISION OF SECTION 207
TOPSOIL**CONSTRUCTION REQUIREMENTS**

207.03 Site Pre-vegetation Conference. Prior to the start of the initial Subgrade Soil Preparation for the project, the Contractor shall request a Site Pre-vegetation Conference. The Engineer will set up the conference and will include: the Engineer or designated representative, the Superintendent or designated representative, the sub-contractor(s) performing the subgrade soil preparation and soil amendments, and the CDOT Landscape Architect representing the Region. Only one meeting is required for the project unless a new sub-contractor is brought on that did not attend the previous meeting.

The Agenda of the Pre-vegetation Conference can be found in Appendix A of the Construction Manual and includes the following:

- (1) Final review of the Topsoil (Offsite) Amendment Protocol
- (2) Review of the Method Statement detailing the equipment which will be used for the subgrade soil preparation operations
- (3) Review of rod penetrometer which will be used to determine subgrade soil preparation of topsoil
- (4) Permanent Stabilization Phasing Plan (identify strategies and site management measures to protect de-compacted, topsoil amended, seeded, and blanketed areas from foot, vehicle loads, and other disturbances).
- (5) Seeding. See subsection 212.03 for submittal requirements.
- (6) Meeting attendee sign-in log

207.04 Topsoil Stockpiling. Stockpiles of topsoil shall be created as shown on the plans or as approved by the Engineer. All Stockpiles of topsoil which are scheduled to remain in place for 14 days or more shall receive interim stabilization in accordance with subsection 208.04. All topsoil stockpiles shall be identified using white pin flags with "TOPSOIL" printed in black letters and shall have their locations shown on the SWMP Plans. Each individual stockpile shall require at least one flag, and one additional flag for each 10 cubic yards of salvaged topsoil. The contractor shall provide only perimeter flags for stockpile larger than 100 cubic yards with a minimum spacing of 25 feet.

Topsoil may be placed in stockpiles or windrowed at the edge of the disturbance. Windrowed topsoil shall not be used as perimeter erosion control or extensively compacted. When topsoil is windrowed, all stockpile requirements still apply.

- (1) Upland Topsoil. If included on the plans, stockpiles shall be treated with herbicide, in accordance with Section 217, or as directed.
- (2) Wetland Topsoil. Wetland stockpiles shall not be treated with herbicide. Weeds shall be hand pulled. Wetland topsoil shall be placed within 24 hours from excavation, unless otherwise approved by the Engineer. Wetland topsoil shall not be stockpiled for more than six months.

207.05 Subgrade Soil Preparation. Before placement of topsoil, the subgrade shall be ripped to a minimum depth of 14 inches. Subgrade shall be mostly dry and friable. Subgrade shall crumble without sticking together, yet not be so dry and hard that it does not break apart easily.

Underground utilities shall be located prior to soil preparation.

REVISION OF SECTION 207
TOPSOIL

Subgrade soil preparation equipment shall meet the requirements for either winged tip or parabolic shanks. Operation shall be performed to fracture the soil uniformly without lifting or furrowing the surface excessively. The Contractor shall submit a method statement for subgrade soil preparation other equipment will be considered.

1. Winged tip shanks (dozer equipment) shall be a minimum of 6 inches wide and have 2 inches of vertical profile change on the blade with a 40 – 60-degree sweep angle.

The Contractor shall calibrate the subgrade soil preparation equipment using a minimum 30 linear feet of the initial pass. The Contractor shall utilize the rod penetrometer to verify that that de-compaction was successfully done. The Contractor shall take penetration measurements every 6 inches across a transect perpendicular to the direction of the tractor and spanning the width of the subgrade soil preparation. Depths of penetration shall confirm that a minimum of 12 inches can be achieved without reaching 300 psi on the rod penetrometer pressure gage (approximately 30 pounds of pressure on the T-handle).

Existing subgrade shall be de-compacted to a depth of 14 inches. If multiple passes are needed, the subsequent passes shall be positioned so that the ripping equipment (subsoilers) from the previous pass are split by the subsequent pass. Following ripping, the Contractor shall remove all sticks, stones, debris, clods, and all other substances greater than 6 inches in diameter. The Contractor shall restrict motorized vehicle and foot traffic from passing over the ripped area since this would recompact the areas that received subgrade soil preparation.

The first 4 feet from the edge of pavement shall be ripped to a depth of 6 inches. If the project is going to use aggregate base course or recycled asphalt as a shouldering technique, those areas will not require subgrade soil preparation. Depth of soil ripping for the subgrade soil preparation shall be checked with the rod penetrometer.

The Contractor shall verify adequate de-compaction of the entire area to have topsoil placed using a rod penetrometer in the presence of the Engineer. Tests shall be performed at a minimum of ten random locations per each acre as selected by the Engineer. The Test shall verify that a depth of 12 inches of penetration into the soil can be achieved without reaching 300 psi on the rod penetrometer pressure gage (approximately 30 pounds of pressure on the T-handle). If this depth cannot be achieved for 80 percent of the penetrations, the Contractor shall re-rip the area at no additional cost to the Department.

207.06 Placement of Topsoil and Seeding Media. Topsoil and Seeding Media shall be hauled and placed at the locations disturbed and will be re-vegetated or as shown on the plans. The contractor shall place a minimum thickness of 6 inches and should only be handled when it is dry enough to work without damaging soil structure. Topsoil and Seeding Media shall be placed a minimum depth of twelve (12) inches when placed over riprap as required on the plans. No Topsoil or Seeding Media shall be placed below ordinary high water mark except as otherwise specified in bio-stabilization bank treatments.

Salvaged topsoil placement deeper than 6 inches is allowed if additional approved material is on-site.

Contractor shall place topsoil in a method that does not re-compact subgrade material using low ground-contact pressure equipment, or by excavators and/or backhoes operating adjacent to it.

The final grade shall be free of all materials greater than 4 inches in diameter within the designed clear zone for the project. Equipment not required for revegetation work will not be permitted in the areas of placed topsoil.

Soil amendments, seedbed preparation, and permanent stabilization mulching shall be accomplished within four working days of placing the topsoil on the de-compacted civil subgrades. If placed topsoil is not mulched with permanent stabilization mulch within four working days, the Contractor shall complete interim stabilization methods in accordance with subsection 208.04(e), at no additional cost to the Department. Time to perform the work may be extended for delays due to weather.

REVISION OF SECTION 207
TOPSOIL

METHOD OF MEASUREMENT

207.07 Topsoil material will be measured by the actual number of cubic yards of topsoil placed and accepted. Subgrade soil preparation will be measured by the square yards of subgrade which is ripped and accepted for adequate de-compaction.

BASIS OF PAYMENT

207.08 The accepted quantities measured will be paid for at the Contract unit price for each of the pay items listed below that appear in the bid schedule.

Payment will be made under:

Pay Item	Pay Unit
Topsoil (Onsite)	Cubic Yard
Seeding Media	Cubic Yard
Topsoil (Offsite)	Cubic Yard
Topsoil (Wetland)	Cubic Yard
Subgrade Soil Preparation	Square Yard

Amendments for Topsoil (Onsite) and Seeding Media will be measured and paid for in accordance with Section 212.

Amendments for Topsoil (Offsite) will not be measured and paid for separately, but shall be included in the work.

Noxious Weed Management will be measured and paid for in accordance with Section 217.

Stockpiling or windrowing of topsoil will not be measured and paid for separately, but shall be included in the work.

Testing of Seeding Media and Topsoil (Offsite) will not be measured and paid for separately but shall be included in the work.

Rod penetrometer and associated verification testing of random locations will not be measured and paid for separately, but shall be included in the work.

The Site Pre-vegetation Conference will not be paid for separately, but shall be included in the work.

Additional passes with the ripping equipment to achieve the desired de-compaction will not be measured and paid for separately, but shall be included in the work.

Removing of clods, sticks, stones, debris, concrete, and asphalt in excess of 4 inches in any dimension for all topsoil and Seeding Media used within the designed clear zone for the project will not be measured and paid for separately, but shall be included in the work.

January 20, 2021

REVISION OF SECTION 208
EROSION CONTROL

NOTICE

This is a standard special provision that revises CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Construction Services Branch with formal instructions regarding its use. It is to be used as written without change. Do not use modified versions of this special provision nor use this special provision in a manner other than specified in the instructions unless such use is first approved by the Construction Services Branch. The instructions for use on CDOT construction projects appear below.

Other agencies that use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects.

REVISION OF SECTION 208
EROSION CONTROL

Section 208 of the Standard Specifications is hereby revised for this project as follows:

Delete the last sentence in the 1st paragraph in Subsection 208.10 (b) and replace with the following:

The Contractor's Surveyor shall submit electronically sealed control measure drawings.

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

NOTICE

This is a standard special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Project Development Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use in projects having earthwork disturbances that will be stabilized with vegetation.

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

Section 212 of the Standard Specifications is hereby deleted for this project and replaced with the following:

DESCRIPTION

212.01 This work consists of application of fertilizer, soil amendments, seedbed preparation, and placing seed and sod.

Substitutions from this specification will not be allowed unless submitted in writing to the Engineer and approved by the Region or Headquarters Landscape Architect.

MATERIALS

212.02 Seed, Fertilizers, Soil Conditioners, Mycorrhizae, Elemental Sulfur, and Sod.

(a) *Seed.* Seed shall be delivered to the project site in sealed bags tagged by a registered seed supplier conforming to the requirements of the Colorado Seed Act, CRS 35-27-111(1). Seed used on the project shall not be in the Contractor's possession for more than 30 days from the date of pickup or delivery on the seed vendors packing slip. Bags which have been opened or damaged prior to Engineer inspection will be rejected. The State required legal tags shall remain on the bag until opened and the seed is placed in either the drill or hydraulic seeders in the presence of the Engineer. The Engineer shall remove all tags after seed has been planted. Each seed tag shall clearly show the following:

- (1) Name and address of the supplier
- (2) Botanical and common name for each species
- (3) Lot numbers
- (4) Percent by weight of inert ingredients
- (5) Guaranteed percentage of purity and germination
- (6) Pounds of Pure Live Seed (PLS) of each seed species
- (7) Total net weight in pounds of PLS in the sealed bag
- (8) Calendar month and year of test date

Seeds shall be free from all noxious weed seeds in accordance with Colorado Seed Act (CRS 35-17) prohibited noxious weed seed list.

Weed seed content shall not exceed the requirements in part 7.2 of the Colorado Department of Agriculture's Seed Act Rules and Regulations.

Seed which has become wet, moldy, or damaged in transit or in storage will not be accepted.

Seed and seed labels shall conform to all current State regulations and to the testing provisions of the Association of Official Seed Analysis. Computations for quantity of seed required on the project shall include the percent of purity and percent of germination.

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

The Contractor shall store seed under dry conditions, at temperatures between 35 °F to 90 °F, under low humidity and out of direct sunlight. The Contractor shall provide the location of where seed is stored and access to stored seed locations to the Engineer. Seed stored by the Contractor for longer than 30 days will be rejected.

- (b) *Organic Fertilizer.* Fertilizer derived directly from plant or animal sources shall conform to Colorado Revised Fertilizer Rules 8 CCR 1202-4. Fertilizer shall be uniform in composition and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer's name, address, and nutrient analysis. Fertilizer bags (containers) which arrive at the project site opened, damaged, or lacking a label will be rejected. The Contractor shall only use bulk shipments such as tote bags or super sacks that have a manufacturer's original label and sealed at the manufacturing facility. Fertilizer which becomes caked or damaged will not be accepted. Fertilizer shall be stored according to manufacturer's recommendations in a dry area where the fertilizer will not be damaged.

Organic fertilizer formulation being submitted for use must be registered with the Colorado Department of Agriculture.

Verification tests may be conducted by CDOT on grab samples of organic fertilizer delivered to the site to determine the reliability of bag label analysis and for ingredients which are injurious to plants. If a product of any supplier is found to consistently deviate from the bag level analysis, the acceptance of that product will be discontinued. Copies of the failing test reports will be furnished to the Colorado State Board of Agriculture for appropriate action under the "Colorado Fertilizer Law".

Fertilizer shall be supplied in one of the following physical forms:

- (1) A dry free-flowing granular fertilizer, suitable for application by agricultural fertilizer spreader.
- (2) A homogeneous pellet, suitable for application by agricultural fertilizer spreader. Pellet size shall be 2-3 mm. Smaller may be allowed when Seeding (Native) Hydraulic is shown on the plans.
- (3) A soluble form that will permit complete suspension of insoluble particles in water, suitable for application by power sprayer.

The application rate of the organic fertilizer shall be either as high or low nitrogen (N) fertilizer as shown on the plans.

High N organic fertilizer chemical analysis shall conform to Table 212-1.

Table 212-1
Chemical Analysis for High N Fertilizer

Ingredient	Range	Test Method
Nitrogen (N) (%)	6 - 10	AOAC Official Method 993.13 Nitrogen (Total) in Fertilizers Combustion Method
Phosphorus (P) (%)	1 - 8	AOAC Official Method 960.03 Phosphorus (Available) in Fertilizers
Potassium (K) (%)	1 - 8	AOAC Official Method 983.02 Potassium in Fertilizers

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

Low N organic fertilizer chemical analysis shall conform to Table 212-2.

Table 212-2
Chemical Analysis for Low N Fertilizer

Ingredient	Range	Test Method
Nitrogen (N) (%)	2 - 5	AOAC Official Method 993.13 Nitrogen (Total) in Fertilizers Combustion Method
Phosphorus (P) (%)	3 - 8	AOAC Official Method 960.03 Phosphorus (Available) in Fertilizers
Potassium (K) (%)	1 - 8	AOAC Official Method 983.02 Potassium in Fertilizers

Organic fertilizers shall conform to Table 212-3.

Table 212-3
Organic Fertilizer Properties

Criteria	Range
Moisture content by weight	< 6%

- (c) *Compost (Mechanically Applied)*. Compost shall be suitable for use in Erosion Log (Type 2) and permanent seeding applications. Compost shall not contain visible refuse, other physical contaminants, or substances considered harmful to plant growth. Compost shall be used in accordance with all applicable EPA 40 CFR 503 standards for Class A biosolids including the time and temperature standards. Materials that have been treated with chemical preservatives as a compost feedstock will not be permitted.

The Contractor shall provide material that has been aerobically composted in a commercial facility. Compost shall be from a producer that participates in the United States Composting Council's (USCC) Seal of Testing Assurance (STA) program. The Department will only accept STA approved compost that is tested in accordance with the USCC Test Methods for Examining of Composting and Compost (TMECC) manual.

Verification tests may be conducted by CDOT on grab samples of compost delivered to the site to determine the gradation and physical properties. Testing may be done for indication of ingredients which are injurious to plants. Sampling procedures will follow the STA 02.01 Field Sampling of Compost Materials and 02.01-B Selection of Sampling Locations for Windrows and Piles. If a product is found to consistently deviate from the gradation and property analysis, the acceptance of that product will be discontinued. Copies of the failing test reports will be furnished to the USCC.

1. Compost for permanent seeding soil conditioner locations onsite and application rates shall be as shown on the plans.

Organic matter in compost shall be no more than 2 inches in length.

Compost (Mechanically Applied) for permanent seeding shall meet the gradation and physical properties as shown in Table 212-4 and Table 212-5. The Contractor shall provide a written explanation for compost tested parameters not within the acceptable requirements for review and consideration.

The Contractor shall provide documentation from the composting facility confirming that the material has been tested in accordance with USCC TMECC.

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

Table 212-4
Gradation for Permanent Seeding Compost

Sieve Size	Percent Passing		
	Minimum	Maximum	Test Method
25.0 mm (1")	100		TMECC 02.02-B, "Sample Sieving for Aggregate Size Classification"
19.0 mm (3/4")	90	100	
6.25 mm (1/4")	70	100	

Note: Compost shall be from a producer that participates in the USCC STA program.

Table 212-5
Properties for Permanent Seeding Compost

Compost Parameters	Reported as	Requirements	Test Method
pH	pH units	6.0 - 8.5	TMECC 04.11-A
Soluble Salts (Electrical Conductivity)	dS/m (mmhos/cm)	< 5.0	TMECC 04.10-A
Moisture Content	%, wet weight basis	25% - 50%	TMECC 03.09-A
Organic Matter Content	%, dry weight basis pounds per cubic yard	20% - 50% >240	TMECC 05.07-A
Carbon to Nitrogen Ratio (C:N)		< 15:1	
Man-made Inert Contamination (plastic, concrete, ceramics, metal, etc.)	%, dry weight basis	< 1%	TMECC 03.08-A
Stability (respirometry)	mg CO ₂ -C per g TS per day mg CO ₂ -C per g OM per day (PASS/FAIL) Limits:	8 or below	TMECC 05.08-B
Select Pathogens and weed free	Salmonella < 3 MPN/4 grams of TS, or Coliform Bacteria < 1000 MPN/gram (PASS/FAIL)	Pass	TMECC 07.01-B Fecal Coliforms, or 07.02 Salmonella
Trace Metals	Limits (mg kg ⁻¹ dw basis): Arsenic (As) 41, Cadmium (Cd) 39, Copper (Cu) 1500, Lead (Pb) 300, Mercury (Hg) 17, Nickel (Ni) 420, Selenium (Se) 100, Zinc (Zn) 2800	Pass	TMECC 04.06
Maturity (Bioassay) Percent Emergence	%, (average)	> 80%	TMECC 05.05-A
Relative Seedling Vigor	%, (average)	> 80%	
Use the STA Lab bulk density lb/cu ft as received, multiplied by organic matter % as received, multiplied by 27 to calculate pounds per cubic yard of organic matter.			

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

2. Compost for Erosion Log (Type 2) shall meet the gradation and physical properties as shown in Table 212-6 and Table 212-7.

Table 212-6
Gradation for Erosion Log (Type 2) Compost

Sieve Size	Percent Passing		
	Minimum	Maximum	Test Method
75.0 mm (3")	100		TMECC 02.02-B, "Sample Sieving for Aggregate Size Classification"
25.0 mm (1")	90	100	
9.5 mm (3/8")	10	50	

Note: Organic matter for erosion log compost shall be no more than 4 inches in length. Compost shall be from a producer that participates in the USCC STA program.

Table 212-7
Properties for Erosion Log (Type 2) Compost

Compost Parameters	Reported as	Requirements	Test Method
pH	pH units	6.0 - 8.5	TMECC 04.11-A
Soluble Salts (Electrical Conductivity)	dS/m (mmhos/cm)	< 5.0	TMECC 04.10-A
Moisture Content	%, wet weight basis	< 60%	TMECC 03.09-A
Organic Matter Content	%, dry weight basis	25% - 100%	TMECC 05.07-A
Man-made Inert Contamination (plastic, concrete, ceramics, metal, etc.)	%, dry weight basis	< 0.5%	TMECC 03.08-A
Stability (respirometry)	mg CO ₂ -C per g TS per day mg CO ₂ -C per g OM per day	N/A	TMECC 05.08-B
Select Pathogens and weed free	(PASS/FAIL) Limits: Salmonella < 3 MPN/4 grams of TS, or Coliform Bacteria < 1000 MPN/gram	Pass	TMECC 07.01-B Fecal Coliforms, or 07.02 Salmonella
Trace Metals	(PASS/FAIL) Limits (mg kg ⁻¹ dw basis): Arsenic (As) 41, Cadmium (Cd) 39, Copper (Cu) 1500, Lead (Pb) 300, Mercury (Hg) 17, Nickel (Ni) 420, Selenium (Se) 100, Zinc (Zn) 2800	Pass	TMECC 04.06
Maturity (Bioassay)			
Percent Emergence	%, (average)	N/A	TMECC 05.05-A
Relative Seedling Vigor	%, (average)	N/A	

- (d) *Biotic Soil Amendments (Hydraulically Applied)*. Soil amendments shall be a combination of natural fibers, growth stimulants, and other biologically active material designed to improve seed germination and vegetation establishment as shown in Table 212-8. Biotic soil amendments shall be pre-packaged in ultraviolet and weather resistant packaging and labeled from the manufacturer. Bags (containers) which arrive at the project site opened, damaged, or lacking a label will be rejected. Bulk shipments such as tote

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

bags will be rejected. Biotic soil amendments shall be stored in locations not exceeding 80 °F. Acceptance of material shall be subject to the requirements of the Department's Approved Product List (APL).

The application rate of the biotic soil amendments shall be in accordance with the rates shown on the plans. Use of mulch tackifier (*Plantago Insularis* or pre-gelatinized corn starch polymer) shall be in accordance with Section 213. It shall be used as a wetting agent at a rate of 30 pounds per acre. Biotic soil amendments shall provide a continuous and uniform cover and shall consist of one of the components in Table 212-8 and all of the performance and physical properties in Table 212-9.

Table 212-8
Required Percentage Ranges of Biotic Soil Amendments

Components	Units	Requirement
Professional grade sphagnum peat moss, professional grade reed sedge peat moss or compost that meets the Seal of Testing Assurance Program of the US Composting Council	%, dry weight basis	> 41%
Mechanically processed straw consisting of weed free agricultural straw, flexible flax fiber or rice hulls	%, dry weight basis	< 57%

Table 212-9
Performance and Physical Requirements of Biotic Soil Amendments

Parameters	Reported as	Requirement	Test Method
pH	pH units	5.0 – 7.5	ASTM D1293
Moisture content	%, wet weight basis	10% - 50%	ASTM D 2974
Organic matter content	%, dry weight basis	> 85%	ASTM D586
Carbon Nitrogen Ratio	Ratio C:N	< 38:1	ASTM E1508
Man-made inert contamination	%, dry weight basis	< 1.0%	
Acute Toxicity	(Pass/Fail)	Pass (non-toxic)	ASTM E729-96(2014) or EPA Method 2021.0 or EPA Method 2002.0
Vegetative Minimum		> 400%	ASTM 7322
The Contractor shall provide a CTR with independent laboratory analysis for the required parameters in accordance with subsection 106.13.			

- (e) *Humate*. The Contractor shall provide a screened dry granular form of organic humic and fulvic acid substance. Humate shall be pre-packaged and labeled from the manufacturer. Bags (containers) which arrive at the project site opened, damaged, or lacking label will be rejected. The Contractor shall only use bulk shipments such as tote bags or super sacks that have a manufacturer's original label and sealed at the manufacturing facility. Humate shall be stored in locations not exceeding 80 °F. Humate shall be provided in accordance with the rates shown on the plans. Product shall conform to the parameters in Table 212-10 and Table 212-11.

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

Table 212-10
Screened Size Requirements for Humate

Seeding Method	Reported as	Requirement
Seeding (Native) Drill, Hydraulic and Broadcast	inches	< 1/4

Table 212-11
Performance and Physical Requirements of Humate

Parameters	Reported as	Requirement	Test Method
Organic Matter	%, dry weight basis	>70%	
Fines (material that is finer than the No. 200 (75- μ m) sieve)	%, dry weight basis	<2%	ASTM D7928
pH	pH units	3.0 - 4.5	ASTM D1293
Acute Toxicity	Pass / Fail	Non Toxic	ASTM 7101 or EPA Method 2021 or 2002
Humic and Fulvic Acids	%, dry weight basis	> 70%	A & L Western method; total alkali extractable
Carbon Content	%, dry weight basis	40% - 50%	
Moisture Content	%, dry weight basis	< 20%	
Heavy Metal / Ash Content	%, dry weight basis	< 15%	
The Contractor shall provide a CTR with independent laboratory analysis for the required parameters in accordance with subsection 106.13.			

(f) *Mycorrhizae*. Mycorrhizae shall arrive onsite in original and undamaged packaging. Handling of this material shall follow manufacturer's safety recommendations. Mycorrhizae shall be stored onsite in such a way as to avoid exposure to direct sunlight for more than four hours and to prevent package temperatures to rise above 85 °F. The endo mycorrhizal inoculum shall provide at least 60,000 propagules per pound and shall contain all of the following species and conform to the parameters in Table 212-12:

- (1) *Glomus intraradices* (a.k.a. *Rhizophagus intraradices*)
- (2) *Glomus mosseae* (a.k.a. *Funneliformis mosseae*)
- (3) *Glomus aggregatum* (a.k.a. *rhizophagus aggregatus*)
- (4) *Glomus etunicatum* (a.k.a. *Claroideoglomus etunicatum*)

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

Table 212-12
Physical Requirements of Endo Mycorrhizae

Parameters	Reported as	Requirement	Test Method
Acute Toxicity	Pass or Fail	Non Toxic	ASTM 7101 or EPA Method 2021 or 2002
The Contractor shall provide a CTR with independent laboratory analysis has been done on the product for the required parameters in accordance with subsection 106.13.			

The following rates shall be used for Seeding Methods:

- (1) For Seeding (Native) Drill, the mycorrhizae product shall be provided as a dry free-flowing granular material, suitable for application by agricultural drill seeder. Application rate shall be 8 pounds per acre.
 - (2) For Seeding (Native) Hydraulic, the mycorrhizae product shall be provided as a fine granular (< 2 mm) or powdered form (particle size less than 300 microns) that will permit complete suspension and used with hydro-seeder equipment. Application rate shall be 20 pounds per acre.
 - (3) For Seeding (Native) Broadcast, the mycorrhizae product shall be provided as a dry free-flowing granular material, suitable for application by fertilizer spreader. Application rate shall be 20 pounds per acre.
- (g) *Elemental Sulfur*. The Contractor shall provide a free-flowing granular material consistent in size suitable for application by agricultural spreader and conform to the parameters in Table 212-13. Elemental sulfur shall arrive onsite in original and undamaged packaging.

Table 212-13
Physical Requirements of Elemental Sulfur

Parameters	Reported as	Requirement
Guaranteed Analysis of Elemental Sulfur (S)	%	> 90
Bulk Density	Lbs per cu. ft.	> 75

- (h) *Sod*. Sod shall be nursery grown and 99 percent weed free. Species shall be as shown on the plans. The 1 percent allowable weeds shall not include undesirable perennial or annual grasses or plants defined as noxious by current State statute or county noxious weed list. Soil thickness of sod cuts shall not be less than $\frac{3}{4}$ inch or more than 1 inch. Sod shall be cut in uniform strips with minimum dimensions of 18 inches in width and 48 inches in length. The Contractor shall submit a sample of the sod proposed for use, which shall serve as a standard if approved. Sod furnished, whether in place or not, that is not up to the standard of the sample will be rejected. CDOT will reject all sod that was cut more than 72 hours prior to installation.

Each load of sod shall be accompanied by a certificate from the grower stating the type of sod and the date and time of cutting. The Contractor shall submit the certificate to the Engineer prior to application of the sod. Only sod that is accompanied by the certificate from the grower will be accepted and paid for.

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

CONSTRUCTION REQUIREMENTS

212.03 Submittals. The Contractor shall provide the name and contact information of the seeding contractor 30 days prior to start of seeding work. The Contractor shall provide two copies of items (1) - (14) listed below to the Pre-vegetation Conference in accordance with Section 207. When the Contractor provides resubmittals to meet Contract requirements, the Region or Headquarters Landscape Architect shall be copied on all correspondence.

- (1) Written confirmation from the registered seed supplier, on the Contractor's letterhead, that the Contract specified seed has been secured. No substitutions of the contract specified seed will be permitted unless evidence is submitted, from one of the registered seed suppliers that the Contract specified seed is not available and will not become available during the anticipated construction period.
- (2) Seed vendor's "seed dealer" endorsement.
- (3) A copy of each seed species germination report of analysis that verifies the lot has been tested by a recognized laboratory for seed testing within 13 months prior to the date of seeding.
- (4) A copy of each seed species purity laboratory report of analysis that verifies that the lot has been tested by a recognized laboratory for seed testing. The report shall list all identified species, seed count, and date of test.
- (5) Manufacturer's documentation stating that the fertilizer meets the Contract requirements.
- (6) Organic fertilizer documentation showing manufacturer and chemical analysis.
- (7) Permit issued from CDPHE confirming that the vendor can produce or sell compost in accordance with House Bill (HB) 1181.
- (8) Documentation from the compost manufacturer that it is a participating member of in the U.S. Composting Council's Seal of Testing Assurance Program (STA).
- (9) Results of compost testing on an STA Compost Technical Data Sheet confirming all required test methods are met using the STA Program.
- (10) Sample of physical compost (at least one cubic foot of material).
- (11) Manufacturer's documentation confirming that biotic soil amendment meets the required physical and performance criteria based on independent testing by the manufacturer.
- (12) Manufacturer's documentation confirming that humate meets the required physical and performance criteria based on independent testing by the manufacture.
- (13) Manufacturer's documentation confirming that mycorrhizae meets the physical criteria based on independent testing and that the minimum required species is provided.
- (14) Pictures and descriptions of seeding equipment proposed to be used on the project. Based on the seeding methods required at a minimum this should include the drill seeder, hydraulic seeder, cultipacker or seed bed roller implements.
- (15) Instructions and documentation on how seeders will be calibrated onsite, in accordance with subsection 212.05(a).

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

212.04 Seeding Seasons. Seeding in areas that are unirrigated shall be restricted according to the parameters in Table 212-14.

**Table 212-14
Seeding Seasons**

Zone	Spring Seeding	Fall Seeding
Areas other than the Western Slope		
Below 6000'	Spring thaw to June 1	September 15 until consistent ground freeze
6000' - 7000'	Spring thaw to June 1	September 1 until consistent ground freeze
7000' - 8000'	Spring thaw to July 15	August 1 until consistent ground freeze
Above 8000'	Spring thaw to consistent ground freeze	
Western Slope		
Below 6000'	Spring thaw to May 1	August 1 until consistent ground freeze
6000' - 7000'	Spring thaw to June 15	September 1 until consistent ground freeze
Above 7000'	Spring thaw to consistent ground freeze	

- (1) "Spring thaw" is the earliest date in a new calendar year in which seed can be buried ½ inch into the surface soil (topsoil) through normal drill seeding methods.
- (2) "Consistent ground freeze" is the time during the fall months in which the surface soil (topsoil), due to freeze conditions, prevents burying the seed ½ inch through normal drill seeding operations. Seed shall not be sown, drilled, or planted when the surface soil or topsoil is in a frozen or crusted state.

Seeding accomplished outside the time periods listed above will be allowed only when the Contractor's request is approved by the Engineer in writing, with coordination from the Region Landscape Architect. If requested by the Contractor, the Contractor must agree to perform the following work at no cost to the Department: reseed, remulch, and repair areas which fail to produce species indicated in the Contract.

If seeding is ordered by the Engineer outside the time periods listed above, the cost to repair areas that fail to produce species will be paid for by the Department.

212.05 Native Seeding Methods. Areas to be seeded shall be installed in accordance with SWMP Permanent Stabilization Plan.

All amendments and seeding shall be applied based on the seeding method and rates specified on the plans.

The Contractor shall complete the Amendments Verification Prerequisite for each of the seeding methods described herein. This shall be done by completing a Seed and Amendment Quantities Worksheet for each work area. This worksheet shall have a list of all amendments and the seed labels for each of the areas to be worked on. The State required legal tags shall remain on the bag until opened and the seed placed in either the drill or hydraulic seeders in the presence of the Engineer. Seeding work shall not begin until written approval of the worksheet has been received from the Engineer.

In determining the weight of seed required for each work area, the Contractor shall use the Pure Live Seed (PLS) weight shown on each bag of seed. Calculations based on net weight will not be accepted.

The Contractor shall submit a proposed Permanent Stabilization Phasing Plan to the Engineer prior to the Pre-revegetation Conference for approval showing how the SWMP Permanent Stabilization Plans will be implemented to minimize traffic loading damage to subgrade soil prepared and seeded areas. The proposed

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

sequencing shall consider and identify strategies and site management control measures to protect seeded areas from foot, vehicle, and other disturbances. The strategic planning of the permanent seeding and mulch shall consider all other phasing of construction activities including traffic management and utility work. Areas damaged due to the Contractor's failing to protect the seeded areas shall be repaired at no cost to the Department. Seeded areas damaged due to circumstances beyond the Contractor's control shall be repaired and reseeded as ordered. Payment for corrective work, when ordered, shall be at the Contract prices shown and in accordance with subsection 109.04.

The following seeding application methods shall not be implemented during winds which are consistently higher than 20 MPH, or when the ground is frozen, excessively wet, or otherwise untillable. The Engineer may test to see if the moisture level in the soil is acceptable to work the soil by performing a Soil Plasticity Test as described in the Construction Manual. Multiple seeding operations shall be anticipated, based on acceptable seeding conditions. The seeding methods to be implemented shall be one or more of the following, as shown on the plans:

(a) *Seeding (Native) Drill.*

- (i) *Fertilizer, Compost, Humates and Elemental Sulfur.* The Contractor shall uniformly apply compost and elemental sulfur on the surface of the topsoil using an agricultural spreader at the rate of application specified on the plans. All competitive, non-native vegetation shall be uprooted and hauled offsite prior to spreading amendments. Prior to starting incorporation of compost and elemental sulfur, the Contractor shall receive written acceptance from the Engineer on the Seed and Amendment Quantities Worksheet. Verification Prerequisite for this method also requires documentation on the Permanent Stabilization SWMP Site Maps with the approved areas outlined, signed, and dated by the Engineer to track progress. If SWMP Site Maps are not included in the Contract, the Contractor shall use the Contract grading or roadway plan sheets.

Once the Quantities Verification Prerequisite is completed for an area, the Contractor shall homogeneously incorporate the compost and elemental sulfur into the top 6 inches of topsoil. Tillage of the amendments shall be completed using a disc and harrow, field cultivator, vibra-shank, or other method suitable to site conditions. For small areas tillage shall be completed using rotary tillers. No measurable depth of organic amendment shall be present on the surface.

The shanks on the back of a grader or dozer shall not be used for tillage. Tillage may take multiple passes to achieve the desired harmonious incorporation. If multiple passes are required, the Contractor shall cross till the soil with the second pass occurring at a 30-degree angle to the first pass. On slope areas, all tillage shall be parallel to the contour. For project that will utilize aggregate or recycled asphalt shouldering material amendments, tillage is not required under shouldering material. Projects seeding up to the edge of pavement, tillage is not required for first 12" from the edge of pavement.

Once incorporation of compost and elemental sulfur is approved, the Contractor shall uniformly apply fertilizer and humates on the surface of the topsoil using an agricultural spreader, as shown in the Contract documents.

- (ii) *Seedbed Preparation.* Amended topsoil shall be cultivated to a firm but friable seedbed using cultipacker or seed bed roller implements. Crusted hard soils shall be broken up and all areas shall be free of clods, sticks, stones, debris, concrete, and asphalt in excess of 4 inches in any dimension in accordance with Section 207. Areas shall be left in a rough and uncompacted condition with a surface variance of 2 to 4 inches.
- (iii) *Seed and Mycorrhizae.* Prior to seeding, the finished grade of the soil shall be 1 inch below the top of all curbs, junction and valve boxes, walks, drives and other structures. Seeding shall be done within two

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

days of seedbed preparation efforts (tilling or scarifying). If a rain event occurs that compacts or erodes the seedbed prior to performing seeding, the seedbed shall be re-prepared as directed by the Engineer.

Areas shall be seeded by mechanical power drawn drills suitable for area soils, topography, and size followed by packer wheels. Mechanical power drawn drills shall have furrow openers and depth bands set to maintain a planting depth of at least ¼ inch and not more than ½ inch and shall be set to space the rows not more than 8 inches apart. Seeding equipment shall have a double disk opener, seed box agitator, and seed metering device.

The seeder shall be calibrated by collecting seed from a single drop tube in the presence of the Engineer based on the following procedure. The Contractor shall provide the tape measure, scale, collection cup, and seed bag with complete label from the supplier. The Contractor may submit an alternative method for approval at the site Pre-vegetation Conference.

- (1) Measure the total width (W) of the drill seeder in feet.
- (2) Count the number of drill rows (N) on the seeder.
- (3) On drill seeders that the tire drives the seeding mechanism, measure the tire circumference (C) in feet.
- (4) Calculate the number of rotations the tire will complete per acre using the following equation:
 - A = one acre or 43,560 square feet (SF)
 - A / W = feet (F) the drill seeder needs to travel for each acre
 - F / C = number of rotations (R) of the tire per acre
- (5) Reduce the amount of tire rotations by one tenth.
 - $.90R = \# \text{ Tire rotations to calibrate seeder (RCS)}$
- (6) Find the seeding rate (LBS PLS / Acre) on the Stormwater Management Plan.
- (7) Using the information from the seed tag, convert the PLS seed rate to a bulk seeding rate using the following equations:
 - $\% \text{ PLS} = (\% \text{ purity (in decimal form) from seed label}) \times (\% \text{ germination (in decimal form) from seed label})$
 - $(\text{LBS PLS} / \text{Acre}) \text{ from the SWMP} / \% \text{ PLS} = \text{Required bulk seed per acre in LBS}$
- (8) Reduce the required bulk seed per acre based on the number of seeder tubes.
 - $\text{Required bulk seed per acre} / N = \text{Weight in LBS of bulk seed from one tube}$
- (9) Reduce the required bulk seed rate from the tube by one tenth.
 - $0.90 \times \text{Weight of bulk seed from one tube} = \text{Collected bulk seed weight (CBS) in LBS}$
- (10) Set the drill seeder to the correct seeding rate using the manufacturer's recommendation.
- (11) With the collection cup under one tube and the driving wheel jacked up, rotate the tire the RCS amount of times. Use the value stem to count the rotations.
- (12) Using the scale, weigh the seed in the collection cup.
- (13) Adjust the drill calibration until the weight of bulk seed in the collection cup equals the CBS in LBS.

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

Drill seeders shall be recalibrated every time the drill is mobilized onsite. The Contractor shall submit a written statement that the equipment is calibrated, and shall provide the correct depth based on conditions before seeding actions are initiated. The Contractor shall continuously monitor equipment to ensure that it is providing a uniform seed application.

If mycorrhizae is called for on the plans, the granules shall be included with the seed in the drill seeder such that the mycorrhizae is placed at or below the seed.

The distance between furrows produced using the drill shall not be more than 8 inches. If rows on the drill exceed 8 inches, the Contractor shall drill the areas twice (if achievable at 30-degree angles to each other) at no additional cost to the Department.

After seeding, the furrows that were created by the drill shall be maintained in place. Construction traffic, other than what is needed to mulch the areas, shall not be permitted on the areas completed.

Permanent stabilization mulching shall be accomplished within 24 hours of drill seeding.

(b) *Seeding (Native) Hydraulic.*

This method utilizes water as the carrying agent and mixes biotic soil amendments, seed, organic fertilizer, humates, mycorrhizae and elemental sulfur into a single slurry for hydraulic application. The Contractor shall furnish and place combined slurry with a hydro-seeder that will maintain a continuous agitation and apply homogenous mixture through a spray nozzle. The pump shall produce enough pressure to maintain a continuous, non-fluctuating spray that will reach the extremities of the seeding area. Water tanks shall have a means of measuring volume in the tank. Seed shall be added to the slurry onsite, no more than 60 minutes before starting application. Slurry shall be applied from a minimum of two opposing directions to achieve complete soil coverage.

The application of the single slurry shall be applied within four hours of adding Mycorrhizae.

The Contractor shall prevent seed, fertilizer, and mulch from falling or drifting onto areas occupied by rock base, rock shoulders, plant beds, or other areas where grass is detrimental. The Contractor shall remove material that falls on plants, roadways, gravel shoulders, structures, and other surfaces where material is not specified.

- (i) *Seedbed Preparation.* All areas shall be loosened to at least 6 inches, leaving the surface in rough condition with a surface variance of 6 to 8 inches. On steep slopes, tillage shall be accomplished with appropriate equipment as the slope is constructed. Soil areas shall be tilled to produce loose and friable surfaces with crusted hard soils broken up. All slopes shall be free of clods, sticks, stones, debris, concrete, asphalt and all other materials in excess of 4 inches in any dimension. All competitive, non-native vegetation shall be uprooted and hauled offsite prior to spreading amendments. Under no circumstances shall the ground surface be smooth and compacted.
- (ii) *Biotic Soil Amendment, Fertilizer, Humate, Mycorrhizae and Seed.* The Contractor shall assemble all materials for proposed areas to hydro-seed and review quantities with area of coverage with the Engineer as the Quantities Verification Prerequisite for this method. Prior to mixing in the tank, the Contractor shall receive written acceptance from the Engineer on the Seed and Amendment Quantities Worksheet that the correct quantities are onsite. This quantities verification prerequisite also requires documentation on the Permanent Stabilization SWMP Site Maps with the approved areas outlined, signed, and dated by the Engineer to track progress. If SWMP Site Maps were not included in the Contract, grading or roadway plan sheets shall be used. For the verification process, the Contractor shall provide the Engineer

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

with all documentation for materials in unopened packaging.

After the Quantities Verification Prerequisite has been approved, the hydro-seeder shall be filled with water to 1/3 of its required volume. Following this, water and biotic soil amendments shall be added to the hydro-seeder at a consistent rate. The ratio of water to Biotic Soil Amendments shall be in accordance with manufacturer's recommendations. Fertilizer, humates and mycorrhizae shall then be added until the tank has reached 3/4 of its required volume. The tank shall then be filled with water to the required volume. Uniform slurries shall be agitated or mixed for a minimum of ten minutes after all water and materials are in the tank.

Hydraulic seeding equipment shall include a pump capable of being operated at 100 gallons per minute and at 100 pounds per square inch pressure. The equipment shall have a nozzle adaptable to hydraulic seeding requirements. Storage tanks shall have a means of estimating the volume used or remaining in the tank.

Seed shall be added to the slurry onsite no more than 60 minutes before starting application. The Contractor shall increase the Seed Plan rates (LBS PLS / Acre) as shown on the plans by 1.5 times at no additional cost to the Department. The Contractor may be required to apply slurry using multiple hoses to ensure uniform application to all areas of the site. Coverage rates shall be based on the volume of material in the tank, as verified by the Engineer. Areas of lighter applications (covering more area than what is calculated) will require additional application, as directed.

An appropriate curing period shall be in accordance with manufacturer's recommendations, and shall consider forecasted weather conditions.

Permanent stabilization mulching shall be accomplished within 24 hours of hydraulic application of native seed.

(c) *Seeding (Native) Broadcast.*

This method utilizes hand equipment to broadcast spread amendments and seed over prepared seedbeds.

- (i) *Fertilizing, Compost, Humate and Elemental Sulfur.* The Contractor shall uniformly apply compost and elemental sulfur on the surface of the placed topsoil using an agricultural spreader at the rate of application specified on the plans. All competitive non-native vegetation shall be uprooted and hauled offsite prior to spreading amendments. Prior to starting incorporation, the Contractor shall receive written acceptance from the Engineer on the Seed and Amendment Quantities Worksheet that the correct quantities will be applied. The Quantities Verification Prerequisite for this method also requires documentation on the Permanent Stabilization SWMP Site Maps with the approved areas outlined, signed, and dated by the Engineer to track progress. If SWMP Site Maps are not included in the Contract, the grading or roadway plan sheets shall be used.

Once the Quantities Verification Prerequisite is completed for an area, the Contractor shall homogeneously incorporate the Compost into the top 6 inches of soil. Tillage of the amendments shall be completed using appropriate tools depending on the size of the area to be worked. Contractor shall use hand tillers or approved small space implements.

Once incorporation of compost and elemental sulfur is approved, the Contractor shall uniformly apply organic fertilizer and humates on the surface of the topsoil using an agricultural spreader.

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

- (ii) *Seedbed Preparation.* Amended topsoil shall be cultivated to a firm but friable seedbed using tractor implements. Crusted hard soils shall be broken up and all areas shall be free of clods, sticks, stones, debris, concrete, and asphalt in excess of 4 inches in any dimension in accordance with Section 207. Areas shall be left in a rough condition with a surface variance of 2 to 4 inches. Under no circumstances shall the ground surface be smooth and compacted.
- (iii) *Seed and Mycorrhizae.* Prior to seeding, the finished grade of the soil shall be 1 inch below the top of all curbs, junction and valve boxes, walks, drives and other structures. Seeding shall be accomplished within two days of seedbed preparation efforts (tilling or scarifying) to make additional seedbed preparation unnecessary. If a rain event occurs that compacts or erodes the seedbed prior to performing seeding, the seedbed shall be re-prepared as directed.

Areas shall be seeded by broadcast-type seeders (cyclone or approved mechanical seeders). The Contractor shall increase the Seed Plan rates (LBS PLS / Acre) as shown on the plans by 1.5 times at no additional cost to the Department.

After seeding, mycorrhizae shall be evenly hand-distributed across the area. Seed and mycorrhizae shall be covered by hand raking and covering with ¼ to ½ inch of topsoil. To ensure seeds have a firm contact with the soil the Contractor shall use a heavy roller as approved in the Site Pre-vegetation Conference. Mycorrhizae shall not be exposed to sunlight for more than four hours. Using equipment with continuous cleat tracks (cat-tracking) to cover seed is not permitted.

Permanent stabilization mulching shall be accomplished within 24 hours of broadcast seed application of native seed.

212.06 Seeding (Temporary). Areas of topsoil shall be seeded with annual grasses in accordance with SWMP Interim Site Maps or as directed by the Engineer.

Seeding may take place at any time during the year as long as the ground is not covered in snow and topsoil is not frozen. Topsoil may be placed in a stockpile or distributed on-grade after receiving subgrade soil preparation.

Interim stabilization for areas that receive temporary seeding shall be in accordance with subsection 208.04(e)2. Seed shall not be included with interim hydraulic mulch applications.

The Contractor shall wait to amend topsoil until the area is ready for permanent seeding with native seed mix shown on the SWMP. The Contractor shall use either the drill, hydraulic, or broadcast method of seeding. Seeding rates (LBS PLS / Acre) shall be increased by 1.5 times for hydraulic and broadcast methods at no additional cost to the Department.

Seed shall meet the requirements of 212.02(a) and shall be selected from Table 212-1 based on the application time.

Table 212-1
Temporary Seed Mixes

Common Name	Botanical Name	Application Time	Seeding Rates (LBS PLS / Acre)	Planting Depth (inches)
Oats	<i>Avena sativa</i>	October 1 - May 1	35	1 - 2
Foxtail Millet	<i>Setaria italica</i>	May 2 - September 30	30	1/2 - 3/4

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

The Contractor shall restrict motorized vehicle and foot traffic from areas that have received temporary seeding.

212.07 Seeding (Lawn). Lawn grass seeding shall be accomplished in the seeding seasons in accordance with subsection 212.03.

- (a) *Fertilizing and Soil Conditioning.* The first application of fertilizer, soil conditioner, or both shall be incorporated into the soil immediately prior to seeding, and shall consist of a soil conditioner, commercial fertilizer, or both as designated in the Contract. Fertilizer called for on the plans shall be worked into the top 4 inches of soil at the rate specified in the Contract. Biological nutrient, culture, or humate based material called for on the plans shall be applied in a uniform application onto the soil service. Organic amendments shall be applied uniformly over the soil surface and incorporated into the top 6 inches of soil.

The second application of fertilizer shall consist of a fertilizer having an available nutrient analysis of 20-10-5 applied at the rate of 100 pounds per acre. It shall be uniformly broadcast over the seeded area three weeks after germination or emergence. The area shall then be thoroughly soaked with water to a depth of 1 inch.

Fertilizer shall not be applied when the application will damage the new lawn.

- (b) *Seedbed Preparation.* In preparation of seeding lawn grass, irregularities in the ground surface, except the saucers for trees and shrubs, shall be removed. Measures shall be taken to prevent the formation of low places and pockets where water will stand.

Immediately prior to seeding, the ground surface shall be tilled or hand worked into an even and loose seedbed to a depth of 6 inches, free of clods, sticks, stones, debris, concrete, and asphalt in excess of 2 inches in any dimension, and brought to the desired line and grade.

- (c) *Seeding.* Seed shall be drilled with mechanical landscape type drills. Broadcast type seeders or hydraulic seeding will be permitted only on small areas not accessible to drills. Seed shall not be drilled or broadcast during windy weather or when the ground is frozen or untillable.

212.08 Sodding.

- (a) *Fertilizing and Soil Conditioning.* Prior to laying sod, the 4 inches of subsoil underlying the sod shall be treated by tilling in fertilizer, compost, or humates as specified on the plans. Amendments shall be applied uniformly over the soil surface and incorporated into the top 6 inches of soil.

After laying the sod, it shall be fertilized with a fertilizer having a nutrient analysis of 20-10-5 at the rate of 200 pounds per acre. Fertilizer shall not be applied when the application will damage the sod.

- (b) *Soil Preparation.* Prior to sodding, the ground shall be tilled or hand worked into an even and loose sod bed to a depth of 6 inches, and irregularities in the ground surface shall be removed. Sticks, stones, debris, clods, asphalt, concrete, and other material more than 2 inches in any dimension shall be removed. Depressions or variances from a smooth grade shall be corrected. Areas to be sodded shall be smooth before sodding occurs.

- (c) *Sodding.* Sod shall be placed by staggering joints with all edges touching. On slopes, the sod shall run approximately parallel to the slope contours. Where the sod abuts a drop inlet, the subgrade shall be adjusted so that the sod shall be 1-½ inches below the top of the inlet.

Within one hour after the sod is placed and fertilized it shall be watered. After watering, the sod shall be permitted to dry to the point where it is still wet enough for effective rolling. The Contractor shall roll the sod in two directions with a lawn roller capable of applying between 50 - 80 pounds per square inch of surface pressure to eliminate air pockets.

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

METHOD OF MEASUREMENT

212.09 The quantities of lawn seeding and the three native seeding types will not be measured but shall be the quantities designated in the Contract, except that measurements will be made for revisions requested by the Engineer, or for discrepancies of plus or minus five percent of the total quantity designated in the Contract.

The quantity of sod will be by the actual number of square feet, including soil preparation, water, fertilizer, and sod, completed and accepted.

Organic Fertilizer, Compost (Mechanically Applied), Humates, Mycorrhizae soil amendments for Seeding (Native) methods drill, hydraulic, and broadcast will be measured by the actual quantity of material applied and accepted.

Measurement for acres will be by slope distances.

BASIS OF PAYMENT

212.10 The accepted quantities of lawn seeding, native seeding, soil conditioning, and sod will be paid for at the contract unit price for each of the pay items listed below that appear in the bid schedule. Rejected seed that has been stored longer than 30 days shall be re-ordered at the expense of the Contractor.

Payment will be made under:

Pay Item	Pay Unit
Organic Fertilizer	Pound
Compost (Mechanically Applied)	Cubic Yard
Biotic Soil Amendments (Hydraulic Applied)	Pound
Humate	Pound
Mycorrhizae	Pound
Elemental Sulfur	Pound
Seeding (Native) Drill	Acre
Seeding (Native) Hydraulic	Acre
Seeding (Native) Broadcast	Acre
Seeding (Wetland) Drill	Acre
Seeding (Wetland) Hydraulic	Acre
Seeding (Wetland) Broadcast	Acre
Seeding (Temporary)	Acre
Seeding (Lawn)	Acre
Sod	Square Foot

Topsoil preparation including incorporating and applying amendments, seedbed preparation, water, and seed mix (LBS PLS / Acre) will not be measured and paid for separately but shall be included in the work.

Calibrating, adjusting, or readjusting seeding or fertilizing equipment will not be measured and paid for separately but shall be included in the work.

No additional cost will be accepted for approved substitution of specified seed mix.

No payment will be made for areas seeded using one of the seeding methods without receiving signed Seed and Amendment Quantities Worksheet from the Engineer.

REVISION OF SECTION 212
SOIL AMENDMENTS, SEEDING, AND SODDING

Additional seedbed preparation prior to seeding to correct compaction or erosion from storm events will not be measured and paid for separately but shall be included in the work.

Additional mobilizations as needed to complete seeding within allowed seeding seasons will not be measured and paid for separately but shall be included in the work.

Removal of all competitive, non-native vegetation prior to spreading amendments will not be measured and paid for separately but shall be included in the work.

July 9, 2020

REVISION OF SECTION 214
NURSERY STOCK CONTAINERS AND UNROOTED CUTTINGS

NOTICE

This is a standard special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Project Development Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use in projects having earthwork disturbances that will be stabilized with vegetation.

REVISION OF SECTION 214
NURSERY STOCK CONTAINERS AND UNROOTED CUTTINGS

Delete and replace Section 214 of the Standard Specifications with the following:

DESCRIPTION

214.01 This work consists of furnishing all plants, labor, materials and equipment to install herbaceous and woody plant material, hereinafter referred to as “nursery stock”. The work may also consist of obtaining live “unrooted cuttings” from approved donor plants and installing them on the site as shown on the plans.

All approvals and direction required from the Engineer in this specification will involve the Engineer working directly with Region or Headquarters Environmental Staff, as identified in the Contract.

MATERIALS

214.02 Nursery Stock and unrooted cuttings shall be of the minimum sizes and species as designated on the plans, in healthy condition with normal well-developed branch and root systems, and shall conform to the requirements of the *American Standard for Nursery Stock* (ANSI Z60.1-2014). For specified deep rooted container stock the container class volume ranges shall be substituted with the requirements of this specification. See subsection 1.1.3.3 of the American Standard for Nursery Stock regarding unclassified containers.

All nursery stock and unrooted cuttings shall be free from plant diseases and insect pests. All shipments of plants shall comply with all nursery inspection and plant quarantine regulations of the State of origin and destination, and the Federal regulations governing Interstate movement of nursery stock. The Contractor shall submit proof of deposit that nursery stock, Contract species and Contract quantity have been secured 30 days post Environmental Pre-Construction Conference. For multi-year projects (two or more continuous years) the contractor shall submit a schedule for approval documenting when proof of deposits on nursery stock will be provided.

The minimum acceptable sizes of all nursery stock, with branches in normal position, shall conform to the measurements specified in the Landscape/Mitigation Plans.

Hardiness zones are defined in U.S. Department of Agriculture (USDA) 2012 Plant Hardiness Zone Map publications. Only Nursery Stock rated for USDA Hardiness Zones 2, 3, 4, and 5 will be accepted.

Other than approved unrooted cuttings or as otherwise approved by the Engineer, plants shall be nursery grown for at least one growing season, or plants that have established themselves in accordance with definitions set forth in the Colorado Nursery Act, Title 35, Article 26, CRS.

Field collected trees and shrubs shall have been root-pruned during their growing period in the nursery in accordance with standard nursery practice outlined in the American Standard for Nursery Stock.

No species substitutions are permitted without written approval. If nursery stock of acceptable quality and specified variety or size are not available, before any species substitutions will be approved the Contractor shall supply to the Engineer three written letters from nurseries verifying that a species or plant size is not available. Once three letters are provided, the Contractor Shall with Engineer’s written approval:

- (1) Substitute acceptable nursery stock that are larger than specified at no change in Contract price. For deep rooted nursery stock, the minimum depth requirement of the container must be maintained as stated in this specification.
- (2) Substitute smaller plants than those specified on the Landscape/Mitigation Plans at the adjusted price or ratio stated in the written approval.
- (3) Substitute of plants of different genus, species or variety shall be submitted to the Engineer for approval 30 days prior to installation at the adjusted price stated in the written request.

REVISION OF SECTION 214
NURSERY STOCK CONTAINERS AND UNROOTED CUTTINGS

At the Environmental Pre-construction Conference, the Contractor shall name the nursery stock supplier for all items. Nursery stock will be rejected for not meeting the Contract at any of the four following times and locations:

- (1) At the nursery stock supplier's location during inspection. The Engineer will notify the contractor when the nursery stock will be inspected.
- (2) On the project site at the time of delivery, prior to planting.
- (3) At the time of installation.
- (4) At the partial or final acceptance walkthroughs on the project site.

Plant materials supplied by the Contractor shall be inspected by the Engineer at the growing site and tagged or otherwise approved for delivery. Inspection at nursery does not preclude right of rejection at construction site. Contractor shall remove rejected materials immediately from the site at Contractors expense. The Contractor shall ensure that all nursery materials meet the requirements of this Section prior to delivery.

Proposed materials shall be flagged at the nurseries by the Contractor prior to viewing by the Engineer. The Contractor shall schedule with the Engineer a time for viewing plant material at the nursery. Trips to nurseries shall be efficiently arranged to allow Engineer to maximize his viewing time. A minimum of two weeks shall be allowed for this viewing prior to time that plants are to be dug. When requested by the Engineer photographs of plant material or representative samples of plants shall be submitted. Viewing of plant materials by the Engineer at the nursery does not preclude their right to reject material at the site of planting.

The Contractor shall notify the Engineer at least three working days in advance of the anticipated delivery date of any plant material. The Contractor shall submit an invoice for each shipment of plants showing the quantities, kinds, and sizes of materials along with the certificate of inspection. Evidence of inadequate protection of plant material following digging, transit, storage or other handling will be cause for rejection. Upon arrival at the temporary storage location or work site, plants shall be inspected for proper handling (including but not limited to shipping procedures) in the presence of the Engineer for damage, including but not limited to dried out roots, broken branches, broken or loosened root balls, or torn bark. The Contractor shall replace the damaged material at his own expense.

Container grown nursery stock shall have a well-established root system reaching the sides and bottom of the container to provide a firm mass of growing medium, but shall not be root bound (i.e. have excessive root growth encircling the inside of the container). Bare root material will not be accepted as a substitution for nursery stock specified as container or balled and burlapped specified nursery stock.

Each species shall be identified by means of grower's label affixed to the plant. The grower's label shall include the data necessary to indicate conformance to specifications. For minimum plant requirements of height, width, minimum multi stems and root ball diameter as appropriate for the specified species type see the Plant Schedule on the Plans.

- (a) *Nursery stock.* Contractor shall file copies of certificates after acceptance of material. Evidence of inadequate protection following digging, carelessness while in transit, or improper handling or storage, will be cause for rejection. When a plant has been rejected, the Contractor shall remove it from the area of the work and replace it with one of the required size and quality conforming to one of the following:
 - (1) Deep Rooted Containers (DRC) shall be containers for growing native plants that are narrower in diameter and longer than standard nursery pots of equal volume. Containers must have physical "anti-spiraling" features such as vertical ribs on the inside walls or side slits in the sidewalls that will air-prune roots. Containers that have been treated with compounds such as copper to chemically prune the roots will not be accepted. Deep rooted container classifications shall have the following properties:

REVISION OF SECTION 214
 NURSERY STOCK CONTAINERS AND UNROOTED CUTTINGS

Deep Rooted Container Class Specification	Minimum Height (Inches)	Minimum Volume (CU. IN.)
DRC #10	8"	10
DRC #40	9"	40
DRC #60	13"	60
DRC #180	14"	180
DRC #300	29"	300

- (2) Standard Nursery Practice Containers (SNC) shall conform to the recommended specification in the *American Standard for Nursery Stock* (ANSI Z60.1-2014). For minimum plant requirements of height or width as appropriate for the specified species type see the Plant List on the drawings. SNC classifications shall have the following properties:

Standard Container Class Specification	Acceptable Volume Range (CU. IN.)
#1	152-251
#5	785-1242
#10	2080-2646
#20	4520-5152

- (3) Balled and burlapped or large container shall conform to the recommended specifications in the *American Standard for Nursery Stock* (ANSI Z60.1-2014). Single stem deciduous tree caliper measurements shall be taken six inches above the ground for field grown stock and from soil line for container grown stock. Multi-stem deciduous tree and evergreen tree height measurement shall be from ground level for field grown and from soil line for container grown stock.

- (b) *Unrooted Cuttings*. Unless otherwise authorized, the Contractor shall notify the Engineer at least five working days in advance of the anticipated start of harvesting cuttings. All cuttings shall be harvested from approved parent material. Approval of parent material shall be in writing from the Engineer. This approval will include a detailed description of the approved locations. The Contractor shall select a site, and if outside of the construction boundary, provide written approval from the Owner, when applicable, for access and harvesting the required number of cuttings. The harvesting site shall be left clean and tidy, to the satisfaction of the Engineer and the Owner, when applicable. Unused material including trimmings shall be cut up to 2 feet in length and evenly distributed around the wetland mitigation site.

Unrooted cuttings shall be harvested and planted in early spring (March 1st to April 15th) while the plants are still dormant. However, the Engineer may authorize an alternative harvesting and planting timeframe based on project timing. Immediately upon harvesting, all cuttings shall be placed in water so that the cut ends are covered in water, and the cuttings shall be stored in a cool location. Plants shall be completely submerged in containers with water if not planted within 24 hours of harvesting. The containers shall be continuously shaded and protected from the wind. Cuttings shall be protected from drying at all times. During transportation, the cuttings shall be kept completely submerged in containers with water in orderly fashion to prevent damage and to facilitate handling. Cuttings should be bundled using natural twine or flexible staking tape (and not with wire) in uniform groups of 25-100 to allow for easy tracking of quantities.

- (1) *Live Willow Stakes* – Shall be unrooted cuttings approximately 3 feet long and between ½ and 1-inch in diameter. All side branches must be trimmed. Willow cuttings shall be cut from branches with smooth undamaged bark. Branches with thick, cracked bark shall not be used because they will not

REVISION OF SECTION 214
NURSERY STOCK CONTAINERS AND UNROOTED CUTTINGS

re-sprout effectively. Cuttings shall be cut about one foot from the ground using sharp loppers or pruning tools. Cuts shall be clean, without stripping the bark or splitting the wood. The base cuts shall be at a 45-degree angle to identify the root end of the cutting. The top shall be cut off with a square cut so that the top of the stake is easily distinguishable from the bottom. If willow stakes are to be planted in the second half of the growing season (June 15th to October 15th), then the cut top end shall be dipped into latex paint (covering approximately 1 inch at the top of the stake) to seal and reduce desiccation in hot/dry establishment conditions.

- (2) *Live Brush Mattress*– Live willow unrooted cuttings to be used in brush mattress as a bioengineering application. The primary branch shall be approximately 6 – 15 feet long and between ½ and 2 inches in diameter at the base. Side branches are not trimmed unless a side branch is large enough to be used as a primary branch itself. Brush cuttings shall be cut at a height of between six to twelve inches above the ground. Cuts shall be clean, without stripping the bark or splitting the wood. Live brush cuttings should be composed primarily of willow cuttings, but may include up to 20% cottonwood branch cuttings
- (3) *Live Brush Fascines* - Live willow unrooted cuttings to be used in fascines as a bioengineering application. Unrooted cuttings diameter shall vary and shall be a minimum 5 feet long and between ¼ and 2 inches in diameter. Up to 30 percent of the bundle may be plant material that does not root easily or dead plant material. The remaining 70 percent of the bundle shall consist of younger wood between 1 to 4 years old (at a minimum 25 willow cuttings per fascines). Fascines bundles may be stored submersed in water for no longer than two weeks, if necessary.
- (c) *Wood Stakes*. Wood stakes for deciduous tree support shall be 2 inches' x 2 inches square, or 2 ½ inch diameter and 6 feet long free from bends. One end of all wood posts shall be pointed. Metal stakes for deciduous tree support shall be studded 6 feet long T-Post with a minimum weight of 1.25 lbs. per linear foot. Metal stakes for evergreen tree support shall be 24 inches long and consist of either minimum weight 1.25 lbs. per linear feet T-Post or #4 or larger rebar. Wood stakes shall be made of untreated wood guaranteed to last in the ground at least two growing seasons.
- (d) *Backfill*. Backfill material consists of topsoil in accordance with the Contract requirements of 207 and additional compost material thoroughly mixed together and reasonably free of rocks and plant material. All other foreign material shall be removed. Do not use subsoil removed from planting pits as backfill unless accepted by CDOT Project Engineer. Compost shall be mixed into the backfill material at a rate of 25 percent by volume.

Live Willow Stake applications do not require additional compost in the backfill material, but holes must be backfilled with topsoil or native fine alluvium (sand or gravel).

Compost for planting pits shall be in accordance with section 212.

- (e) *Wood Mulch*. Mulch shall consist of virgin moist wood product with shavings having approximate dimensions of: Width: ¼ to ½ inch, Length 3 to 4 inches. Mulch shall be free of material injurious to plant growth. Sources of mulch should be free of weeds and invasive plant parts or seeds. Sawdust, dirt, garbage, or other debris mixed in the mulch is not acceptable. Contractor shall submit one pound of proposed mulch for approval.
- (f) *Flex Pipe Bark Protector*. Bark Protector shall be made of flexible UV stabilized plastic that shall be able to push off and separate with tree growth, without harming the bark, stem, wood or any part of the tree.
- (g) *Wildlife Protection Fencing*. When specified on plans fencing shall be made of 20-gage steel with black-

REVISION OF SECTION 214
NURSERY STOCK CONTAINERS AND UNROOTED CUTTINGS

vinyl coating, with a maximum opening of 1 inch.

- (h) *Deciduous Tree Wrapping Materials.* Wrapping material shall be horticulturally standard waterproof corrugated cardboard material that allows stretching over time to prevent girdling of the tree.
- (i) *Tree Straps.* Breathable nylon webbing 18 inches long and 1 ½ inches wide with metal grommets at each end.

CONSTRUCTION REQUIREMENTS

214.03 All nursery stock shall be protected from drying out or other injury with acceptable practices within the industry. Broken and damaged roots shall be pruned before planting.

- (a) *Planting Seasons.* Nursery stock shall be planted in accordance with the Contract.

Areas to be planted shall be brought to the lines and grades designated or approved. The Contractor shall place all plant material according to the approved Landscape/Mitigation Plans to the degree that unsuitable planting locations shall be avoided. Trees shall be planted outside of the clear zone, except when guardrail or vertical curb exists, this distance may be reduced to 20 feet. Shrubs shall not be planted closer than 6 feet from the edge of pavement. Locations of all nursery stock and unrooted cuttings shall be staked in the field prior to planting. Plants and planting locations shall be checked in the field by CDOT Region Biologist or CDOT Landscape Architect and shall be adjusted to the position as approved before planting begins. Planting holes shall not be constructed until written approval has been received from the Engineer.

- (b) *Excavation.* Planting pits shall be circular in outline with vertical or sloped sides. The Contractor shall roughen sides of the pit to remove any compacting or glazing. When conditions detrimental to plant growth are encountered, such as over compacted topsoil, rubble fill, debris, or obstructions, notify the Engineer before planting. Use of a tree spade to dig plant pits is prohibited.
- (c) *Planting.* Planting shall be done in accordance with good horticultural practices and only after topsoil has been placed. Plants of upright growth shall be set plumb and plants of prostrate type shall be set normal to the ground surface. Plants with dry, broken, or crumbling roots will not be accepted for planting. When conditions detrimental to plant growth are encountered, such as over compacted topsoil, rubble fill, debris, or obstructions, notify the Engineer before planting. Use of a tree spade to dig plant pits is prohibited. Pits excavated with a backhoe shall be scarified as needed.

For automated irrigated areas planting pits shall be dug 2 to 4 inches shallower than the height of the rootball for trees, and 2 inches shallower for shrubs. In non-irrigated areas, planting pits shall be dug so that the top of the rootball is 2-4 inches depressed from surrounding final grades. The nursery stock shall be set in the center of the planting pit on undisturbed soil.

Trees shall be stabilized and then the top third of the wire basket, any twine and burlap shall be removed before the pit is backfilled. Shrubs shall be planted in the center of the pit. All of the plastic, metal and fabric, containers shall be removed. Peat containers shall be removed if directed by the Engineer. If the nursery stock is root-bound (roots circle the root ball) shallow scores with a sharp knife ¼ to ½ inch deep shall be made along the edges and the bottom of the rootball.

Areas to be planted with ground cover shall be prepared by placing topsoil and a ½ inch layer of soil conditioner on the ground surface, and rototilling to a depth of 6 inches. Ground cover shall be planted by excavating to a depth sufficient to accommodate the root structure of plant materials without crimping or bending roots. After planting, backfill shall be placed around the ground cover and compacted firmly

REVISION OF SECTION 214
NURSERY STOCK CONTAINERS AND UNROOTED CUTTINGS

around the roots. The planted areas shall be brought to a smooth and uniform grade, and then top dressed with a 2-inch-deep wood mulch.

- (d) *Backfilling.* Backfill shall be thoroughly worked and watered-in to eliminate air pockets. For trees backfill $\frac{1}{2}$ of the planting pit and saturate to remove air pockets. After settling finish backfilling and saturate again. After the soil has settled, nursery stock must be in the proper position and at the proper depth. Saucers shall be prepared around each plant to the dimensions shown on the planting details. For all nursery stock the excavated area shall be covered with a 4-inch-thick layer of wood mulch. After completion of all planting and before acceptance of the work, the Contractor shall water nursery stock installed under this Contract, as needed to maintain a moist root zone optimum for plant growth. Nursery stock or prepared surfaces damaged during planting operations by the Contractor's operations shall be replaced at the Contractor's expense.

Surplus soil remaining after backfilling is completed shall be used for constructing water retention berms, or, if not needed for berms, shall be thinly distributed (wasted) in the vicinity, subject to approval of the Engineer.

- (e) *Wood Mulch.* Mulch shall be placed to a minimum of 4-inch depth to cover nursery stock excavated areas, but not touching the trunk of trees.
- (f) *Pruning.* All deciduous trees and shrubs shall be pruned in accordance with standard horticultural practice, preserving the natural character of the plant. Guidelines for pruning are indicated in the planting details. Pruning cuts shall be made with sharp clean tools.

All clippings shall become the property of the Contractor and be removed from the site.

- (g) *Guying.* All deciduous trees 2-inch caliper and greater shall be staked as designated on the plans. Coniferous trees 4 feet or taller shall be staked as designated on the plans.
- (h) *Deciduous Wrapping Materials.* Wrapping shall be applied from the base of the tree upward to the second scaffold branch and secured with arbor tape. Populus species shall be exempt from tree wrap. The Contractor shall submit the manufacturer's certification for the wrapping material requirements. Wrapping shall be done in the fall months prior to freeze, and removed in the spring. Wrapping shall not remain on any trees throughout the summer months. Wrapping shall be removed by the Contractor.

All plant tags shall be removed from plants and all packing or other material used by the Contractor shall be removed from the site. Upon completion of work, the Contractor shall remove plant containers, bags and other debris and leave area in clean, acceptable condition.

- (i) *Unrooted Cuttings.* Upon arrival at the construction site, cuttings shall be inspected for acceptability. Only healthy, undamaged material will be accepted. During installation activities, the cuttings shall be kept wet and out of the direct sun light. No cuttings shall be out of water for more than 10 minutes before planting. Water shall be applied to areas around the cuttings until the soil mass is saturated. Cuttings shall be watered thoroughly every day for a period of one month, unless natural soil saturation occurs within 12 inches of soil surface, as verified by the Engineer. Unrooted cuttings shall be used in the following:

1. *Live Willow Stakes.* Using a rock bar or other mechanical method such as a stinger backhoe attachment or trenching equipment, create a vertical hole or trench deep enough to reach a depth at which the water table will be present throughout the growing season, or deep enough to extend below the low summer flow, or groundwater elevation of the adjacent stream channel. Planting zones shall be surveyed and staked in the field for approval by the Engineer prior to planting. Insert $\frac{2}{3}$ of the live cutting into the hole/trench, with the 45 degree cut end down, so that the end of the cutting maintains contact with the

REVISION OF SECTION 214
NURSERY STOCK CONTAINERS AND UNROOTED CUTTINGS

natural water table throughout the entire growing season; planting depth must consider the natural fall of the water table that typically occurs in late summer. Planting depth shall be verified by Engineer. The placement of these cuttings shall be in areas shown on the plans and at the spacing specified. Minor adjustments in placement and spacing may be necessary based on field conditions.

The root end of cuttings shall be tamped into the pilot hole or placed in a trench to a minimum depth of 2 feet, or until the root-end of the cutting meets elevation at which groundwater will be present at the driest point of the growing season. Note that some water tables will vary greatly from April to October; the Contractor shall consult with the Engineer and Region environmental staff for proper depth.

The top of the cutting shall protrude a minimum of 4 inches, but no more than 1/3 of its length with at least two live buds showing above ground. Dead blow hammers or rubber mallets shall be used to tamp in the cuttings into holes, in such manner as to not cause the wood to split. Trench planting should not require any tamping.

Live cuttings require direct contact with soil. Soil shall be placed/backfilled in any spaces around the cuttings and tamped into place to remove any air pockets; if necessary, a soil-water slurry should be used to ensure good soil contact with cutting.

Water shall be applied to the planted cutting stakes areas until the soil mass is saturated. Cuttings shall be watered thoroughly every day for a period of one month, unless natural soil saturation occurs within 12 inches of soil surface, as determined by the Engineer, in consultation with the Region environmental representative.

2. *Live Brush Mattress.* Live unrooted cuttings shall be evenly distributed in the dimensions shown on the plans and laid flat against sloped stream bank to create a continuous mat of brush. The cut-end of the *branches* shall be buried in the toe of the slope. At a minimum, the ends shall be buried 6 inches at the toe of slope or otherwise secured with willow fascines, log and/or rock as specified in plans. The Contractor shall ensure that the lower willow tips are in contact with soil that is saturated during normal low flow stream conditions. The mattress will be secured to the stream embankment with a network of wood stakes and twine. Utilize minimum length 24-inch-long wood stakes and 0.25-inch diameter machine spun bristle coil twine (tensile strength: 140 pounds).

The Contractor shall cover the mattress with a thin layer of clean topsoil and seed with wetland seed mix. Soil covering should cover 90 percent of the unrooted cuttings. Approximately 10 percent but no more than 20 percent of the cuttings should daylight above the soil covering once soil has settled into the voids of the mattress.

3. *Live Brush Fascine.* A fascine is a bundle of unrooted cuttings, fastened together with 0.25-inch diameter machine spun bristle coil twine (tensile strength: 140 lbs.) to keep the bundles tightly tied until placed in the ground and buried. Clean topsoil shall be worked over and around the bundles, no compaction is required. The length of the wattle bundle shall be placed parallel with the contour of the ground. Wood stakes shall be placed as shown on the plans centered along bundle. Utilize minimum length 24-inch wood stakes and 0.25-inch diameter machine spun bristle coil twine (tensile strength: 140 pounds). The Contractor shall puddle with water and allow soil to settle, then repeat backfill procedure until wattle bundle is covered to three-quarters of bundle height. Unrooted cuttings installed above reliable ground water supply shall be watered thoroughly every day for a period of one month. Watering shall be continued after the first month at a minimum of once a week until the completion of the project.

REVISION OF SECTION 214
NURSERY STOCK CONTAINERS AND UNROOTED CUTTINGS

(j) *Watering.*

1. Watering for nursery stock in irrigated areas (projects with 623 pay items). Irrigation system shall be operating and supplying the correct amount of water to the immediate area prior to any nursery stock being planted. Plants shall be thoroughly watered within 15 minutes of planting.
2. Watering in newly planted nursery stock and unrooted cuttings in non-irrigated areas. The Contractor shall furnish and supply the correct amount of water to the area receiving unrooted cuttings and nursery stock to keep the plants in a healthy and vigorous condition. All plantings shall be watered within four hours of placement. All plant material shown on the plans (excluding seeded areas) shall be watered to ensure successful establishment of the plant. Rate of flow shall allow the water to soak into the soil adjacent to the planting. At no time shall watering operations be applied at a rate or intensity that causes surface run off.

- (k) *Maintenance of landscape during construction.* Maintenance of landscaping shall start immediately upon placement of first permanent landscaping and continue until the Notice of Substantial Landscape Completion has been received. The Contractor shall maintain the seeded areas, nursery stock and unrooted cuttings in a healthy and vigorous growing condition to ensure successful establishment. Maintenance shall consist of the following:

Work Item	Function	Notes
Weed control of areas having native seed	Areas shall be kept free of harmful insects, disease and weeds	Weed management strategies shall be discussed during the Site Pre-Vegetation Conference.
Hand watering trees	All plant material shown on the plans (excluding seeded areas) shall be watered to ensure successful establishment of the tree. Rate of flow must allow the water to soak into the soil adjacent to the planting. At no time shall watering operations be applied at a rate or intensity that causes surface run off.	Trees shall be watered two times a month at a rate of 10 gallons for each diameter inch of the tree for the months of May through October, and one time per month for the months of November through April.
Hand watering trees, shrubs, herbaceous plants and unrooted cuttings	All plant material shown on the plans (excluding seeded areas) shall be watered to ensure successful establishment of the plant. Rate of flow must allow the water to soak into the soil adjacent to the planting. At no time shall watering operations be applied at a rate or intensity that causes surface run off.	All plant material shown on the plans (excluding seeded areas) shall be watered to ensure successful establishment of the plant. Rate of flow must allow the water to soak into the soil adjacent to the planting. At no time shall watering operations be applied at a rate or intensity that causes surface run off.

REVISION OF SECTION 214
NURSERY STOCK CONTAINERS AND UNROOTED CUTTINGS

214.04 Nursery Stock Warranty Period. After all landscaping work in the Contract has been installed and completed, a Substantial Landscape Completion Inspection shall be held including the Contractor, Engineer and the Region Environmental Staff to determine acceptability of the landscaping work. During the inspection, an inventory of rejected material will be made, and corrective and necessary cleanup measures will be determined. The approval of the Notice of Substantial Landscape Completion will take place upon successful removal of rejected material and required cleanup measures.

The beginning of the Nursery Stock Warranty Period depends upon the time the receipt from the Engineer of a written Notice of Substantial Landscape Completion is issued. If the Notice of Substantial Landscape Completion is issued between March 20 and June 21, the Nursery Stock Warranty Period begins immediately and lasts for a period of 12 months. If the Notice of Substantial Landscape Completion is issued prior to this time (January 1 through March 19), Nursery Stock Warranty begins on March 20 of that year and lasts for the remaining months until March 20 of the following year. If the Notice of Substantial Landscape Completion is issued after this time (June 22 through December 31), the Nursery Stock Warranty Period begins on March 20 of the following year and lasts for a period of 12 months. Variations to these dates are permitted, and shall be as directed.

Dead, dying, or rejected material shall be removed each month during the Nursery Stock Warranty Period as directed. DRC #10 and SNC #1 along with all larger nursery stock container sizes shall be replaced only one time during the spring calendar dates as shown above. Nursery stock containers smaller than DRC #10 and SNC #1 along with seeding and unrooted cuttings will not be included in Nursery Stock Warranty Period. Nursery Stock replacements shall be planted in accordance with the Contract and shall be subject to all requirements specified for the original material.

Contractor access to private property for nursery stock replacement work will not be extended beyond the terms of the temporary construction easement(s) for the project, unless another temporary easement agreement or extension of the original temporary easement is granted.

The contract performance and payment bond, as required in subsection 103.03, shall include all required work involved during the Nursery Stock Warranty Period.

METHOD OF MEASUREMENT

214.05 The quantity of nursery stock to be measured will be the number of plants, of the types and sizes designated in the Contract that are actually planted and accepted.

Live Willow Stakes will be measured by the number actually installed and accepted.

Live Brush Mattress will be measured by the actual number of linear feet installed and accepted.

Live Brush Fascines will be measured by the actual number of linear feet installed per the detail on the plans and accepted.

BASIS OF PAYMENT

214.06 The accepted quantities of nursery stock and unrooted cuttings will be paid for at the contract unit price for each of the items listed below:

Payment for the total cost of the item will be made at the completion of the installation of each item.

Cost of the performance bond shall be included in the cost of the plant items.

Payment will be made under:

REVISION OF SECTION 214
NURSERY STOCK CONTAINERS AND UNROOTED CUTTINGS

Pay Item	Pay Unit
_____ Tree (_____ Inch Caliper)	Each
_____ Tree (_____ Foot)	Each
Nursery Stock Container (DRC # _____)	Each
Nursery Stock Container (SNC# _____)	Each
Live Willow Stakes	Each
Live Willow Fascine	Linear Feet
Live Brush Mattress	Linear Feet

Nursery Stock Warranty Period will not be measured and paid for separately, but shall be included in the work. All costs associated with replacing nursery stock larger than DRC#10 and SNC #1 shall be at the Contractor's expense.

Additional slow-release organic fertilizer for nursery stock shall be used as specified in the plans will not be measured and paid for separately, but shall be included in the work.

Compost required for backfill of nursery stock will not be paid for separately, but shall be included in the work.

All water required for nursery stock and unrooted cuttings in projects without 623 pay items will be measured and paid for in accordance with Section 209 under Pay Item Water (Landscaping), up to the Notice of Substantial Completion.

Water required after the acceptance of the Notice of Substantial Completion will not be measured and paid for separately but shall be included in the work.

Standard waterproof tree wrap and flex pipe bark protector for nursery stock will not be measured and paid for separately, but shall be included in the work.

Cleaning or repair of site conditions from equipment used by the Contractor for planting operations will not be measured and paid for separately by shall be included in the work.

Wood mulch, stakes, guy wire, PVC protector, safety caps, wrapping, and all other materials required to install a tree will not be measured and paid for separately but shall be included in the work.

Wood stakes and other materials required to secure Live Brush Mattresses and Live Brush Fascines will not be measured and paid for separately but shall be included in the work.

Seeding will be measured and paid for in accordance with Section 212 and Topsoil will be measured and paid for in accordance with Section 207.

Maintenance of Landscaping during construction will not be measured and paid for separately but shall be included in the work.

January 20, 2021

REVISION OF SECTION 250
ENVIRONMENTAL SAFETY AND HEALTH

NOTICE

This is a standard special provision that revises CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Construction Engineering Services Branch with formal instructions regarding its use on CDOT Construction Projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT Construction Projects, and do not use this special provision on CDOT projects in a manner other than specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies that use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects.

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REVISION OF SECTION 250
ENVIRONMENTAL SAFETY AND HEALTH

Section 250 of the Standard Specifications is hereby revised for this project as follows:

In the 2nd paragraph in Subsection 250.03 (c), revise as follows:

The Contractor shall submit a signed (or electronically sealed when HSO is a Professional Engineer) electronic HASP to the Engineer for acceptance. The Engineer shall have seven days to review and accept or reject the proposed HASP. Within five days after acceptance, the HSO shall distribute the accepted HASP to each emergency response agency servicing the project area, the HASP designated emergency hospital, and the Engineer. Earth or demolition work shall not occur until after the HASP is accepted and distributed. The HASP shall also be available to the Contractor's employees, their representatives, officials of OSHA, EPA, Colorado Department of Public Health and Environment (CDPHE), local government health department, Federal Highway Administration, and as determined by the Engineer. The Engineer will distribute the accepted HASP to appropriate Department personnel. The HSO shall revise and update the HASP as warranted by changes in the field conditions.

REVISION OF SECTION 412
DOWEL BARS FOR JOINTS

NOTICE

This is a standard special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Project Development Branch with formal instructions regarding its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by the Standards and Specifications Unit of the Project Development Branch. The instructions for use on CDOT construction projects appear below.

Other agencies that use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects with concrete pavement.

REVISION OF SECTION 412
DOWEL BARS FOR JOINTS

Section 412 of the Standard Specifications is hereby revised for this project as follows:

Delete subsection 412.13 (b) 2. and replace it with the following:

Transverse Weakened Plane. Joints. When dowel bars are specified in the Contract, they shall be installed within the tolerances and of the size, grade, and spacing specified. Dowel bars shall be furnished in a rigid welded assembly or placed by a dowel bar insertion (DBI) machine. The center of the dowel assembly or the insertion location shall be marked on both sides of the pavement slab for reference in sawing the joint.

When a DBI is used, the Contractor shall submit details and specifications of the proposed slip-form paver and DBI to the Engineer a minimum of 14 calendar days prior to the Concrete Pavement Pre-Paving Conference. The Contractor shall detail his methodology for ensuring correct marking of dowel bar insertion points and correct sawing of the joints. The Contractor shall ensure that the slip-form paver is compatible with the DBI.

When a rigid assembly (dowel basket) is used, the rigid assembly shall be fabricated from number 1/0 wire or heavier with vertical support wires every 1 foot. The rigid assembly shall be securely fastened to the subbase and constructed to firmly hold all the dowel bars at T/2 depth, parallel to each other and to the pavement grade and alignment. Horizontal support wires or shipping braces shall be non-deformed bars or wires with a diameter less than or equal to 0.307 inches (gauge 0 wire). The number of horizontal support wires or shipping braces shall be limited to five per rigid assembly. Shipping braces shall not be cut.

The Contractor shall perform a pull test after dowel baskets are staked. The minimum staking method will be determined using the pullout test. The pullout test shall be performed on all dowel baskets placed in a test section and one dowel basket per day thereafter when the minimum staking method is used. The test section for determining staking method shall be the first 10 joints with dowel baskets for each base type. Each dowel basket in the test section shall withstand a minimum of 25 pounds of force when pulled vertically at three equally spaced locations along the length of the dowel basket frame using a fish scale, or approved equivalent. If any dowel basket moves more than 0.5 inches, a new staking method and test section will be required.

The use of the MIT Scan-2 will be used for joint acceptance. Joint acceptance or rejection will be based on the Joint Map generated by the MIT Scan software. Should the joint map show missing or misaligned bars the Contractor will have the choice of either performing additional testing using a method approved by the Engineer or perform corrective measures. Colorado Procedure 79 in the CDOT Field Materials Manual will be used to determine if dowel bars are misaligned or missing. Dowels in rigid assemblies will be inspected by the Engineer prior to concrete placement for misalignment and dowel bar depth. If misalignments and/or dowel bar depths exceeding the rejection tolerances are found, the rigid assembly shall be reset and re-inspected. The MIT Scan-2 shall be used for determining the depth of dowel bars placed by a DBI.

See Standard Plan M-412-1 for schematic describing the measurement of each tolerance.

Joint Rejection Criteria:

- (1) Any joint that does not have at least three acceptable dowel bars in each wheel path.
- (2) Rotational Alignment:
Bars with a misalignment greater than 1.5 in.
- (3) Longitudinal (side) shift:
Bars that are not embedded at least 6 inches on each side of the joint (saw-cut).

REVISION OF SECTION 412
DOWEL BARS FOR JOINTS

(4) Depth:

Bars within the top 3 inches of the pavement or at a depth less than the saw-cut depth. Bars within the bottom 3 inches of the pavement.

Corrective Measures: The following corrective measures will be allowed for the bars or joints that are rejected.

(1) Rotational misalignment.

Saw-cut the misaligned bars. Joints with less than three un-cut bars in each wheel path will require the addition of dowel bars using an approved dowel bar retrofit method.

(2) Longitudinal (side) Shift and missing bars.

Addition of dowel bars using an approved dowel bar retrofit method.

(3) Depth.

Inadequate cover above the bar—saw-cut the bar and install a replacement bar using an approved dowel bar retrofit method.

Inadequate cover below the bar— Addition of dowel bars using an approved dowel bar retrofit method.

Retrofitted dowel bars shall not exceed the dowel bar rejection criteria.

In addition to the above procedures, the Contractor may propose removal and replacement of the affected slabs. The Contractor shall submit his method of repair to the Engineer for approval.

The Contractor shall demonstrate his ability to place dowel bars in conformance with the specifications by placement of a test section. The test section shall be a minimum of 300 feet in length. Upon completion of the test section, the Contractor shall shut down paving operations. During the shutdown period, the Contractor shall evaluate all joints in the test section using the MIT-Scan-2 and CP-79 and submit the results to the Engineer. Paving operations shall not be restarted until the Engineer approves the test section results. The test section will be found acceptable if 100% of the joints are found to be acceptable. All unacceptable joints must be addressed using the above corrective measures. The Contractor may continue paving at his own risk before the test section evaluation is complete.

If the Project has less than 500 linear feet of pavement, the test section will not be required. If a Project does not have sections of continuous pavement greater than 45 linear feet, the test section will not be required.

Upon completion of the test section(s) and for each week of production, the Contractor shall prepare an electronic report generated using MagnoProof software and submit it to the Engineer at the start of each working week during production, for the previous week's work. The reports shall show the joint map generated by the MIT-Scan-2 and the joint pass/fail rating according to CP-79

When the test section is found to be unacceptable, the Contractor shall perform corrective actions and place a second test section. If the second test section is found to be unacceptable, the Contractor shall pave no more than 500 feet per day until an acceptable test section has been achieved.

Once a test section is successfully completed, Dowel Bar Placement testing frequency shall be a minimum of one location per 1,250 linear feet of each continuous lane including climbing lanes, passing lanes, acceleration and deceleration lanes and ramps. Sections greater than 45 linear feet and less than 1,250 linear feet require a minimum one of test location. Testing locations shall be determined by a random procedure so that each area has a randomly selected transverse joint location. At each location, five consecutive joints shall be tested.

REVISION OF SECTION 412
DOWEL BARS FOR JOINTS

Sections of continuous pavement constructed by the project less than 45 linear feet will not require Dowel Bar Placement Testing.

When any joint exceeds the rejection criteria, joints shall be tested in each direction from the rejected joint, until two consecutive joints in each direction are found to be acceptable.

All delays or costs associated with equipment being rejected for use by the Engineer will not be paid for by the Department, and will be considered a Non-excusable Delay in accordance with subsection 108.08 (c) 2.

When concrete shoulders or widenings are constructed subsequent to the driving lanes, transverse weakened plane joints shall immediately be formed in the plastic concrete of these widenings to create an extension of the existing transverse joint. This tooled joint shall be formed in such a manner that it controls the cracking and shall be sawed and sealed in accordance with the above requirements.

September 3, 2020

REVISION OF SECTION 412
PORTLAND CEMENT CONCRETE PAVEMENT

NOTICE

This is a standard special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Project Development Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use in projects with Portland Cement Concrete Pavement.

REVISION OF SECTION 412
PORTLAND CEMENT CONCRETE PAVEMENT

Section 412 of the Standard Specifications is hereby revised for this project. Delete the first paragraph of Subsection 412.15 and replace with the following:

412.15 Cold Weather Concrete Paving. The Contractor is responsible for the strength and quality of the concrete placed during cold weather. Before starting paving operations, the Contractor shall be prepared to protect the concrete from freezing. Maturity meters, to monitor and record time and pavement temperature, shall be installed at the time of placement when the air temperature is expected to fall below 40 °F during the next three days or as requested by the Engineer when the air temperature is expected to fall below 45 °F during the next three days. The Contractor shall maintain the temperature of the pavement at or above 40 °F until the pavement has attained a compressive strength of at least 2000 psi. The compressive strength of the concrete shall be determined by the use of maturity meters. Maturity meters shall be placed in three locations for each day's concrete paving operations. One maturity meter shall be placed in the final 15 feet of paving, and the two other maturity meters shall be placed at locations designated by the Engineer. The maturity meter probes shall be located on the outside edge of the slab, at least 1 foot and not more than 2 feet from the edge and at mid depth of the slab. Each maturity meter shall be capable of recording the time and temperature. The maturity meters shall remain in place until the concrete has attained a compressive strength of 2000 psi.

January 20, 2021

REVISION OF SECTION 503
DRILLED SHAFTS

NOTICE

This is a standard special provision that revises CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Construction Engineering Services Branch with formal instructions regarding its use on CDOT Construction Projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT Construction Projects, and do not use this special provision on CDOT projects in a manner other than specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies that use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects.

REVISION OF SECTION 503
DRILLED SHAFTS

Section 503 of the Standard Specifications is hereby revised for this project.

In the last paragraph of Subsection 503.19 revise the following:

Drilled shaft excavations and completed drilled shafts not constructed within the required tolerances will be considered defective. The Contractor shall be responsible for correcting all defective drilled shafts to the satisfaction of the Engineer. Materials and work necessary, including engineering analysis and redesign, to complete corrections for out-of-tolerance drilled shafts shall be furnished without cost to the Owner or an extension of the completion date of the project. The Contractor shall submit redesign drawings electronically sealed by the Contractor's Engineer.

In the 4th paragraph of Subsection 503.21 revise the following:

An electronically sealed report of load test results shall be submitted within five business days of the testing completion. Load testing results will be evaluated by the Engineer before installing any production drilled shafts, to allow for design modifications based on the load test results. Load test data as reported shall conform to the Drilled Shaft Foundation Testing (DSHAFT) and be available in electronic form at the project website (<http://srg.cce.iastate.edu/shaft>).

- (a) Static Load Tests. Static load tests shall be performed in accordance with the procedures specified in ASTM D1143.
- (b) Force Pulse (Rapid) Load Tests. Force pulse (rapid) load tests shall be performed in accordance with the procedures specified in ASTM D7383.

September 3, 2020

REVISION OF SECTIONS 504 AND 606
PRECAST CONCRETE

NOTICE

This is a standard special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Project Development Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use in projects having precast concrete.

REVISION OF SECTIONS 504 AND 606
PRECAST CONCRETE

Sections 504 and 606 of the Standard Specifications are hereby revised for this project as follows:

In subsection 504.06 Delete the 1st paragraph and (1), (2), (3) & (4) following the 1st paragraph and replace with the following:

504.06 Pre-Cast Concrete Panel Facing Unit and Panel Joint Material. The pre-cast concrete panels shall conform to the requirements shown on the plans and these specifications including the color, texture, dimensions and pattern. These facing units shall be factory made with an approved Class D or G Concrete and shall conform to the requirements of Section 601. The Contractor may elect to use an approved self-consolidating Class D or G concrete. Pre-cast panels shall be cured in accordance with AASHTO M170.

606.02 Materials shall meet the requirements specified in the following subsections. Delete the 3rd through 7th paragraph and replace with the following:

Concrete for precast or cast-in-place barrier shall be made with an approved Class D Concrete and shall conform to the requirements of Section 601. The Contractor may elect to use an approved self-consolidating Class D concrete. Reinforcing steel, unless otherwise noted, shall be epoxy coated and conform to the requirements of Section 602.

Concrete for bridge rail shall be an approved Macro Fiber-Reinforced Class D Concrete and conform to the requirements of Section 601.

January 20, 2021

REVISION OF SECTION 518
WATERSTOPS AND EXPANSION JOINTS

NOTICE

This is a standard special provision that revises CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Construction Services Branch with formal instructions regarding its use. It is to be used as written without change. Do not use modified versions of this special provision nor use this special provision in a manner other than specified in the instructions unless such use is first approved by the Construction Services Branch. The instructions for use on CDOT construction projects appear below.

Other agencies that use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects.

REVISION OF SECTION 518
WATERSTOPS AND EXPANSION JOINTS

Section 518 of the Standard Specifications is hereby revised for this project.

Delete Subsection 518.05 (a) and replace with the following:

- (a) The transverse separation beams (center beams), support bars, and other structural elements including welds shall be fatigue tested and designed following the guidelines provided in NCHRP Report 402, "Fatigue Design of Modular Bridge Expansion Joints" as well as the provisions included in Chapter 14 of the latest edition of the AASHTO LRFD Design Specification. The Contractor shall provide calculations electronically sealed by the Contractor's Engineer to the Engineer.

REVISION OF SECTION 601
STRUCTURAL CONCRETE

NOTICE

This is a standard special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Project Development Branch with formal instructions regarding its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by the Standards and Specifications Unit of the Project Development Branch. The instructions for use on CDOT construction projects appear below.

Other agencies that use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on projects with structural concrete.

1
REVISION OF SECTION 601
STRUCTURAL CONCRETE

Section 601 of the Standard Specifications is hereby revised for this project as follows:

Delete subsections 601.01 thru 601.07 and replace with the following:

601.01 This work consists of furnishing and placing hydraulic cement concrete in accordance with these specifications and in conformity with the lines, grades and dimensions as shown on the plans or established.

This work includes preparing concrete surfaces designated in the Contract and applying an approved colored Structural Concrete Coating to them.

601.02 Classification. The classes of concrete shown in Table 601-1 shall be used when specified in the Contract.

**Table 601-1
CONCRETE FIELD REQUIREMENTS**

Concrete Class	Required Field Compressive Strength (psi)	Air Content: % Range (Total)	Slump ²	Maximum Water/Cementitious Material Ratio:
B	4500 at 28 days	5 - 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373
BZ	4000 at 28 days	N/A ¹	6" – 9"	w/cm on Form 1373
D	4500 at 28 days	5 – 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373
DT	4500 at 28 days	5 – 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373
G	4500 at 28 days	5 – 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373
PS (Girders)	8500 at 28 days	N/A ¹	9" maximum	0.45
PS (Deck Panels)	6000 at 28 days	N/A ¹	9" maximum	0.45
P	4500 at 28 days	4 – 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373
S35	5000 at 28 days	5 – 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373
S40	5800 at 28 days	5 – 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373
S50	7250 at 28 days	5 – 8	+/- 2" of Form 1373 Slump	w/cm on Form 1373
Shotcrete	4500 at 28 days	7-10 ³	N/A	0.45

¹ 5 - 8% when specified

² Slump shall be a maximum of 9.0 inches for all classes of concrete. Concrete may have a slump above 9.0 inches when designed as Self Consolidating Concrete (SCC). The requirements for slump flow, blocking assessment, and segregation shall apply.

³ Prior to pumping for wet process.

REVISION OF SECTION 601
STRUCTURAL CONCRETE

Class B concrete is an air entrained concrete for general use. Class D, G or P concrete may be substituted for Class B concrete. Additional requirements are:

- (1) The coarse aggregate shall have a nominal maximum size of 1½ inches or smaller.
- (2) Class B Concrete for Slope and Ditch Paving shall be macro-fiber reinforced.

Class BZ concrete is concrete for drilled shafts. Additional requirements are:

- (1) Entrained air is not required unless specified in the Contract. When entrained air is specified in the Contract, the air content shall be 5 to 8 percent.
- (2) Slump shall be a minimum of 6 inches and a maximum of 9 inches. A minimum slump of 6 inches shall be maintained during the anticipated pour period. The use of retarders and hydration stabilizers are allowed to extend the slump life of the concrete. When the Contractor elects to use SCC, the slump requirement for Class BZ Concrete does not apply.
- (3) The coarse aggregate size shall be AASHTO M43 size #8 unless otherwise approved by the Engineer.
- (4) The mix shall either have a permeability not exceeding 2,500 coulombs at an age of not more than 56 days when tested in accordance with ASTM C1202, or have a surface resistivity of at least 12 kΩ-cm at 28 days using AASHTO T358.
- (5) The unrestrained shrinkage shall not exceed 0.050 percent at 28 days when tested by CP-L 4103.

Class D concrete is a denser general use concrete. Class G may be substituted for Class D concrete. Additional requirements are:

- (1) The mix shall either have a permeability not exceeding 2,500 coulombs at an age of not more than 56 days when tested in accordance with ASTM C1202, or have a surface resistivity of at least 12 kΩ-cm at 28 days using AASHTO T358.
- (2) The unrestrained shrinkage shall not exceed 0.050 percent at 28 days when tested by CP-L 4103.
- (3) The mix may use an optimized gradation (OG) with a nominal maximum aggregate size of at least ¾ inch.
- (4) The mix shall have a nominal maximum aggregate size of at least ¾ inch if an OG is not used.
- (5) When used in slip forming, an edge slump less than 6 mm (0.25 in.) and less than 30 percent surface voids (ranking of 2 or less) is required. The box test is described in CP 63.
- (6) Class D Concrete for sidewalks on bridge decks and bridge rail shall be macro-fiber reinforced.

Class DT concrete is used for bridge deck resurfacing. Additional requirements are:

- (1) The concrete mix shall consist of a minimum 50 percent AASHTO M 43 size No. 7 or No. 8 coarse aggregate by weight of total aggregate.
- (2) The mix shall either have a permeability not exceeding 2,500 coulombs at an age of not more than 56 days when tested in accordance with ASTM C1202, or have a surface resistivity of at least 12 kΩ-cm at 28 days using AASHTO T358.
- (3) The unrestrained shrinkage shall not exceed 0.050 percent at 28 days when tested by CP-L 4103.

Class G concrete is a low shrinkage macro fiber-reinforced concrete. Additional requirements are:

- (1) The concrete mix shall include approved macro or hybrid polyolefin fibers at a minimum dosage of 4 lbs/cy or the minimum dosage specified on the Department's Approved Product List (APL), whichever is greater.

REVISION OF SECTION 601
STRUCTURAL CONCRETE

- (2) Shrinkage reducing admixtures may be incorporated into the mix.
- (3) The unrestrained shrinkage shall not exceed 0.030 percent at 28 days when tested by CP-L 4103.
- (4) The mix shall either have a permeability not exceeding 2,500 coulombs at an age of not more than 56 days when tested in accordance with ASTM C1202, or have a surface resistivity of at least 12 kΩ-cm at 28 days using AASHTO T358.
- (5) The mix may use an OG with a nominal maximum aggregate size of at least $\frac{3}{4}$ inch. The mix shall have a nominal maximum aggregate size of $\frac{3}{4}$ inch if an OG is not used.
- (6) An expansive cement additive may be added to an ASTM C150 Type I/II cement and fly ash to produce an ASTM C845 Type K cement. The proportion of the expansive cement additive will be determined by testing the cementitious material blend in accordance with ASTM C806. The blended material shall have an expansion of 0.04 to 0.10 percent at 7 days when tested in accordance with ASTM C806. When an expansive cement is used, the w/cm ratio shall be 0.45 to 0.55 and the expansion of the laboratory trial mix shall be 0.05 to 0.09 percent at 7 days when tested in accordance with ASTM C878.

Class P concrete is used in pavements. Additional requirements are:

- (1) The Required Field Flexural Strength shall be 650 psi.
- (2) The concrete mix shall consist of a minimum 55 percent AASHTO M 43 sizes No. 57, No. 6, No. 67, No. 357, or No. 467 coarse aggregate by weight of total aggregate.
- (3) The mix may use an OG with a nominal maximum aggregate size of at least $\frac{3}{4}$ inch.
- (4) ASTM C150 Type III and ASTM C1157 Type HE cements may be used for early opening.
- (5) The mix shall either have a permeability not exceeding 2,500 coulombs at an age of not more than 56 days when tested in accordance with ASTM C1202, or have a surface resistivity of at least 12 kΩ-cm at 28 days using AASHTO T358.
- (6) The unrestrained shrinkage shall not exceed 0.050 percent at 28 days when tested by CP-L 4103.
- (7) When concrete is to be placed using a paver, an edge slump less than 6 mm (0.25 in.) and less than 30 percent surface voids (ranking of 2 or less) is required. The box test is described in CP 63.
- (8) A minimum of 20 percent Class F fly ash or 30 percent Slag cement by weight shall be used to replace any ASTM C150 cement, any ASTM C1157 cement, or ASTM C595 Type IL cement. ASTM C595 Type IT(MS), IT(HS), IP(MS) or IP(HS) cements may be used without cement substitutions. Class C fly ash may be used if the calcium oxychloride is determined to be less than 15 g CaOXY/100 g cementitious paste as determined in accordance with AASHTO T 365 for Class 0 Sulfate Exposure.

Class PS Class PS concrete is used for prestressed concrete members. Requirements for Class PS concrete are specified in subsection 618.11. ASTM C150 Type III and ASTM C1157 Type HE cements may be used.

Class S35, S40, and S50 concretes are dense high strength concretes. Additional requirements are:

- (1) The concrete mix shall be made with AASHTO M 43 sizes No. 57, No. 6, No. 67, No. 7 or No. 8 coarse aggregate.
- (2) When placed in a bridge deck, the mix shall have a nominal maximum aggregate size of at least $\frac{3}{4}$ inch.
- (3) The mixes may use an OG with a nominal maximum aggregate size of at least $\frac{3}{4}$ inch.
- (4) For S35 and S40 concretes, the unrestrained shrinkage shall not exceed 0.050 percent at 28 days when tested by CP-L 4103.
- (5) For S50 concretes, the unrestrained shrinkage shall not exceed 0.040 percent at 28 days when tested by CP-L 4103.

REVISION OF SECTION 601
STRUCTURAL CONCRETE

- (6) For S35 and S40 concretes, the mix shall either have a permeability not exceeding 2,000 coulombs at an age of not more than 56 days when tested in accordance with ASTM C1202, or have a surface resistivity of at least 14 k Ω -cm at 28 days using AASHTO T358.
- (7) For S50 concrete, the mix shall either have a permeability not exceeding 1,500 coulombs at an age of not more than 56 days when tested in accordance with ASTM C1202, or have a surface resistivity of at least 18 k Ω -cm at 28 days using AASHTO T358.

Class Shotcrete concrete is used for shotcrete applications. Additional requirements are:

- (1) The required air content prior to the pump for wet process applications shall be 7–10 percent.
- (2) Additional requirements are listed in subsection 641.02.

The Contractor may design Class B, Class BZ, Class D, Class G, Class PS, Class S35, Class S40, and Class S50 concrete to be Self Consolidating Concrete (SCC) with the following requirements:

- (1) SCC shall have a slump flow of 20 to 26 inches when tested in accordance with ASTM C1611 using an inverted slump cone.
- (2) SCC shall have a maximum blocking assessment of 2.0 inches when tested in accordance with ASTM C1621.
- (3) SCC shall have a maximum static segregation of 10 percent when tested in accordance with ASTM C1610.

MATERIALS

601.03 Materials shall meet the requirements specified in the following subsections:

Fine Aggregate	703.01
Coarse Aggregate	703.02
Portland Cement	701.01
Fly Ash	701.02
Silica Fume	701.03
Water	712.01
Air Entraining Admixtures	711.02
Pigments and Admixtures	711.03
Curing Materials	711.01
Preformed Joint Material	705.01
Reinforcing Steel	709.01
Bearing Materials	705.06
Epoxy	712.10
Structural Concrete Coating	708.08
High-reactivity Pozzolans	701.04
Slag Cement	701.05

Pozzolans shall consist of fly ash, silica fume, and high-reactivity pozzolan.

Prestressing steel shall meet the requirements of subsection 714.01 except as noted on the plans.

Calcium Chloride shall not be used in reinforced concrete. Calcium Chloride shall be used in non-reinforced concrete only when specified.

5
 REVISION OF SECTION 601
 STRUCTURAL CONCRETE

Where Fiber-Reinforced Concrete is specified or designated on the plans, the concrete mix shall include approved polyolefin fibers. Unless otherwise specified, a minimum of 1.5 pounds or the manufacturer's recommended dose per cubic yard of polyolefin fiber reinforcement shall be evenly distributed into the mix. Mixing shall be as recommended by the manufacturer such that the fibers do not ball up. Polyolefin fibers shall meet the requirements of ASTM C1116 and ASTM D7508.

Where Macro Fiber-Reinforced Concrete is specified or designated on the plans, the concrete mix shall include approved macro or hybrid polyolefin fibers at a minimum dosage of 4 lb/cy or the minimum dosage specified on the APL, whichever is greater. The dosage of the fiber may be reduced if trial mix data shows a minimum residual strength of 150 psi as determined in accordance with ASTM C1609 using a load support apparatus compliant with the requirements of ASTM C1812, "Standard Practice for Design of Journal Bearing Supports to be Used in Fiber Reinforced Concrete Beam Tests." Mixing shall be as recommended by the manufacturer such that the fibers are evenly distributed in the mix and do not ball up. Macro or hybrid polyolefin fibers shall meet the requirements of ASTM C1116 and ASTM D7508.

601.04 Sulfate Resistance. The Contractor shall provide protection against sulfate attack on concrete structures and pavements by providing concrete manufactured according to the requirements of the specified Sulfate Exposure Class. The sulfate exposure class for all concrete except Class PS shall be Class 2 unless otherwise specified on the plans. The sulfate exposure class for Class PS shall be Class 0. The requirements for a higher sulfate exposure class may be used for lower sulfate exposure classes.

The Contractor may request to test the soil and water at a structure location to change the sulfate exposure class. Testing and sampling of the location shall be at a frequency approved by the Engineer, in consultation with the Region Materials Engineer. If the Contractor provided test reports that show another class of exposure exists at a structure location, the Engineer may accept a concrete mix for that location at the changed sulfate exposure class.

Cementitious material requirements for each Sulfate Exposure Class are as follows:

Class 0 requires that the concrete have a maximum Water/Cementitious Material Ratio of 0.45 and one of the following:

- (1) ASTM C150 Type I, II, III or V
- (2) ASTM C595 Type IL, IP, IP(MS), IP(HS) or IT
- (3) ASTM C1157 Type GU, HE, MS or HS

Class 1 requires that the concrete have a maximum Water/Cementitious Material Ratio of 0.45 and one of the following:

- (1) ASTM C150 Type II or V
- (2) ASTM C595 Type IP(MS) or IP(HS)
- (3) ASTM C1157 Type MS or HS
- (4) ASTM C150 Type III. Type III shall have no more than 8 percent C3A.
- (5) ASTM C595 Type IL(MS), IL(HS), IT(MS) or (HS)

Class 2 requires that the concrete have a maximum Water/Cementitious Material Ratio of 0.45 and one of the following:

- (1) ASTM C150 Type V with a minimum of a 20 percent substitution of Class F fly ash or slag cement by weight

6
 REVISION OF SECTION 601
 STRUCTURAL CONCRETE

- (2) ASTM C150 Type II or III with a minimum of a 20 percent substitution of Class F fly ash or slag cement by weight. The Type II or III cement shall have no more than 0.040 percent expansion at 14 days when tested according to ASTM C452.
- (3) ASTM C1157 Type HS
- (4) ASTM C150 Type II, III, or V plus High-Reactivity Pozzolan where the blend has less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C1012
- (5) ASTM C1157 Type HE or MS plus Class F fly ash, slag cement, or High-Reactivity Pozzolan where the blend has less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C1012
- (6) A blend of portland cement meeting ASTM C150 Type II or III with a minimum of 20 percent Class F fly ash or slag cement by weight, where the blend has less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C1012
- (7) ASTM C595 Type IP(HS), IL(HS) or IT(HS). Class F fly ash, slag cement, or High-Reactivity Pozzolan may be substituted for Type IL cement.
- (8) ASTM C595 Type IL(MS) or IT(MS) plus Class F fly ash, slag cement, or High-Reactivity Pozzolan where the blend has less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C1012

Class 3 requires that the concrete have a maximum Water/Cementitious Material Ratio of 0.40 and one of the following:

- (1) A blend of portland cement meeting ASTM C150 Type II, III, or V with a minimum of a 20 percent substitution of Class F fly ash or slag cement by weight, where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C1012
- (2) ASTM C 1157 Type HS having less than 0.10 percent expansion at 18 months when tested according to ASTM C1012. Class F fly ash, slag cement, or High-Reactivity Pozzolan may be substituted for cement.
- (3) ASTM C1157 Type HE, MS or HS plus Class F fly ash, slag cement, or High-Reactivity Pozzolan where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C1012
- (4) ASTM C150 Type II, III, or V plus High-Reactivity Pozzolan where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C1012
- (5) ASTM C595 Type IL(MS) or IT(MS) plus High-Reactivity Pozzolan where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C1012
- (6) ASTM C595 Type IP(HS), IL(HS), or IT(HS) having less than 0.10 percent expansion at 18 months when tested according to ASTM C1012. Class F fly ash, slag cement, or High-Reactivity Pozzolan may be substituted for Type IL cement.
- (7) ASTM C595 Type IL with a minimum of a 20 percent substitution of Class F fly ash or slag cement by weight, where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C1012
- (8) ASTM C150 Type I, II, III, or V plus a minimum of 20 percent Class F fly ash when the R factor of the fly ash is less than 0.75. R factor is determined using the following from the chemical composition of the fly ash:

$$R = \frac{CaO - 5}{Fe_2O_3}$$

ASTM C150 Type III and ASTM C1157 Type HE cements may only be used in Class P or PS Concrete when approved by the Engineer.

REVISION OF SECTION 601
STRUCTURAL CONCRETE

Class C fly ash shall not be substituted for cement when Class 1, 2, or 3 sulfate resistance/exposure class is specified.

The maximum Water/Cementitious Material Ratio may be exceeded when an expansive cement additive is used.

When fly ash or high-reactivity pozzolan is used to enhance sulfate resistance, it shall be used in a proportion greater than or equal to the proportion tested in accordance to ASTM C1012, shall be the same source, and shall have a calcium oxide content no more than 2.0 percent greater than the fly ash or high-reactivity pozzolan tested according to ASTM C1012. ASTM C1012 test results are acceptable for up to two years from the completion date of the test.

Table 601-2

Water-Soluble Sulfate (SO ₄) in Dry Soil, (%)	Sulfate (SO ₄) in Water, ppm	Sulfate Exposure Class
0.00 to 0.10	0 to 150	Class 0
0.11 to 0.20	151 to 1,500	Class 1
0.21 to 2.00	1,501 to 10,000	Class 2
2.01 or greater	10,001 or greater	Class 3

CONSTRUCTION REQUIREMENTS

601.05 Mix Design Submittal Requirements. The Contractor shall submit a Concrete mix design for each class of concrete being placed on the project. Concrete shall not be placed on the project before the Concrete mix design has been approved by the Engineer. The Concrete mix design will be reviewed following the procedures of CP 62. The Concrete mix design will not be approved when the laboratory trial mix data or aggregate data are the results from tests performed more than two years in the past. The concrete mix design shall show the weights and sources of all ingredients including cements, pozzolans, aggregates, fibers, pigments, water, additives and the water to cementitious material ratio (w/cm). When determining the w/cm, the weight of cementitious material (cm) shall be the sum of the weights of the cement, slag cement, fly ash, silica fume, and high-reactivity pozzolan. Water from dosages of admixtures greater than 10 ounces per 100 pounds of cementitious materials shall be included in the calculation of w/cm.

The laboratory trial mix data shall include results of the following:

- (1) AASHTO T 119 (ASTM C143) Slump of Hydraulic Cement Concrete, except when the concrete is SCC
- (2) AASHTO T 121 (ASTM C138) Weight per Cubic Foot, Yield, and Air Content (Gravimetric) of Concrete
- (3) AASHTO T 152 (ASTM C231) Air Content of Freshly Mixed Concrete by the Pressure Method
- (4) ASTM C39 Compressive Strength of Cylindrical Concrete Specimens shall be performed with at least two specimens at 7 days and three specimens at 28 days.
- (5) Class P concrete shall include AASHTO T97 (ASTM C78) Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading). At least two specimens will be tested at 7 days and four specimens at 28 days. The lab trial mix shall produce a flexural strength at 28 days of at least 650 psi.
- (6) Concrete with an OG shall indicate the gradation of the blended aggregates. Optimized gradations shall be developed by an approved mix design technique such as Tarantula Curve, Shilstone, or KU mix.
- (7) SCC concrete shall include ASTM C1611 Standard Test Method for Slump Flow of Self-Consolidating Concrete. Slump flow shall be measured using an inverted slump cone.

8
REVISION OF SECTION 601
STRUCTURAL CONCRETE

- (8) SCC concrete shall include ASTM C1621 Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring.
- (9) SCC concrete shall include ASTM C1610 Standard Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique.
- (10) When concrete is to be placed using a paver, the edge slump and surface voids shall be reported in accordance with CP 63.

Prior to placement of accelerated Class P Concrete, the Contractor shall provide the Engineer a report of maturity relationships in accordance with CP 69.

Except for Class PS concrete, the laboratory trial mix must produce an average compressive strength of at least the required field compressive strength specified in Table 601-1. For Class PS concrete, the laboratory trial mix must produce an average compressive strength at least 115 percent of the required field compressive strength specified in Table 601-1.

When entrained air is specified in the Contract for Class BZ concrete, the trial mix shall be run with the required air content.

The laboratory trial mix shall have a relative yield of 0.99 to 1.02.

Aggregate data shall include the results of the following:

- (1) AASHTO T 11 (ASTM C117) Materials Finer Than 75 um (No. 200) Sieve in Mineral Aggregates by Washing
- (2) AASHTO T 19 (ASTM C29) Unit Weight and Voids in Aggregate
- (3) AASHTO T 21 (ASTM C40) Organic Impurities in Fine Aggregate for Concrete
- (4) AASHTO T 27 (ASTM C136) Sieve Analysis of Fine and Coarse Aggregates
- (5) AASHTO T 84 (ASTM C128) Specific Gravity and Absorption of Fine Aggregate
- (6) AASHTO T 85 (ASTM C127) Specific Gravity and Absorption of Coarse Aggregate
- (7) AASHTO T 96 (ASTM C131) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- (8) AASHTO T 104 (ASTM C88) Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
- (9) CP 37 Plastic Fines in Graded Aggregates and Soils by use of the Sand Equivalent Test
- (10) ASTM C535 Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- (11) ASTM C1260 Determining the Potential Alkali Reactivity of Aggregates (Accelerated Mortar-Bar Method).
When an aggregate source is known to be reactive, ASTM C1567 results may be submitted in lieu of ASTM C1260 results.

Aggregate tested by ASTM C1260 with an expansion of 0.10 percent or more, or that is known to be reactive, shall not be used unless mitigative measures are included in the mix design.

Mitigative measures shall be tested using ASTM C1567 and exhibit an expansion less than 0.10 percent by one of the following methods:

- (1) Combined Aggregates. The mix design sources of aggregates, cement and mitigative measures shall be tested. The proportions of aggregates, cement and mitigative measures shall be those used in the mix design.
- (2) Individual Aggregates. Each source and size of individual aggregates shall be tested. The source of cement and mitigative measures shall be those used in the mix design. The highest level of mitigative measures for any individual aggregate shall be the minimum used in the mix design.

REVISION OF SECTION 601
STRUCTURAL CONCRETE

For all concrete mix designs with ASTM C150 and ASTM C595 Type IL cements, the total substitution of cement shall not exceed 50 percent by weight of total cementitious material.

For all concrete mix designs with ASTM C595 Type IP, IP(MS), IP(HS), or IT cements: fly ash or high-reactivity pozzolan shall not be substituted for cement.

For all concrete mix designs with ASTM C595 IT cements, slag cement shall not be substituted for cement.

For all concrete mix designs with ASTM C595 Type IP, IP(MS), IP(HS) cements, when slag cement is substituted for cement, the total substitution of cement shall not exceed 50 percent by weight of total cementitious material.

For all concrete mix designs with ASTM C1157 cements, the total pozzolan content including pozzolan in cement shall not exceed 30 percent by weight of the cementitious material content. Up to a maximum of 30 percent slag cement by weight of total cementitious material may be substituted for cement.

The Contractor shall submit a new Concrete Mix Design Report meeting the above requirements when a change occurs in the source, type, or proportions of cement, slag cement, fly ash, high-reactivity pozzolan, silica fume, or aggregate. Adjustments to aggregate weights may be made to adjust yield if the combined gradation remains constant (+/-1 percent) or within the optimized band.

When a change occurs in the source or type of approved admixtures or the addition of approved accelerating, retarding or hydration stabilizing admixtures to existing mix designs, the Contractor shall submit a letter stamped by the Concrete Mix Design Engineer approving the changes to the existing mix design. The change shall be approved by the Engineer prior to use.

Unless otherwise permitted by the Engineer, the product of only one type of hydraulic cement from one source of any one brand shall be used in a concrete mix design.

Approval of the concrete mix design by the Engineer does not constitute acceptance of the concrete. Acceptance will be based solely on the test results of concrete placed on the project.

Once approved for a project, the mix design may be used for the duration of the project.

601.06 Batching Measuring and batching of materials shall be done in accordance with AASHTO M 157 (ASTM C94).

The Contractor shall furnish a batch ticket (delivery ticket) with each load for all classes of concrete. Concrete delivered without a batch ticket containing complete information as specified shall be rejected. The Contractor shall collect and complete the batch ticket at the placement site and deliver all batch tickets to the Engineer on a daily basis. The Engineer shall have access to the batch tickets at any time during the placement. The following information shall be provided on each batch ticket:

- (1) Supplier's name and date
- (2) Truck number
- (3) CDOT Project number and location
- (4) Concrete class designation and item number
- (5) Cubic yards batched
- (6) Time batched
- (7) CDOT mix design number
- (8) Type, brand, and amount of each admixture and pigment
- (9) Type, brand, and amount of cement, slag cement, fly ash, and high-reactivity pozzolan

10
 REVISION OF SECTION 601
 STRUCTURAL CONCRETE

- (10)Weights of fine and coarse aggregates or combined weight when an OG is pre-blended
- (11)Moisture of fine and coarse aggregates or combined moisture when an OG is pre-blended
- (12)Gallons (Pounds) of batch water (including ice)
- (13)Weight of polyolefin fiber reinforcement

The Contractor shall add the following information to the batch ticket at the placement site:

- (14)Gallons of water added by truck operator, the time the water was added, and the quantity of concrete in the truck each time water is added
- (15)Number of revolutions of drum at mixing speed (for truck mixed concrete)
- (16)Discharge time
- (17)Location of batch in placement
- (18)Water to cementitious material ratio

Electronic tickets are allowed as long as CDOT has access to the batch ticket and the batch ticket can be downloaded and saved by the Engineer in PDF format before placement, at any time during placement, and until the project is accepted.

- (a) *Hydraulic Cement, Fly Ash, High-Reactivity Pozzolan, Slag Cement and Silica Fume.* All cementitious material shall be measured by mass. Supplementary cementitious materials may be weighed cumulatively with cement. Cement and other cementitious material shall be weighed on a scale and in a weigh hopper, which is separate and distinct from those used for other materials. When the quantity of cementitious material exceeds 30 percent of the full capacity of the scale, the quantity of cement and the cumulative quantity of cement plus supplementary cementitious material shall be within ± 1 percent of the required mass. For small batches to a minimum of 1 cubic yard, the quantity of cement and the quantity of cement plus supplementary cementitious material used shall not be less than the required amount or more than 4 percent in excess. A fraction of a bag of cement shall not be used unless weighed.
- (b) *Water.* Mixing water shall consist of water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates, and water introduced in the form of admixtures. The added water shall be measured by mass or volume to an accuracy of 1 percent of the required total mixing water. Added ice shall be measured by weight. In the case of truck mixers, wash water retained in the drum for use in the next batch of concrete shall be accurately measured or shall be discharged prior to loading the next batch of concrete. Total water (including any wash water) shall be measured or weighed to an accuracy of ± 3 percent.
- (c) *Aggregates.* Aggregates from different sources and of different gradings shall not be stockpiled together.

Aggregate shall be handled from stockpiles or other sources to the batching plant in such manner as to secure a uniform grading of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipment requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. In case the aggregates contain high or non-uniform moisture content, storage or stockpile period in excess of 12 hours may be required.

Aggregate shall be measured by mass. The quantity of aggregate used in any batch of concrete as indicated by the scale shall be within ± 2 percent of the required mass when weighed in individual weigh batchers. In a cumulative aggregate weigh batcher, the cumulative mass after each successive weighing shall be within ± 1 percent of the required cumulative amount when the scale is used in excess of 30 percent of its capacity. For cumulative mass for less than 30 percent of scale capacity, the tolerance shall be ± 0.3 percent of scale capacity or ± 3 percent of the required cumulative mass, whichever is less.

11
REVISION OF SECTION 601
STRUCTURAL CONCRETE

- (d) *Bins and Scales.* The batching plant may include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. A bin, hopper, and scale for cementitious material shall be included. A single weighing hopper with an accumulative scale will be permitted, provided a separate scale is used for weighing cementitious material.

Scales shall meet the requirements of subsection 109.01.

601.07 Mixing. Mixing of materials shall be done in accordance with AASHTO M 157 (ASTM C94). Concrete shall be mixed in stationary mixers, in a central-mix plant, in truck mixers, or in self-contained mobile mixers. Mixing time shall be measured from the time all materials, except water, are in the drum.

Admixtures listed in the mix design, or admixtures approved in accordance with subsection 601.04, and water may be added at the project.

- (a) *Mixing General.* Concrete shall be deposited in place within 90 minutes after batching when concrete is delivered in truck mixers or agitating trucks, and within 60 minutes when delivered in non-agitating trucks.

The 90 minute time limit for mixer or agitating trucks may be extended to 120 minutes if:

- (1) No water is added after 90 minutes.
- (2) The concrete temperature prior to placement is less than 90 °F.

The 90 minute time limit for mixer or agitating trucks may be extended to 180 minutes if:

- (1) No water is added after 90 minutes.
- (2) The concrete temperature prior to placement is less than 90 °F.
- (3) The approved concrete mix contains an approved retarding admixture.

The 90 minute time limit for mixer or agitating trucks may be extended longer than 180 minutes if:

- (1) An Extended Set Control Admixture (ESCA) is added at the time of batching. Procedures and doses shall be in accordance with manufacturer's recommendations. The ESCA shall be on the approved products list.
- (2) The concrete temperature prior to placement is less than 90 °F.
- (3) Each load of concrete shall be sampled and tested by the Contractor for air content according to CP 61.
- (4) The Department will cast three additional acceptance cylinders. If the acceptance cylinders tested at 28 days do not meet design strength, the additional cylinders will be tested at 56 days for acceptance.

- (b) *Central-Mixed Concrete.* Concrete that is mixed completely in a stationary mixer and transported to the point of delivery either in a truck agitator or a truck mixer operating at agitating speed, or in non-agitating equipment approved by the Engineer, shall conform to the following:

- (1) The mixing time shall be counted from the time all the solid materials are in the drum.
- (2) The batch shall be so charged into the mixer so that some water will enter in advance of the cement and aggregate.
- (3) All water shall be in the drum by the end of the first one fourth of the specified mixing time.
- (4) The volume of concrete mixed per batch may exceed the mixer's nominal capacity, as shown on the manufacturer's standard rating plate on the mixer, by up to 10 percent provided concrete test data for

12
REVISION OF SECTION 601
STRUCTURAL CONCRETE

strength, segregation, and uniform consistency are satisfactory, and provided spillage of concrete does not occur.

- (5) Where no mixer uniformity tests are made, the acceptable mixing time for mixers having capacities of 1 cubic yard or less shall be not less than 1 minute. For mixers of greater capacity, this minimum shall be increased 15 seconds for each cubic yard or fraction thereof of additional capacity. Uniformity testing shall be in accordance with AASHTO M157 (ASTM C94).

(c) *Truck Mixing.* Truck mixed concrete shall conform with one of the following:

- (1) Concrete that is completely mixed in a truck mixer shall be mixed 70 to 100 revolutions at the mixing speed to produce uniform concrete. Concrete uniformity tests shall be made in accordance with AASHTO M157 (ASTM C94). Additional revolutions of the mixer beyond the number found to produce the required uniformity of concrete shall be at a designated agitating speed.
- (2) For concrete that is partially mixed in a stationary mixer, and then mixed completely in a truck mixer (shrink mixed concrete), the time of partial mixing shall be the minimum required to intermingle the ingredients. After transfer to a truck mixer, it shall be mixed at a speed to produce uniform concrete. Concrete uniformity tests shall be made in accordance with AASHTO M157 (ASTM C94). Additional revolutions of the mixer beyond the number found to produce the required uniformity of concrete shall be at a designated agitating speed.
- (3) Concrete mixed entirely in a stationary mixer and delivered to the job in a truck mixer shall be remixed for a minimum of 20 revolutions of the mixing drum at mixing speed at the job site prior to discharge.

When water is added at the delivery site to control the consistency of the concrete, the concrete shall be mixed for at least 30 revolutions of the mixer drum at mixing speed for each addition of water before discharge. These revolutions are in addition to the minimum revolutions required for mixing at the delivery site. The added water shall not cause the w/cm ratio to exceed the approved mix design w/cm ratio. Water from all sources shall be documented by the Contractor on the delivery slip for each load of concrete.

The Contractor shall provide a Concrete Truck Mixer Certification. This certification shall show the various pick-up and throw-over configurations and wear marks so that the wear on the blades can be checked. Blades shall be replaced when any part or section is worn 1 inch or more below the original height of the manufacturer's design. A copy of the manufacturer's design, showing the dimensions and arrangement of blades, shall be available to the Engineer at all times.

The Contractor shall furnish a water-measuring device in good working condition, mounted on each transit mix truck, for measuring the water added to the mix after the truck has left the charging plant. Each measuring device shall be equipped with an easy-to-read gauge. Water shall be measured to an accuracy of ± 3 percent.

(d) *Self Contained Mobile Mixer.* Proportioning and mixing equipment shall be of the self-contained, mobile, continuous mixing type in accordance with ASTM C685 and subject to the following:

- (1) The mixer shall be self-propelled and capable of carrying sufficient unmixed dry, bulk cementitious materials, fine aggregate, coarse aggregate, admixtures, and water to produce on the site at least 6 cubic yards of concrete. The mixer shall have one bin for each size aggregate.
- (2) The mixer shall be capable of positive measurement of cementitious materials being introduced into the mix. A recording meter visible at all times and equipped with a ticket printout shall indicate the quantity of total concrete mix.
- (3) The mixer shall provide positive control of the flow of water into the mixing chamber. Water flow shall be indicated by flow meter and be readily adjustable to provide for minor variations in the aggregate moisture.

13
REVISION OF SECTION 601
STRUCTURAL CONCRETE

- (4) The mixer shall be capable of calibration to automatically proportion and blend all components of indicated composition on a continuous or intermittent basis as required by the finishing operation, and shall discharge mixed material through a conventional chute directly in front of the finishing machine.
- (5) The Contractor shall perform calibration tests according to the equipment manufacturer's recommendations at the beginning of each project, and when there is a change in the mix design proportions or source of materials. The Engineer may require a calibration test or yield check when a change in the characteristics of the mixture is observed. The tolerances in proportioning the various ingredients shall be according to ASTM C685.

Subsection 601.09(h) shall include the following:

When ESCAs are used, the removal of forms, supports and housing, and the discontinuance of heating and curing may begin when the concrete is found to have the required compressive strength.

In subsection 601.12(g) delete the fifth paragraph and replace with the following:

When concrete is placed by pumping, the pumping equipment shall be thoroughly cleaned prior to concrete placement. Excess form release agent shall be removed from the hopper. The pump shall be primed at the Contractor's expense by pumping and discarding enough concrete to produce a uniform mix exiting the pump. At least 0.25 cubic yards of concrete shall be pumped and discarded to prime the pump. Water or admixtures shall not be added directly into the concrete pump hopper after placement has commenced. If water or admixtures are added to the concrete pump hopper, all concrete in the concrete pump hopper and the line shall be discarded and the pump shall be re-primed at the Contractor's expense.

In subsection 601.15 delete the second paragraph and replace with the following:

A Pre-placement Conference shall be held at a time mutually agreed upon before the initial placement of bridge deck concrete. Representatives of the ready mix producer and the Contractor shall meet with the Engineer to discuss the following topics:

Delete subsection 601.15(a) and replace with the following:

- (a) *Surface Preparation.* Tops of girders, precast deck panels, pier caps, and abutments that will come into contact with bridge deck concrete shall be heated to raise the temperature above 35 °F prior to concrete placement. The proposed preheating method is subject to approval by the Engineer.

Delete subsection 601.15(b).

In subsection 601.15(c) delete paragraphs 3 through 8.

In subsection 601.16 delete paragraphs 1 to 3 and replace with the following:

The minimum curing period shall be 120 hours.

The concrete surface shall be kept moist at all times by fogging with an approved atomizing nozzle or applying a monomolecular film coating to retard evaporation until the curing material is in place.

Concrete bridge decks, including bridge curbs and bridge sidewalks, shall be cured as follows:

Delete subsection 601.16(e).

Delete subsection 601.17 and replace with the following:

601.17 Acceptance and Pay Factors. These provisions apply to all concrete. The Contractor shall sample concrete for both Process Control (PC) and Owner Acceptance (OA) in accordance with CP 61. The Engineer will

14
REVISION OF SECTION 601
STRUCTURAL CONCRETE

witness the sampling and take possession of the OA samples at a mutually agreed upon location. The Contractor shall be responsible for Process Control (PC) testing for concrete. PC testing shall be performed at least once per day and then once per 50 cubic yards for concrete slump, unit weight, and concrete temperature.

If the produced concrete does not have a relative yield of 0.99 to 1.02 for two consecutive yield determinations, concrete production shall cease and the Contractor shall present a plan to correct the relative yield to the Engineer.

When SCC is used, the Contractor shall test the first load of SCC prior to placement for Slump Flow (ASTM C1611) and Blocking Assessment (ASTM C1621). The Contractor shall take a sample from the first portion of the load and complete the slump flow and blocking assessment prior to depositing any portion of the load. The tests shall not be performed more than 15 minutes prior to placement. The slump flow shall be 20 to 26 inches. The blocking assessment shall be less than or equal to 2.0 inches. The Contractor will be allowed to make adjustments to the load with admixtures. After adjustments have been made, the slump flow and blocking assessment shall be retested. Each subsequent load of SCC shall be tested for Slump Flow. If the slump flow differs from the first load by more than 2.0 inches, the load shall be adjusted to have a slump flow within 2.0 inches of the first load, or the load may be tested for Blocking Assessment (ASTM C1621). If the load is tested for and meets the requirements for Blocking Assessment (ASTM C1621), the load's slump flow will be used for the acceptance of the following loads. When concrete placement is halted for more than 15 minutes, the slump flow and blocking assessment shall be retested prior to resuming placement. When the slump flow exceeds 26 inches, the concrete may be placed if the depth of penetration is less than 11 millimeters when tested using ASTM C1712 Test Method for Static Segregation Resistance of Self-Consolidating Concrete. If a load of concrete has a slump flow greater than 26 inches and a depth of penetration less than 11 millimeters, the next load shall be tested for slump flow and blocking assessment to establish a new slump flow target.

When SCC is used, subsection 601.17(b) does not apply.

When SCC is used, the test methods for fabricating specimens in accordance with subsections 601.17(a) and 601.17(c) acceptance shall be modified to use ASTM C1758, Practice for Fabricating Test Specimens with SCC, for filling the test specimens with concrete.

- (a) *Air Content.* The first three batches at the beginning of each day's production shall be tested by the Contractor's PC and CDOT's OA for air content. When the PC and OA air content measurements differ by more than 0.5 percent, both the PC and OA air meters shall be checked in accordance with ASTM C231. When air content is below the specified limit, it may be adjusted in accordance with subsection 601.08. Successive batches shall be tested by the Contractor's PC and witnessed by the Engineer until three consecutive batches are within specified limits. After the first three batches, CDOT will follow the random minimum testing schedule. After the first three batches, the Contractor shall perform PC testing at a frequency of one random sample per 50 cubic yards. Air content shall not be adjusted after a CDOT OA test.

At any time during the placement of the concrete, when an OA test on a batch deviates from the minimum or maximum percent of total air content specified, the batch that deviates from the specified air content by 1 percent or less may be accepted at a reduced price using Table 601-3.

Portions of loads incorporated into structures prior to determining test results which indicate rejection as the correct course of action shall be subject to acceptance at reduced price, no payment, or removal as determined by the Engineer.

- (b) *Slump.* Except for Class BZ concrete, the slump of the delivered concrete shall be the slump of the approved concrete mix design plus or minus 2.0 inches. The maximum slump shall be 9.0 inches. Slump acceptance, but not rejection, may be visually determined by the Engineer. Any batch that exceeds the slump of the approved concrete mix design by more than 2.0 inches will be retested. If the mix design slump is exceeded by more than 2.0 inches a second time, that load will be rejected. If the slump is greater than 2 inches lower than the approved concrete mix design, the load may be adjusted by adding a water reducer or by adding water (if the w/cm allows) and retested.

15
REVISION OF SECTION 601
STRUCTURAL CONCRETE

Portions of loads incorporated into structures prior to determining test results which indicate rejection as the correct course of action shall be subject to reduced payment or removal as determined by the Engineer.

- (c) *Strength (When Specified)*. The concrete will be considered acceptable when the running average of three consecutive strength tests per mix design for an individual structure is equal to or greater than the specified strength and no single test falls below the specified strength by more than 500 psi. A test is defined as the average strength of three test cylinders cast in plastic molds from a single sample of concrete and cured under standard laboratory conditions prior to testing. If the compressive strength of any one test cylinder differs from the average by more than 10 percent that compressive strength will be deleted and the average strength will be determined using the compressive strength of the remaining two test cylinders.

When the average of three consecutive strength tests is below the specified strength, the individual low tests will be used to determine the pay factor in accordance with Table 601-3. If less than three strength tests are available the individual low tests, if any, will be used to determine the pay factor in accordance with Table 601-3. The pay factor will be applied to the quantity of concrete represented by the individual low test. For concrete having a specified strength of less than 4500 psi, when the compressive strength test is below the specified strength by more than 500 psi, the concrete represented will be rejected. For concrete having specified strength of 4500 psi or greater, when the compressive strength test is below the specified strength by more than 500 psi but not more than 1000 psi, the concrete represented will be evaluated by the Department for removal, corrective action, or acceptance at a reduced price. All costs of the evaluation shall be at the Contractor's expense. When the compressive strength test is below the specified strength by more than 1000 psi, the concrete represented will be rejected.

The Contractor may take cores at its own expense and in accordance with Colorado Procedure 65 within 10 working days of being notified of a price reduction or up to 45 days after placement, whichever is later, to provide an alternative determination of strength. Price reduction for strength will be based on the 28 day compressive strength of acceptance cylinders or corresponding cores strength, whichever is greater. If the core compressive strength is at least 90 percent of the specified field compressive strength, the concrete represented by the cores will be accepted with no price reduction.

The Engineer may use cores to determine acceptance or rejection of a part of the structure instead of acceptance cylinders. The Engineer will notify the Contractor in writing that CDOT will core the structure. The location of the coring will be directed by the Engineer. Coring and testing will be performed at the expense of the Department regardless of the result. Cores will be taken and tested in accordance with AASHTO T24 between 28 days and 45 days after concrete placement. Cores will be a minimum of 4 inches in diameter, unless otherwise approved by the Engineer. A minimum of three cores in a two square foot area will be obtained for locations of the structure that are suspect. If the compressive strength of any one core differs from the average by more than 10 percent that compressive strength will be deleted and the average strength will be determined using the compressive strength of the remaining two cores. If the compressive strength of more than one core differs from the average by more than 10 percent, the average strength will be determined using all three compressive strengths of the cores. If the average core compressive strength is greater than or equal to 85 percent of the specified 28 day compressive strength, the concrete represented by the cores will be accepted. If the average core compressive strength is less than 85 percent of the specified 28 day compressive strength, the structure will be evaluated by the Department according to subsection 105.03 for removal and replacement. Pay factors will not be based on cores taken by the Engineer. If the concrete represented by the cores is accepted, all costs associated with the repair of the core holes, including preparation and submittal of the repair method, will be measured and paid for separately.

After the Department performs additional core testing as described above, the Contractor may make one request that the structure be cored by the Contractor, tested and re-evaluated by the Department within 45 days after concrete placement. Coring and testing costs will be at the expense of the Contractor regardless of the result. Cores shall be taken at the same area of the structure as those obtained by the Engineer. The Engineer will approve the location of the cores prior to the Contractor coring the structure. All costs associated with the repair of these core holes, including preparation and submittal of the repair method, will not be measured and paid for separately, but shall be included in the work.

16
 REVISION OF SECTION 601
 STRUCTURAL CONCRETE

If the concrete in the structure is found to be sufficient resulting time delays will be considered excusable. If the concrete in the structure is still found to be deficient, resulting time delays will be considered non-excusable for this evaluation. Compensation for time delays will be evaluated by the Engineer in accordance with subsection 108.08.

The Contractor shall submit a proposed repair method for the core holes for approval prior to coring. The method shall use an approved non-shrink concrete patching material with a minimum compressive strength of 4500 psi. The Contractor shall submit the manufacturer’s recommendations along with the repair method. The Engineer will review and approve the proposed methodology prior to patching.

The Engineer will distribute electronically to the concrete supplier all compressive strength Owner Acceptance (OA) data for the concrete supplied to the project. The Engineer will distribute the OA compressive strength data within two business days of the 7 day and 28 day compressive strength testing. The data will include the compressive strength and batch ticket number at a minimum. The Contractor shall not have a valid dispute or claim as a result of any action or inaction by the Department related to the distribution of test results.

- (d) *Pay Factors.* The pay factor for concrete which is allowed to remain in place at a reduced price shall be determined according to Table 601-3 and shall be applied to the unit price bid for the Item.

If deviations occur in air content and strength within the same batch, the pay factor for the batch shall be the product of the individual pay factors.

**Table 601-3
 PAY FACTORS**

Percent Total Air		Strength		
Deviations From Specified Air (Percent)	Pay Factor (Percent)	Below Specified Strength (psi) [< 4500 psi Concrete]	Pay Factor (Percent)	Below Specified Strength (psi) [≥ 4500 psi Concrete]
0.0 – 0.2	98	1 – 100	98	1 – 100
0.3 – 0.4	96	101 – 200	96	101 – 200
0.5 – 0.6	92	201 – 300	92	201 – 300
0.7 – 0.8	84	301 – 400	84	301 – 400
0.9 – 1.0	75	401 – 500	75	401 – 500
Over 1.0	Reject	Over 500	Reject	
Concrete represented by out-of-spec tests will only be priced reduced with the lowest pay factor, not for each pay factor.			65	501 – 600
			54	601 – 700
			42	701 – 800
			29	801 – 900
			15	901 – 1000
			Reject	Over 1000

- (e) *Bonding of Bridge Deck Overlay.* After the curing period for Class DT concrete has elapsed, the overlay shall be “sounded” by the Contractor in accordance with ASTM D4580 Standard Practice for Measuring Delamination in Concrete Bridge Decks by Sounding to determine if the Class DT concrete has bonded to the bridge deck. In areas where the Class DT concrete has not bonded to the bridge deck, it shall be removed and replaced at the Contractor’s expense.
- (f) *Maturity Meter Strength.* When maturity meters are specified for determining strength for removing forms, removing false work, backfilling against structures, or loading the structure, the Contractor shall provide the Engineer a report of maturity relationships in accordance with CP 69 prior to placement of concrete.

If a maturity meter fails, is tampered with, destroyed, or was not placed, the following shall apply:

17
REVISION OF SECTION 601
STRUCTURAL CONCRETE

The minimum curing time or waiting time for removing forms, removing false work, backfilling against structures, or loading the structure shall be 28 days.

The Contractor may choose at his own expense to core the structure represented by the maturity meter. Cores shall be obtained and tested according to CP 65. Cores shall be a minimum of 4 inches in diameter. A minimum of three cores in a two square foot area shall be obtained. If the compressive strength of any one core differs from the average by more than 10 percent that compressive strength will be deleted and the average strength will be determined using the compressive strength of the remaining two cores. If the compressive strength of more than one core differs from the average by more than 10 percent, the average strength will be determined using all three compressive strengths of the cores. The average compressive strength of the cores shall achieve the specified compressive strength of the structure. A structure may be cored only once.

- (g) *Water to Cementitious Material Content (w/cm) Ratio.* The maximum w/cm ratio is the ratio that was used in the laboratory trial mix for the Concrete mix design. The w/cm ratio shall be determined for each batch of concrete by the Contractor and provided to the Engineer for approval prior to placement. If an adjustment to the mix is made after the Engineer's approval, the w/cm ratio shall be determined and submitted to the Engineer prior to the continuation of placement. Concrete that is placed without the Engineer's approval shall be removed and replaced at the Contractor's expense.

March 30, 2021

REVISION OF SECTION 601
CONCRETE MIX DESIGNS

NOTICE

This is a project special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Construction Engineering Services Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects with structural concrete.

March 30, 2021

1

REVISION OF SECTION 601
CONCRETE MIX DESIGNS

Revise Section 601 of the Standard Specifications for this project as follows:

Revise Subsection 601.05, second paragraph as follows:

- (12) For air entrained concrete, report the SAM number according to AASHTO TP118 Characterization of the Air-Void System of Freshly Mixed Concrete by the Sequential Pressure Method (Super Air Meter). The SAM meter readings for each step shall be included. Perform a SAM leak test prior to the SAM testing. Results of the leak test shall be included in the SAM data.

January 20, 2021

REVISION OF SECTION 601
STRUCTURAL CONCRETE

NOTICE

This is a standard special provision that revises CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Construction Services Branch with formal instructions regarding its use. It is to be used as written without change. Do not use modified versions of this special provision nor use this special provision in a manner other than specified in the instructions unless such use is first approved by the Construction Services Branch. The instructions for use on CDOT construction projects appear below.

Other agencies that use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects.

REVISION OF SECTION 601
STRUCTURAL CONCRETE

Section 601 of the Standard Specifications is hereby revised for this project.

In Subsection 601.05 delete the last five paragraphs and replace them with the following:

The Contractor shall submit a new Concrete Mix Design Report meeting the above requirements when a change occurs in the source, type, or proportions of cement, slag cement, fly ash, high-reactivity pozzolan, silica fume, or aggregate. When a change occurs in the source of approved admixtures, the Contractor shall submit a letter electronically sealed by the Concrete Mix Design Engineer approving the changes to the existing mix design. The Engineer shall approve the change prior to use.

The Engineer may permit the use of approved accelerating, retarding or hydration stabilizing admixtures to existing mix designs when documentation includes the following:

- (1) The manufacturer's recommended dosage of the admixture
- (2) A letter approving the changes to the existing mix design electronically sealed by the Concrete Mix Design Engineer.

Unless otherwise permitted by the Engineer, the product of only one type of hydraulic cement from one source of any one brand shall be used in a concrete mix design.

When Fiber-Reinforced Concrete is specified in the Contract, polyolefin fibers may be added to an approved mix design except when Macro Fiber-Reinforced Concrete is specified. If Macro Fiber-Reinforced Concrete is specified a new trial mix will be required. When polyolefin fibers are added to an approved concrete mix design, the Contractor shall submit a letter electronically sealed by the Concrete Mix Design Engineer approving the changes. The Engineer will approve the letter prior to use. The electronically sealed letter shall include the following:

- (1) The mix design number, both the CDOT mix ID number and the suppliers mix ID number.
- (2) The brand and type of polyolefin fibers.
- (3) The dosage of polyolefin fibers in pounds per cubic yard.
- (4) Adjustment to the fine aggregate batch weight.

Review and approval of the concrete mix design by the Engineer does not constitute acceptance of the concrete. Acceptance will be based solely on the test results of concrete placed on the project.

Delete Subsection 601.10 (c) 8. and replace it with the following:

8. The Contractor shall submit two sets of the fabricator's shop and erection drawings to the Engineer. The drawings shall be designed and electronically sealed by the Contractor's Engineer. The drawings will not be approved or returned to the Contractor. The drawings shall indicate the grade of steel, the physical and section properties of all permanent steel bridge deck form sheets, and attachment details.

Delete Subsection 601.11 (a) and replace it with the following:

- (a) *General.* The Contractor shall be responsible for designing and constructing falsework. The Contractor's Engineer shall determine whether falsework is necessary. When the Contractor's Engineer determines falsework is unnecessary, the Contractor shall submit a written statement signed by the Contractor's Engineer so stating. The Contractor's Engineer shall prepare and electronically seal all falsework drawings including revisions, which shall meet the requirements of subsection 601.11. The Contractor shall stamp the drawings "Approved for Construction" and submit to the Engineer. The Engineer will not approve the drawings.

December 28, 2020

REVISION OF SECTIONS 601 & 701
STRUCTURAL CONCRETE

NOTICE

This is a project special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Construction Engineering Services Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on projects with structural concrete.

REVISION OF SECTIONS 601 & 701 STRUCTURAL CONCRETE

The Standard Special Provision issued October 4, 2019 is revised as follows:

Delete subsection 601.02 Class P Items (4) & (8) and replace with the following:

(4) ASTM C150 Type III cement may be used for early opening.

(8) A minimum of 20 percent Class F fly ash or High Reactivity Pozzolan or 30 percent Slag cement by weight shall be used to replace any ASTM C150 cement, or ASTM C595 Type IL cement. ASTM C595 Type IT(MS), IT(HS), IP(MS) or IP(HS) cements may be used without cement substitutions. Class C fly ash may be used if the calcium oxychloride is determined to be less than 15 g CaOXY/100 g cementitious paste as determined in accordance with AASHTO T 365 for Class 0 Sulfate Exposure.

Delete subsection 601.02 Class PS and replace with the following:

Class PS Class PS concrete is used for prestressed concrete members. Requirements for Class PS concrete are specified in subsection 618.11. ASTM C150 Type III cement may be used.

Delete subsection 601.04 and replace with the following:

601.04 Sulfate Resistance. The Contractor shall provide protection against sulfate attack on concrete structures and pavements by providing concrete manufactured according to the requirements of the specified Sulfate Exposure Class. The sulfate exposure class for all concrete except Class PS shall be Class 2 unless otherwise specified on the plans. The sulfate exposure class for Class PS shall be Class 0. The requirements for a higher sulfate exposure class may be used for lower sulfate exposure classes.

The Contractor may request to test the soil and water at a structure location to change the sulfate exposure class. Testing and sampling of the location shall be at a frequency approved by the Engineer, in consultation with the Region Materials Engineer. If the Contractor provided test reports that show another class of exposure exists at a structure location, the Engineer may accept a concrete mix for that location at the changed sulfate exposure class.

Cementitious material requirements for each Sulfate Exposure Class are as follows:

Class 0 requires that the concrete have a maximum Water/Cementitious Material Ratio of 0.45 and one of the following:

- (1) ASTM C150 Type I, II, III or V
- (2) ASTM C595 Type IL, IP, IP(MS), IP(HS) or IT
- (3)

Class 1 requires that the concrete have a maximum Water/Cementitious Material Ratio of 0.45 and one of the following:

- (1) ASTM C150 Type II or V
- (2) ASTM C595 Type IP(MS) or IP(HS)
- (3) ASTM C150 Type III. Type III shall have no more than 8 percent C3A.
- (4) ASTM C595 Type IL(MS), IL(HS), IT(MS) or (HS)

REVISION OF SECTIONS 601 & 701 STRUCTURAL CONCRETE

Class 2 requires that the concrete have a maximum Water/Cementitious Material Ratio of 0.45 and one of the following:

- (1) ASTM C150 Type V with a minimum of a 20 percent substitution of Class F fly ash or slag cement by weight
- (2) ASTM C150 Type II or III with a minimum of a 20 percent substitution of Class F fly ash or slag cement by weight. The Type II or III cement shall have no more than 0.040 percent expansion at 14 days when tested according to ASTM C452.
- (3) ASTM C150 Type II, III, or V plus High-Reactivity Pozzolan where the blend has less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C1012
- (4) A blend of portland cement meeting ASTM C150 Type II or III with a minimum of 20 percent Class F fly ash or slag cement by weight, where the blend has less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C1012
- (5) ASTM C595 Type IP(HS), IL(HS) or IT(HS). Class F fly ash, slag cement, or High-Reactivity Pozzolan may be substituted for Type IL cement.
- (6) ASTM C595 Type IL(MS) or IT(MS) plus Class F fly ash, slag cement, or High-Reactivity Pozzolan where the blend has less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C1012

Class 3 requires that the concrete have a maximum Water/Cementitious Material Ratio of 0.40 and one of the following:

- (1) A blend of portland cement meeting ASTM C150 Type II, III, or V with a minimum of a 20 percent substitution of Class F fly ash or slag cement by weight, where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C1012
- (2)
- (3) ASTM C150 Type II, III, or V plus High-Reactivity Pozzolan where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C1012
- (4) ASTM C595 Type IL(MS) or IT(MS) plus High-Reactivity Pozzolan where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C1012
- (5) ASTM C595 Type IP(HS), IL(HS), or IT(HS) having less than 0.10 percent expansion at 18 months when tested according to ASTM C1012. Class F fly ash, slag cement, or High-Reactivity Pozzolan may be substituted for Type IL cement.
- (6) ASTM C595 Type IL with a minimum of a 20 percent substitution of Class F fly ash or slag cement by weight, where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C1012
- (7) ASTM C150 Type I, II, III, or V or ASTM C595 Type IL plus a minimum of 20 percent Class F fly ash when the R factor of the fly ash is less than 0.75. R factor is determined using the following from the chemical composition of the fly ash:

$$R = \frac{CaO - 5}{Fe_2O_3}$$

REVISION OF SECTIONS 601 & 701 STRUCTURAL CONCRETE

ASTM C150 Type III cements may only be used in Class P or PS Concrete when approved by the Engineer.

Class C fly ash shall not be substituted for cement when Class 1, 2, or 3 sulfate resistance/exposure class is specified.

The maximum Water/Cementitious Material Ratio may be exceeded when an expansive cement additive is used.

When fly ash or high-reactivity pozzolan is used to enhance sulfate resistance, it shall be used in a proportion greater than or equal to the proportion tested in accordance to ASTM C1012, shall be the same source, and shall have a calcium oxide content no more than 2.0 percent greater than the fly ash or high-reactivity pozzolan tested according to ASTM C1012. ASTM C1012 test results are acceptable for up to two years from the completion date of the test.

Table 601-2

Water-Soluble Sulfate (SO₄) in Dry Soil, (%)	Sulfate (SO₄) in Water, ppm	Sulfate Exposure Class
0.00 to 0.10	0 to 150	Class 0
0.11 to 0.20	151 to 1,500	Class 1
0.21 to 2.00	1,501 to 10,000	Class 2
2.01 or greater	10,001 or greater	Class 3

Delete subsection 601.05, fourteenth and fifteenth paragraph and replace with the following:

The Contractor shall submit a new Concrete Mix Design Report meeting the above requirements when a change occurs in the source, type, or proportions of cement, slag cement, fly ash, high-reactivity pozzolan, silica fume, or aggregate. Addition, removal, change of source, dosage change or type of fibers to an approved mix design shall require a new mix design. Adjustments to aggregate weights may be made to adjust yield if the combined gradation remains constant (+/-1 percent) or within the optimized band.

In subsection 701.01, delete ASTM C1157 Type GU, MS & HS

September 3, 2020

REVISION OF SECTION 602
REINFORCING STEEL

NOTICE

This is a standard special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Project Development Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use in projects having reinforcing steel.

REVISION OF SECTION 602 REINFORCING STEEL

DESCRIPTION

602.1 This work consists of furnishing and placing reinforcing steel in accordance with these specifications and in conformity with the plans.

MATERIALS

602.2 Reinforcing steel and welded wire fabric that will be furnished either uncoated or coated shall meet the requirements of subsection 709.01.

The coating material for epoxy coated reinforcing shall be a light colored powdered epoxy resin which will highlight rusting of untreated bar areas.

Reinforcing steel that requires welding shall conform to ASTM A706. Welding shall be done in accordance with ANSI/AWS D1.4.

All accessories, including reinforcing steel supports, ties, and splicers used in conjunction with the reinforcing steel, shall be of the same, or compatible coating as the reinforcing utilized.

Reinforcing steel not identified on the plans as epoxy coated may be supplied as epoxy coated, at the Contractor's option, at no additional cost to the Department. Epoxy coated reinforcing steel may not be substituted for Stainless, Continuous Hot dipped Galvanized, Zinc Coated (Galvanized), and Chromium reinforcing alternatives.

Reinforcing alternatives such as: Stainless, Continuous Hot dipped Galvanized, Zinc Coated (Galvanized), and Chromium reinforcing may be supplied for reinforcing steel or epoxy coated reinforcing, at the Contractor's option, at no additional cost or time to the Department as approved by the Engineer.

Length of lap splices for reinforcing steel shall be in accordance with AASHTO *LRFD Bridge Design Specifications*, unless otherwise specified.

CONSTRUCTION REQUIREMENTS

602.3 Bar List. Two copies of a list of all reinforcing steel and bending diagrams shall be furnished to the Engineer at the site of the work at least one week before the placing of reinforcing steel is begun. Such lists will not be reviewed for accuracy. The Contractor shall be responsible for the accuracy of the lists and for furnishing and placing all reinforcing steel in accordance with the details shown on the plans.

Bar lists and bending diagrams which are included on the plans, do not have to be furnished by the Contractor. When bar lists and bending diagrams are included on the plans, they are intended for estimating approximate quantities. The Contractor shall verify the quantity, size and shape of the bar reinforcement against those shown on the plans and make all necessary corrections before ordering.

602.4 Protection of Materials. Reinforcing steel and its coating shall be protected at all times from damage. When placed in the work, the reinforcing steel shall be free from dirt, loose mill scale, paint, oil, loose rust, or other foreign substance.

602.5 Bending. Unless otherwise permitted, all reinforcing bars shall be bent cold. Bars partially embedded in concrete shall not be field bent except as shown on plans or permitted. Bars shall not be bent or straightened in a manner that will injure the material or the coating. Should the Engineer approve the application of heat for field bending reinforcing bars, precautions shall be taken to assure that the physical properties of the steel will not be materially altered.

Hooks and bends shall conform to the provisions of the AASHTO LRFD Bridge Design Specifications

**REVISION OF SECTION 602
REINFORCING STEEL**

Bars which are shown as “hooked” on the plans shall have “standard hooks” unless otherwise indicated. The term “standard hook” as used herein shall mean one of the following:

- (1) A 180-degree turn plus an extension of four bar diameters but at least 2½ inches at the free end of the bar, or
- (2) A 90-degree turn plus an extension of 12 bar diameters at the free end of the bar, or
- (3) For stirrup and tie anchorage only
 - (i) No. 5 bar and smaller, 90-degree turn plus an extension of six bar diameters at the free end of the bar.
 - (ii) No. 6, 7, and 8 bar, 90-degree turn plus an extension of 12 bar diameters at the free end of the bar.
 - (iii) No. 8 bar and smaller, 135-degree turn plus an extension of six bar diameters at the free end of the bar

The inside diameter of bend measured on the inside of the bar, other than for stirrups and ties, shall be as follows:

Bar Size	Grade 60
No. 3 thru No. 8	6 bar dia.
No. 9, No. 10, and No. 11	8 bar dia.
No. 14 and No. 18	10 bar dia.

The inside diameter of bend for stirrups and ties shall not be less than four bar diameters for sizes No. 5 and smaller, and five bar diameters for No. 6 to No. 8 inclusive.

Inside diameter of bend in welded wire fabric, smooth or deformed, shall not be less than four wire diameters for deformed wire larger than D6 and two wire diameters for all other wires. Bends with inside diameter of less than eight wire diameters shall not be less than four wire diameters from the nearest welded intersection.

602.6 Placing and Fastening. The minimum spacing center to center of parallel bars shall be 2½ times the diameter of the bar. However, the clear distance between the bars shall not be less than 1½ times the maximum size of the coarse aggregate or 1½ inches, whichever is greater.

Bundle bars shall be tied together at not more than 6 foot centers.

All reinforcement shall have a clear coverage of 2 inches, except as shown on the plans. Clear coverage shall be measured from the surface of the concrete to the outside of the reinforcement.

Reinforcement used in post-tensioned concrete shall be adjusted or relocated during the installation of prestressing ducts or tendons, as required, to provide location and planned clearances to the prestressing tendons, anchorages, jacks and equipment as approved by the Engineer.

All reinforcement shall be tied at all intersections except where spacing is less than 1 foot in each direction, in which case alternate intersections shall be tied.

In concrete bridge decks the upper mat of bars shall be tied to the lower mat of bars at 4 foot maximum spacing in each direction. Slab bolsters for the bottom mat and high chairs for the top mat shall each be placed at a maximum spacing of 4 feet on centers.

Welding on reinforcing bars will not be permitted except as noted on the plans. Reinforcement placed in any

**REVISION OF SECTION 602
REINFORCING STEEL**

member shall be inspected and approved before any concrete is placed.

The placing, fastening, splicing and supporting of reinforcing steel and wire mesh or bar mat reinforcement shall be in accordance with the plans and the latest edition of "CRSI Recommended Practice for Placing Reinforcing Bars." In case of discrepancy between the plans and the CRSI publication stated above, the plans shall govern. Automated tie wire devices may be used. The total cross-sectional area of the automated tie wire wrap shall roughly equal the total cross-sectional area of a manually installed tie wire wrap. The tie wire shall be epoxy coated or plastic coated for use with epoxy coated reinforcing steel. All epoxy coating on the reinforcing steel that is damaged from the use of automated tie wire devices shall be repaired at the Contractor's expense.

Precast concrete blocking or other approved blocking material shall be used to support footing bars and bars in slabs on grade. All other reinforcing steel shall be supported with steel chairs or precast mortar blocks. All chairs coming in contact with forms shall be CRSI Class 1 or Class 2, Type B.

The location of splices, except where shown on the plans, shall be based upon using 60 foot stock length bars for No. 6 bars and larger and 40 foot stock length bars for No. 4 and No. 5 bars (this does not preclude the use of 60 foot). Minimum splice lengths are as shown on the plans. Where bars of different size are spliced together, the splice length for the smaller bar will govern.

Unless otherwise shown on the plans or approved, splices in adjacent lines of reinforcing bars shall be staggered. The minimum distance between staggered splices for reinforcing bars shall be the length required for a lapped splice in the bar.

Lapped splices will be permitted only at locations where the concrete section is sufficient to provide a minimum clear distance of 2 inches between the splice and the nearest adjacent bar. The clearance to the surface of the concrete shall not be reduced.

Reinforcing bars may be continuous at locations where splices are shown on the plans. Reinforcing bars No. 14 and No. 18 shall not be spliced by lapping, but shall be joined by butt welding in accordance with AWS D1.4 in such a way as to develop at least 125 percent of the specified yield strength of the bar in both tension and compression. Alternate systems of welding or mechanical butt splices may be submitted for approval.

**REVISION OF SECTION 602
REINFORCING STEEL**

METHOD OF MEASUREMENT

602.7 The weight of reinforcing steel for payment will not be measured but shall be the quantities designated in the Contract; except, measurements will be made for revisions requested by the Engineer, or for an error of plus or minus 2 percent of the total weight shown on the plans for each structure.

Prospective bidders shall verify the weight of reinforcing steel before submitting a proposal. Adjustment will not be made in the weight shown on the plans, other than for approved design changes or for an error as stipulated above, even though the actual weight may deviate from the plan weight.

The computed weight of coated reinforcing bars will be based on the nominal weight before application of the coating. Nominal weights for various bar sizes are shown below.

Bar Size	Weight per Linear Foot (in Pounds)	Bar Size	Weight per Linear Foot in Pounds
¼ inch	0.167	No. 8	2.670
No. 3	0.376	No. 9	3.400
No. 4	0.668	No. 10	4.303
No. 5	1.043	No. 11	5.313
No. 6	1.502	No. 14	7.650
No. 7	2.044	No. 18	13.600

BASIS OF PAYMENT

602.8 The accepted quantities of reinforcing steel will be paid for at the contract unit price per pound. No allowance will be made for supports, clips, wire or other material used for fastening reinforcement in place.

Payment will be made under:

Pay Item	Pay Unit
Reinforcing Steel Pound	Pound
Reinforcing Steel (Epoxy Coated)	Pound
Reinforcing Steel (Galvanized)	Pound
Reinforcing Steel (Stainless)	Pound
Reinforcing Steel (High Performance)	Pound

REVISION OF SECTION 613
LIGHTING

NOTICE

This is a standard special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Project Development Branch with formal instructions regarding its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by the Standards and Specifications Unit of the Project Development Branch. The instructions for use on CDOT construction projects appear below.

Other agencies that use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects with roadway lighting. This standard special provision shall be paired with CDOT's standard special provision 715 – Lighting and Electrical Materials.

1
REVISION OF SECTION 613
LIGHTING

Section 613 of the Standard Specifications is hereby revised for this project. Delete and replace it with the following:

DESCRIPTION

613.01 This work consists of furnishing and installing foundations, light standards, luminaires, light sources, conduit, cable, wiring, and incidental materials for highway lighting and electrical systems in accordance with these specifications and in conformance with the details, lines, grades, and locations shown on the plans or established.

MATERIALS

613.02 Roadway lighting materials shall conform to Section 715 and shall be compatible with the requirements of the local agency having jurisdiction.

- (a) *Foundation.* Concrete Foundation Pads and Light Standard Foundations shall be cast-in-place concrete. A complete foundation includes the concrete, reinforcing steel, grounding electrode, connector bolts, and anchor bolts.

Connector bolts and anchor bolts shall accommodate the anchorage of the light pole from its base flange to the base or transformer base, and from the base or transformer base to the light standard foundation.

- (b) *Light Standard.* A complete light standard includes the metal light pole, mast arm or arms, base or transformer base, approved breakaway device (optional), in-use receptacles (optional), grounding system, and all hardware. When a transformer base is not used, the pole shall have a handhole.
- (c) *Conduit.* Conduit includes all junction boxes, pull wire, weatherheads, adaptors, and expansion joints for conduit required to install complete runs.
- (d) *Electrical Warning Tape.* Electrical warning tape shall consist of pre-manufactured non-adhesive polyethylene material that is unaffected by acids, alkalis, and other soil components. The tape shall be detectable. The color of the tape shall be red, and it shall be a minimum 3.5 mils thick and 6 inches wide. Its tensile strength shall be 1,750 psi lengthwise.

The electrical tape shall include the following identification printed in black letters continuously along the length of the tape: "CAUTION BURIED ELECTRIC LINE BELOW".

The identification note and color of tape shall conform to the requirements of the "American Public Works Association (APWA) Uniform Color Codes (Red) – Electrical Power Lines, Cables, Conduit and Lighting Cables".

- (e) *Luminaire.* A complete luminaire includes the housing, lens, Light Emitting Diode (LED) board, dimming driver, slip-fitting clamp or approved manufacturer mounting, all necessary internal wiring, and 7-pin photoelectric control receptacle. Luminaires shall operate at either 120 VAC (Volts Alternating Current), 60 Hz, 277 VAC, 60 Hz. or 120-277VAC, 60 Hz.
- (f) *Lighting Control Center.* A complete lighting control center includes the load center, grounding system, contactors, relays, meter housing (optional per region requirements), meter disconnect (optional per region and utility company requirements), maintenance receptacle, photoelectric control, NEMA 4 enclosure, HVAC (optional per region requirements), snow skirt (optional per region requirements) and all related components, and connections to the power supply.
- (g) *Meter Power Pedestal.* A complete pedestal includes the NEMA 3R enclosure and all related components, load center, grounding system, meter housing, meter disconnect (optional per utility company requirements) maintenance receptacle (optional), photoelectric control, and connections to the power supply.

2
REVISION OF SECTION 613
LIGHTING

- (h) *Secondary Service Pedestal.* A complete pedestal includes the NEMA 3R enclosure and all related components and connections to the power supply.
- (i) *Heavy Duty Safety Switch.* Provide switches, mounted on the cabinet, with the following ratings:
- (1) 30 to 1200 amperes.
 - (2) 250 volts AC; 600 volts AC.
 - (3) 2, 3, 4 and 6 poles (2, 3 and 4 poles on 800 A; 2 and 3 on 1200 A).
 - (4) Fusible and non-fusible.
 - (5) Mechanical lugs suitable for copper conductors.
- (j) *Wiring.* Complete wiring includes control wiring, luminaire wiring, traffic signal wiring, main circuit wiring, ground wiring, service entrance wiring, and all other wiring necessary for a complete installation.
- (k) *Materials List.* At the Pre-Construction Conference, the Contractor shall submit to the Engineer three copies of a list of all materials and equipment to be incorporated into the work. The Contractor shall include the following items on the list:
- (1) Light standard foundations.
 - (2) Foundation pads.
 - (3) Light standard type (steel or aluminum).
 - (4) Luminaire manufacturer's product information including data in Illuminating Engineering Society (IES) format, IES photometric distribution type for vertical and lateral distribution and IES TM-15-11 rating (example: B2-U0-G1, Type III), and a photograph or line drawing.
 - (5) Luminaire mounting hardware.
 - (6) Luminaire initial lumen output.
 - (7) LED dimming driver or power supply.
 - (8) Lighting control center(s) and photoelectric control device(s).
 - (9) Secondary service pedestals.
 - (10) All other items required for a complete installation.

The Engineer will return lists that are incomplete or that include unacceptable materials to the Contractor for correction and re-submission.

The Contractor shall not order materials or equipment until the Engineer and the party or agency responsible for maintenance have reviewed and approved the materials and equipment list. The Engineer's approval of the list shall not relieve the Contractor of responsibility for the proper functioning of the completed installation.

- (l) *LED Luminaire Warranty.* The Contractor shall ensure that the LED luminaire has a manufacturer's minimum warranty of 10 years for all parts, materials, and shipping required to repair or replace the luminaire. The Contractor shall provide the manufacturer's warranty to the Engineer prior to installing the luminaire.

3
REVISION OF SECTION 613
LIGHTING

The warranty shall cover all failures including:

- (1) Failure in luminaire housing, wiring, connections, drivers, and photoelectric control devices.
- (2) More than 10 percent decrease in lumen output.
- (3) Significant change in color.

The warranty shall begin upon the date the Contractor receives the luminaire. The bill of lading shall be provided to the Engineer prior to final payment of the lighting.

- (m) *Technical Support.* During the manufacturer's warranty period, technical support shall be available from the manufacturer via telephone within 24 hours of the time the call is made from the Contractor, and this support shall be made available from factory certified personnel or factory certified installers at no additional charge to the Department.
- (n) *Temporary Lighting.* A complete temporary lighting system includes the temporary light standard, luminaire, mast arm, conduit, wiring, power source, temporary metering per the local utility standards, and all related components and connections to the power source.

CONSTRUCTION REQUIREMENTS

613.03 General. All work shall conform to these specifications and the National Electric Code (NEC) and shall comply with applicable regulations as specified in subsection 107.01.

Each system shall be installed as designated. The Contractor shall furnish and install all incidentals necessary to provide a complete working unit or system.

613.04 Concrete Foundation Pads and Light Standard Foundations.

Foundations shall be installed complete with grounding electrodes. Concrete Class D shall be used for foundation pads and concrete Class BZ shall be used for the light standard foundation. Concrete Class D can be used for light standard foundation if the rebar spacing in the foundation is at least 3 inches and the slump of the concrete is 6 to 9 inches. All concrete shall meet the requirements of Section 601. The drilled shaft (caisson) of the light standard foundation shall meet the requirements of Section 503.

The Contractor shall test and report soil conditions to the Engineer if any of the following soil conditions are encountered during roadway work:

- (1) Light standards are not installed within the roadway earthwork prism.
- (2) The soil has a high organic content or consists of saturated silt and clay.
- (3) The site will not support the weight of the drilling rig.
- (4) The foundation soils are not homogenous.
- (5) Firm bedrock is encountered.

Between drilling of the shaft and placing of concrete the hole shall not be disturbed. Wet or caving holes shall be backfilled with flow-fill and re-drilled after a three-day curing period without the use of casing. If testing is required, then soil testing shall be performed at the lowest elevation light standard location for all light connected to a single electrical circuit. Foundations shall be installed at the final grade.

All anchor bolts shall be positioned by means of steel templates. The center of the template shall coincide with the center of the base.

4
REVISION OF SECTION 613
LIGHTING

Conduits shall be properly positioned and anchored before the concrete is placed.

All foundations shall have ground electrodes conforming to the NEC. All foundations on structures shall be bonded to the structure steel by a method that is in accordance with the NEC and which is approved by the Engineer.

613.05 Light Standards. Poles shall be set plumb on the light standard foundation using non-corrosive metal shims or upper and lower nuts. Poles shall be level and plumb to the foundation. Defects and scratches on galvanized poles shall be given two coats of acceptable zinc-rich paint as directed. Defects and scratches on painted poles shall be primed and painted to match undamaged pole sections.

613.06 Luminaires, Light Sources, and Lamps. Roadway luminaires shall be mounted on the mast arm by a slip-fitter clamp or other approved device. Luminaires shall be adjusted vertically and horizontally to be plumb with the foundation and provide the required orientation and maximum light distribution on the roadway and meet IES TM-15 upright rating of U0 (no upright).

Luminaires are to be controlled by a centralized photoelectric control. For modified systems, individual photoelectric control may be used. The photoelectric control shall be positioned northward to minimize sun interference.

Luminaires of the specified type and initial lumen output shall be installed as specified. The type and initial lumen output shall be marked on each luminaire or pole in accordance with American National Standards Institute (ANSI) specifications. ANSI approved tags shall be provided and installed by the Contractor.

Wall type luminaires for use under overpass structures shall be mounted as specified. All wall type luminaires shall include side shielding to prevent glare in the motorist's view. The beam angle setting shall be adjusted to meet the project illumination requirements.

After installation and prior to acceptance, refractors and lenses shall be cleaned to provide maximum lumen output.

613.07 Conduit. The electrical conduit system shall be installed in accordance with subsection 715-07 Conduit and CDOT's "A Policy on the Accommodation of Utilities on Colorado Highways Rights-of-Way" and the following:

In the conduit system the locations of conduit, pull boxes, splice boxes and expansion joints shown on the plans are approximate. Actual locations shall be established during construction. The conduit system shall be located to avoid interference with known present or known future construction installations. All underground conduit runs and conduit risers on poles shall be installed as required for a complete installation.

All conduit installed under the roadway shall be at least 2-inch inside diameter unless otherwise designated. The Contractor may use larger conduit than specified at no additional cost to the project. If larger conduit is used, it shall be for the entire run from outlet to outlet. Reducer couplings shall not be used.

Existing underground conduit to be incorporated into a new system shall be cleaned with a round wire brush the same size as the internal diameter of the conduit, proofed with a mandrel ¼-inch less in diameter than the conduit inner diameter size, and blown out with compressed air.

Where new conductors are to be added to existing conductors in a conduit, all conductors shall be removed and the conduit cleaned as described above. All conductors shall be pulled into the conduit as a unit.

Conduit terminating in standards or pedestals shall extend approximately 2 inches vertically above the foundations and shall slope toward the handhole opening.

Conduit entering pull boxes shall terminate 2 inches inside the box wall and no more than 1.5 inches above the bottom and shall slope toward the top of the box to facilitate pulling of conductors. Conduit entering through the

5
REVISION OF SECTION 613
LIGHTING

bottom of a pull box shall be located near the end walls to leave the major portion of the box clear. All conduits shall be labeled as to the direction of their run.

The ends of all conduits, whether shop or field cut, shall be reamed to remove burrs and rough edges. Cuts shall be made square and true so that the ends will butt or come together for their full circumference.

Slip joints or running threads shall not be used for coupling conduit. When a standard coupling cannot be used for coupling metal type conduit, an approved threaded union coupling shall be used. All threads on ferrous metal conduit, not previously treated with a corrosion preventative, shall be painted with rust preventive paint before couplings are connected. All couplings for metal type conduit shall be tightened providing a continuous connection throughout the entire length of the conduit run to increase raceway mechanical strength. Areas where the coating on ferrous metal conduit has been damaged shall be painted with rust preventive paint.

All metal conduit ends shall be threaded and capped until wiring is started. When caps are removed, the threaded ends shall be provided with conduit bushings.

Non-metallic conduit shall be cut with a hacksaw or other approved tool. Non-metallic conduit connections shall be solvent-weld type or approved equal. Non-metallic conduit ends shall be capped until wiring is started.

All conduit stub-outs shall include a sweeping elbow and shall terminate in the box. All conduit stub-outs shall be capped.

Surface conduit connections at junction or splice boxes shall be tightly secured and waterproofed. All conduit ends shall be sealed with duct seal after installation of wiring. The duct seal shall be rated for outdoor use and easily removable.

When specified, conduit shall be installed under existing pavement by jacking or drilling operations. Where plans show that existing pavement is to be removed, jacking the conduit is not required. Boring, jacking or drilling pits shall be kept a minimum of 2 feet clear of the edge of pavement. Water shall not be used as an aid in the jacking or drilling operations, except when required to cool the cone head for directional boring.

Red, detectable electrical warning tape shall be installed between 6 inches and 12 inches below finished grade for all underground trenched conduit runs.

Trenched PVC conduit shall use rigid metallic conduit for all elbows and sweeps. All rigid metallic conduit elbows and sweeps shall be a PVC-coated, schedule 40 galvanized rigid conduit (GRC) minimum 36-inch radius bent to shape at the factory. All connections to non-metallic conduit shall be made with threaded couplings.

When trenching is specified to place conduit under existing pavement that is not to be removed, the trench width shall be 6 inches or less. Trenches shall be filled to 2 inches below the existing grade with structure backfill (flowfill), or another material if directed. The remaining 2 inches shall be filled to existing grade with hot mix asphalt within one calendar day after the roadway is trenched, in accordance with section 403.

Trenching shall be backfilled and compacted as follows: backfill shall be deposited in uniform layers. The thickness of each layer shall be 6 inches or less prior to compaction under all hardscape. The space under the conduit shall be completely filled. The remainder of the trench and excavation shall be backfilled to the finished grade. The backfill material shall be compacted to the density of at least 95 percent of maximum dry density. The maximum dry density and optimum moisture content (OMC) for A-1, A-2-4, A-2-5 and A-3 materials will be determined in accordance with AASHTO T 180 as modified by CP 23. The maximum dry density and OMC for all other materials will be determined in accordance with AASHTO T 99 as modified by CP 23. Materials shall be compacted at ± 2 percent of Optimum Moisture Content (OMC). Materials having greater than 35 percent passing the 75 μm (No. 200) sieve shall be compacted at 0 to 3 percent above OMC. Each layer shall be mechanically compacted by tamping with power tools approved by the Project Engineer. Compaction methods or equipment that damage the conduit shall not be used.

6
REVISION OF SECTION 613
LIGHTING

Underground conduit shall be buried a minimum of 30 inches below finished grade. There shall be no sag between boxes. Conduit under roadways shall be buried at 48 inches below finished grade. If the Contractor encounters bedrock such that the minimum conduit depths cannot be achieved, the Contractor shall be allowed to cover the conduit with 2 inches or more of concrete at a lesser burial depth.

All schedule 80 PVC conduits shall have slip fit expansion fittings at 100-foot intervals and 6 feet maximum from each elbow. Expansion fittings will be installed per the NEC requirements for 65 °F temperature change.

Pull or splice boxes shall be installed at a maximum distance of 400 feet or less. Boxes shall be placed at conduit ends, at all wiring splices, at all conduit angle points where total conduit bends within a stretch of conduit exceeds 360 degrees, and at all other locations shown on the plans. The Contractor may install additional pull or splice boxes to facilitate the work at no additional cost to the project

Where practical, pull and splice boxes near curbs shall be placed adjacent to the back of the curb. Pull boxes adjacent to light standards shall be placed behind or along the side of foundations.

Pull and splice boxes shall be installed so that the top of the covers are flush with the sidewalk and match the sidewalk slope and grade. Covers shall be level with the surrounding ground when no grade is established.

On bridges or other structures, rigid metallic conduits shall have an expansion fitting at every expansion joint of the bridge. Expansion joint fittings shall be precisely aligned with the conduit run to ensure proper expansion and deflection and to prevent binding. For vertical conduit runs, the fitting shall be installed close to the top of the structure to prevent water running across the fitting and entering the conduit. The fitting's deflection sleeve coupling, and pressure bushing at the barrel of the expansion body shall be installed flush with the structure ends; only the connecting expansion nipple shall cross the opening between structures. The fitting shall be supported by points on the conduit immediately adjacent to the fitting. The metal conduit fitting shall have an external bonding jumper.

613.08 Wiring. Unless otherwise authorized, the multiple system of electrical distribution shall be used. Conductors of the size and material required, whether single or in cable, shall be installed for control wiring, luminaire wiring, traffic signal wiring, main circuit wiring, ground wiring, service entrance wiring, and all other wiring necessary for a complete installation.

Conductors shall be sized to prevent a voltage drop of more than 3 percent per feeder run at the ambient temperature. All conductors shall be installed in conduit.

When 120-volt luminaires are installed, 120/240 VAC shall be brought to the base of each light standard, and individual luminaires shall be connected to one leg or the other in a manner that minimizes overall voltage drop.

A complete grounding system shall be installed for the entire electrical installation. Grounding shall consist of:

- (1) ground cables.
- (2) conduits.
- (3) grounding electrodes.
- (4) wire or strap.
- (5) and ground fittings, as required by the NEC.

Permissible grounding electrodes shall be:

- (1) ground rods.
- (2) concrete-encased electrodes.
- (3) grounding plates and grounding rings.

Alternative grounding electrodes per the NEC shall be approved by the Project Engineer prior to installation.

All electrical conductors shall be identified and tagged as follows: electrical conductor cable tags shall be located at each splice termination. The tags shall be attached with cable ties. The information shall be written on the tag

7
REVISION OF SECTION 613
LIGHTING

with a permanent marker. The information shall include the direction and approximate length of the cable, and the feeder or circuit destination (line and load sides). Each incoming (line side) conductor shall be individually color coded with one tape mark; each outgoing conductor (load side) shall be coded with two tape marks

613.09 Lighting Control Center, Meter Power Pedestal and Secondary Service Pedestals. Each lighting control center, meter power pedestal, and secondary service pedestals shall include:

- (1) a load center, a panel board.
- (2) Contactors.
- (3) a maintenance receptacle.
- (4) a meter housing (if applicable).
- (5) a photoelectric control.
- (6) a grounding electrode system with ground wells (if applicable).
- (7) a NEMA 4 or NEMA 3R enclosure with all related components.
- (8) HVAC (optional per region requirements).
- (9) snow skirt (optional per region requirements), and
- (10) connections to the power supply.

One copy of the cabinet drawings, one-line diagram, luminaire schedule, and a list of all system components and their manufacturers shall be placed in a heavy-duty plastic envelope with side opening that is attached to the inside cabinet door.

613.10 Heavy Duty Safety Switch. Install disconnect (safety) switches as required for a complete operating system. Each safety switch shall include pad-lockable handle, reinforced, rejection type fuse clips, NEMA 3R enclosure unless otherwise noted, grounding system, and shall connect with conduit and wiring as required for a complete operating system.

613.11 Temporary Lighting. The temporary lighting system shall include the temporary light standard, luminaire, mast arm, conduit, wiring, power source, temporary metering per the local utility standards, and all related components and connections to the power source. Temporary lighting system shall meet the requirements of Section 715 unless otherwise approved by the Engineer. For temporary lighting, wood poles may be substituted for metal poles.

- (a) *Temporary Lighting Levels.* Temporary lighting shall provide lighting levels equal to or exceeding the existing lighting levels and quality. Temporary luminaires shall meet backlight, uplight, and glare ratings listed in Table 715-1. Permanent luminaires shall meet all requirements listed in Section 715.

The Contractor shall keep the existing lighting system, the approved temporary replacements, or the temporary construction lighting in effective operation for the benefit of the traveling public during construction progress, except when shutdown is permitted to allow alteration or final removal of the system. Lighting system shutdowns shall not interfere with the regular lighting schedule unless otherwise permitted. Shutdown schedules are subject to approval by the Engineer. Existing installations to be removed shall be kept in operation until the new installations are operational, or as otherwise directed by the Engineer.

The Contractor shall maintain, provide, and install temporary roadway lighting within the project limits throughout the entire construction schedule. The contractor is responsible for the design and maintaining of all temporary roadway lighting throughout all stages of the project throughout the project duration. Use of the existing lighting system, temporary roadway lighting poles and installation of the permanent lighting shall be permitted to achieve the required lighting level criteria.

The Contractor shall submit a design for approval of the temporary roadway lighting. The submission shall show direct association to the proposed staging and construction schedule. No work shall commence until a temporary lighting design is approved by the Engineer.

All luminaires that have been used for temporary lighting shall be cleaned before being reinstalled for other temporary lighting locations. The Contractor shall keep temporary construction lighting installations in effective

8
REVISION OF SECTION 613
LIGHTING

operation until they are no longer required for the protection of the traveling public.

Reusable equipment damaged when the Contractor is removing and salvaging existing material shall be replaced or repaired at the Contractor's expense.

- (b) *Electrical Service.* The Contractor is responsible for all work to gain approvals, coordinate with the appropriate electrical utility, and arrange for service work to provide power source location. The contractor is also responsible for the annual or monthly bill, and other tasks to provide electrical service for the temporary lighting.
- (c) *Existing Systems.* All circuits to lighting outside of Project scope shall stay energized without interruption. If damage is caused by the Contractors' operations, damaged facilities shall be repaired or replaced promptly at the Contractor's expense. Where roadways are to remain open to traffic and existing lighting systems are to be modified, the existing systems shall be kept in operation until the final connection to the modified circuit(s) is made. The modified circuit(s) shall be complete and operating by nightfall of the same day the existing system is disconnected.

The Contractor shall determine the exact location of existing conduit runs and pull boxes before using equipment that may damage such facilities or interfere with any system.

Existing materials which interfere with or which are incompatible with new construction shall be removed or salvaged in the order directed or approved, before completion of the new construction. The Contractor shall notify CDOT and the appropriate utility at least four calendar days in advance of removing or salvaging the existing materials. Material damaged by the removal and salvage operations shall be repaired or replaced at the Contractor's expense.

- (d) *Temporary Service.*

All temporary lighting standards and temporary meters shall be located outside of the clear zone, or protected behind appropriate barrier or impact attenuator, as approved by the Engineer.

The Contractor shall install and energize the temporary lighting system prior to de-energizing and removing the existing lighting system.

The Contractor shall be responsible for obtaining and paying for temporary power through the duration of the project. The Contractor shall be responsible for removing the temporary lighting system after the permanent lighting system has been installed and energized. The Contractor shall be responsible for notifying CDOT and the appropriate utility of cancellation of temporary electrical service. After removing the temporary lighting and temporary meter, the Contractor shall be responsible for canceling the temporary power service with the utility.

613.12 Testing. Prior to final acceptance, the Contractor shall demonstrate to the Engineer's satisfaction that all electrical and lighting equipment installations are in proper working condition. Temporary power and all cable connections required for testing shall be provided by the Contractor.

The Contractor shall operate the lighting system from sunset to sunrise for ten consecutive days. Light sources, drivers or power sources, power generators, control systems, or photoelectric control that fail shall be replaced immediately. Replacement of these items will not require a restart of the test.

The Contractor shall perform grounding tests at each grounding system location including light standards, lighting control centers, meter power pedestals, and other grounding electrode locations. Grounding tests shall show that the ground resistance is 10 ohms or less. If the measured resistance to ground exceeds 10 ohms, additional grounding electrodes shall be added to the grounding electrode system at the Contractor's cost.

The Contractor shall perform voltage drop tests at a point ~~or~~ farthest from each circuit such that voltage drop is

9
REVISION OF SECTION 613
LIGHTING

within 3 percent of supply voltage.

The Contractor shall certify the records of all testing including grounding, voltage drop (within 3 percent) and other required tests as meeting specification requirements and submit the records to the Engineer.

METHOD OF MEASUREMENT

613.13 Concrete Foundation Pads and Light Standard Foundations will be measured by the actual number installed and accepted.

Light standards will be measured by the number of light standards installed.

Luminaires will be measured by the number of luminaires of the specified initial luminaire lumens installed and accepted.

Lighting control centers will be measured by the number of control centers installed. and accepted.

Meter power pedestals will be measured by the number of pedestals installed and accepted by the local electrical utility.

Secondary service pedestals will be measured by the number of pedestals installed. and accepted.

Heavy Duty Safety Switches will be measured by the number of switches installed. and accepted.

Conduit will be measured by the linear foot in place and shall include all expansion joints, conduit bodies, and other hardware for a complete installation.

All wiring necessary for the complete installation will be measured as a single lump sum.

Pull and/or splice boxes will be measured by number of boxes installed per the project plans.

Temporary lighting shall include install and removal of the temporary light standards, luminaires, mast arms, temporary conduit, temporary wiring, and all other equipment necessary for the complete installation and accepted. Temporary lighting shall be measured as a single lump sum.

BASIS OF PAYMENT

613.14 The accepted quantities will be paid for at the contract unit price for each of the pay items listed below that appear in the bid schedule.

Payment will be made under:

Pay Item	Pay Unit
Light Standard Foundation	Each
Concrete Foundation Pad	Each
Light Standard ____ (____ Foot) (Furnish Only) (Install Only)	Each
Luminaire (____) (____ Lumens)	Each
Luminaire (____) (____ Lumens) (Furnish Only) (Install Only)	Each
____ Inch Electrical Conduit (Furnish Only) (Install Only)	Linear Foot
____ Inch Electrical Conduit (Plastic) (Furnish Only) (Install Only)	Linear Foot
____ Inch Electrical Conduit (Jacked) (Furnish Only) (Install Only)	Linear Foot
Wiring	Lump Sum
Lighting Control Center	Each
Meter Power Pedestal	Each
Secondary Service Pedestal	Each

10
REVISION OF SECTION 613
LIGHTING

Temporary Lighting	Lump Sum
Power Transformer (___ kVA, ___ V- ___ V, ___ Phase)	Each
Circuit Breaker (___ A, ___ Pole)	Each
Safety Switch NEMA 3R, ___ A, ___ pole, ___ V)	Each
Pull box (_____)	Each

The lump sum price bid for Temporary Lighting shall be full compensation for all work and materials, and the removal of all said temporary lighting at job completion.

Payment for the temporary power shall not be included in the lump sum but shall be paid for under the Force Account Furnish and Install Electrical Service.

When the Contractor, at their option, installs larger conduit than specified, it will be paid for at the original contract price for the size specified.

The following items will not be measured and paid for separately, but shall be included in the work:

- (1) Soil testing for foundations;
- (2) Junction boxes, pull wire, weatherheads, adaptors, and expansion joints for conduit;
- (3) Additional pull and/or splice boxes installed at the Contractor's option;
- (4) Saw cutting; trenching; excavation; backfill; jacking; drilling pits; underground electrical warning tape; removal of pavement, sidewalks, gutters, and curbs and their replacement in kind to match existing grade; and all other work necessary to complete conduit installation;
- (5) Electrical conductor tagging;
- (6) Direct burial cable in conduit;
- (7) Testing of the lighting installation, including temporary power and all required cable connections.

The lump sum price bid for wiring will be full compensation for all electrical circuitry necessary to complete the electrical installation. All conductors in conduit, regardless of type, are part of the wiring item and will not be measured and paid for separately.

January 23, 2020

REVISION OF SECTION 614
PEDESTRIAN PUSH BUTTONS

NOTICE

This is a standard special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Project Development Branch with formal instructions regarding its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by the Standards and Specifications Unit of the Project Development Branch. The instructions for use on CDOT construction projects appear below.

Other agencies that use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects with Pedestrian Push Buttons, Accessible Pedestrian Signals, and Pedestrian Push Button Assembly Posts.

REVISION OF SECTION 614
PEDESTRIAN PUSH BUTTONS

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Delete subsection 614.08(f) and replace with the following:

- (f) *Pedestrian Push Buttons*. Pedestrian push buttons shall be a piezo, direct push button contact type and shall consist of electronic control equipment, mounting hardware, and push button.

The pedestrian push button shall be weatherproof, tamper-proof, constructed so that it will be impossible to receive any electrical shock under any weather condition, and operate on a voltage not to exceed 24 VAC.

The housing shall be shaped to fit the curvature of the pole to which it is attached to provide a rigid installation. Saddles shall be provided to make a neat fit when required.

Materials for Pedestrian Push Button Post Assembly shall conform to the following:

- (1) The Pedestrian Push Button Post Assembly, sign, and push button shall conform to the following:
 - (i) The latest version of the ADA Standards for Accessible Design, Chapter 3, Section 309 Operable Parts.
 - (ii) Current CDOT adopted Manual of Uniform Traffic Control Devices (MUTCD), Chapter 4E-Pedestrian Control Features.
 - (iii) NEMA TS 2 Section 2.1 requirements for Temperature and Humidity, Transient Voltage Protection, and Mechanical Shock and Vibration.
 - (iv) IEC 61000-4-4; 4-5 Transient Suppression requirements.
 - (v) FCC Title 47, Part 15, Class A, Electronic Noise requirements.
- (2) The post for the Pedestrian Push Button Post Assembly shall be aluminum Schedule 40.
- (3) Wiring for the Pedestrian Push Button Post Assembly shall conform to the manufacturer's recommendations.
- (4) A #10 AWG (minimum) bare copper wire shall be used to connect the Pedestrian Push Button to the signal grounding system.
- (5) For signalized intersection crossings, the system shall have a programmable Extended Push Activation feature with the ability to extend the Walk time. Activation shall be programmable from one to six seconds.

Delete subsection 614.08(g) and replace with the following:

- (g) *Accessible Pedestrian Signals*. The Accessible Pedestrian Signal (APS) shall be an audible vibro-tactile pedestrian signal system and shall consist of all electronic control equipment, mounting hardware, and push button, designed to provide both a push button with a raised, vibrating tactile arrow on the button as well as a variety of audible indications for differing pedestrian signal functions.

The integrated pedestrian push button shall be weatherproof, tamper-proof, constructed so that it will be impossible to receive any electrical shock under any weather condition, and operate on a voltage not to exceed 24 VAC.

The housing shall be shaped to fit the curvature of the pole to which it is attached to provide a rigid installation. Saddles shall be provided to make a neat fit when required.

2
REVISION OF SECTION 614
PEDESTRIAN PUSH BUTTONS

Materials for Pedestrian Push Button Post Assembly shall conform to the following:

- (1) The pedestrian push button post assembly, integrated push button, and sign shall meet the following requirements:
 - (i) The latest version of the ADA Standards for Accessible Design, Chapter 3, Section 309 Operable Parts.
 - (ii) Current CDOT adopted Manual of Uniform Traffic Control Devices (MUTCD), Chapter 4E – Pedestrian Control Features.
 - (iii) NEMA TS 2 Section 2.1 requirements for Temperature and Humidity, Transient Voltage Protection and Mechanical Shock and Vibration.
 - (iv) IEC 61000-4-4; 4-5 Transient Suppression requirements.
 - (v) FCC Title 47, Part 15, Class A, Electronic Noise requirements.
 - (vi) The APS pushbutton enclosure shall meet the NEMA 250 – Type 4X enclosure requirement.
- (2) The post for the Pedestrian Push Button Post Assembly shall be aluminum, Schedule 40.
- (3) Wiring for the Pedestrian Push Button Assembly shall conform to the manufacturer's recommendations.
- (4) A #10 AWG (minimum) bare copper wire shall be used to connect the Pedestrian Push Button Post Assembly to the signal grounding system.
- (5) For signalized intersection crossings, the system shall have a programmable Extended Push Activation feature with the ability to extend the Walk time and provide an informational audible message. Activation shall be programmable from one to six seconds.

The Accessible Pedestrian Signal shall have the following functional requirements:

1. APS functional features.

The APS shall be programmable and adjustable. Programming and adjustments shall be made using a laptop computer, smart device, or vendor supplied programmer. No additional hardware or equipment shall be required. The APS shall be fully compatible with the three latest versions of the Windows operating platform. The programmable features shall be:

- (1) Push-button locator tone.
- (2) Walk and Wait audible message.
- (3) Audible push-button informational message.
- (4) Audible crossing beacon.
- (5) Vibrating, tactile arrow push button.
- (6) Independent minimum and maximum volume limits for the Locator Tone, Walk, and Audible Beacons features.

Audible features shall emanate from the pedestrian pushbutton housing. The APS shall utilize digital audio technology, having a minimum 12-bit sample at a 16k Hz sample rate. Total harmonic distortion shall be less than 3 percent at 75 decibels. The APS shall provide independent ambient sound

REVISION OF SECTION 614
PEDESTRIAN PUSH BUTTONS

adjustment for the Locator Tone feature. The APS shall allow for Locator Tone volume to be set below the ambient noise level. The system shall have a minimum of three programmable locator tones. All sound levels shall adjust automatically utilizing an internally mounted, interval ambient sensing microphone, in accordance with the MUTCD.

For signalized intersection crossings, the APS shall monitor the Walk condition for conflict operation. As a standalone unit, the APS shall disable the Walk functionality should a conflict be detected.

The APS system shall log cumulative call data. The data shall be date and time stamped, and shall be accessible via laptop or smart device.

For signalized intersection crossings, the system shall provide a programmable audible Wait message when the button is pushed. The message shall only announce once per actuation.

2. Power Control Unit (PCU).

The PCU shall be mounted in the pedestrian signal head and shall be powered by the activation of Walk or Don't Walk using 120 Volts Alternating Current (VAC).

The PCU shall utilize separate power inputs for Walk and Don't Walk. The PCU shall not require more than four wires from the PCU to the corresponding push button.

3. Push Button Assembly (PBA).

The PBA shall be a single assembly containing an ADA compliant, vibro-tactile (signalized) directional arrow button, weatherproof audible speaker, and informational sign with optional placard braille messages. The PBA housing shall not incorporate any plastic or polycarbonate parts.

The PBA tactile arrow shall be 2 inches in length and shall be field adjustable to two directions.

The push button shall utilize Piezo switch technology rated at greater than twenty million operations. Vibro-tactile operation shall pulse at 20 Hz with a minimum 0.003-inch displacement against a 2 pound applied force.

The PBA assembly shall be capable of mounting on a curved or flat surface utilizing either machine screws or bolts or banding type mounting hardware. The PBA shall accommodate mounting to a minimum 4-inch diameter pole.

Delete paragraph 3 of subsection 614.09(4) and replace with the following:

Prior to start of the installation of a APS, the Contractor shall submit all units for testing. Installation of the APS shall not begin until written approval of each unit has been received from the Engineer. If a unit fails to pass testing, the Contractor shall repair or replace the unit at their expense.

Delete paragraphs 4 and 5 of subsection 614.09(4)

Subsection 614.10(j) shall include the following:

- (j) A field test of a single APS shall be performed in the presence of the Engineer. All repairs or replacements required to ensure a fully operational system shall be at the Contractor's expense.

The APS shall be installed in accordance with the manufacturer's recommendations.

Subsection 614.13 shall include the following:

Pedestrian Push Button will be measured by the actual number that are installed and accepted.

4
REVISION OF SECTION 614
PEDESTRIAN PUSH BUTTONS

Subsection 614.14 shall include the following:

Payment will be made under:

Pay Item	Pay Unit
Pedestrian Push Button	Each

January 20, 2021

REVISION OF SECTION 625
CONSTRUCTION SURVEYING

NOTICE

This is a standard special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Construction Services Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects.

1
REVISION OF SECTION 625
CONSTRUCTION SURVEYING

Section 625 of the Standard Specifications is hereby revised for this project as follows:

Subsection 625.01 shall include the following:

Adobe Sign software shall be used for electronic seals by the Contractor's Engineer, a Professional Engineer, or a Professional Land Surveyor. Electronic signatures and seals shall comply with the requirements of the Architects, Professional Engineers, and Professional Land Surveyors Rules and Regulations, 4 CCR 730-1.

Delete the 2nd and 3rd paragraphs in Subsection 625.11 and replace with the following:

The Contractor shall make all survey records generated available to the Engineer for inspection or reproduction at all times. The Contractor shall submit all survey records to the Engineer before final project acceptance. All survey records are considered property of the Department. The responsible PLS or PE identified in subsection 625.01 shall electronically seal all survey records.

The electronic format shall contain the information and format as required in the Survey Manual Chapter 6, Section 6.1.15 including stakeout data and the raw data from the actual placement of stakes. The records shall be electronically sealed by the PLS or PE in responsible charge identified in subsection 625.01.

Delete the 4th paragraph in Subsection 625.13 and replace with the following:

Before final payment, the Contractor's responsible P.L.S. or P.E. shall complete and electronically seal all survey records and the Project Control Diagram (supplemental or amended). Submit the survey records and the supplemental or amended Project Control Diagram to the Engineer and the Region Survey Coordinator for review.

January 20, 2021

REVISION OF SECTION 629
SURVEY MONUMENTATION

NOTICE

This is a standard special provision that revises CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Construction Engineering Services Branch with formal instructions regarding its use on CDOT Construction Projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT Construction Projects, and do not use this special provision on CDOT projects in a manner other than specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies that use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects.

REVISION OF SECTION 629
SURVEY MONUMENTATION

Section 629 of the Standard Specifications is hereby revised for this project.

In Subsection 629.03 revise the fifth and sixth paragraphs with the following:

The Contractor shall make all survey records generated available to the Engineer for inspection or reproduction at all times. The Contractor shall submit all survey records to the Engineer before Final Acceptance. All survey records are considered property of the Department. The responsible PLS or PE identified in subsection 629.01, shall electronically seal all survey records.

The electronic format shall contain the information and format as required in the Survey Manual Chapter 6, Section 6.1.15 including stakeout data and the raw data from the actual placement of the monuments.

In Subsection 629.05, last (4) revise with the following:

Before Survey Monumentation payment is made, the Contractor's surveyor shall submit legible electronically sealed copies of the survey records in accordance with subsection 629.03.

Before final Survey Monumentation payment and prior to depositing with the county, in accordance with Title 38 CRS, Property – Real and Personal, State Board Rules and Policies, MOU, and the CDOT Survey Manual, the Contractor shall complete and electronically seal all survey records, the ROW Plans, and the Project Control Diagram (new, supplemental or amended) and submit copies the Engineer.

December 28, 2020

REVISION OF SECTION 630
CONSTRUCTION ZONE TRAFFIC CONTROL

NOTICE

This is a project special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Construction Engineering Services Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects.

REVISION OF SECTION 630
CONSTRUCTION ZONE TRAFFIC CONTROL

Section 630 of the Standard Specifications is hereby revised:

Revise Section 630.11 Traffic Control Management first and second paragraph as shown:

630.11 Traffic Control Management.

The Contractor shall designate an individual, other than the superintendent, to be the Traffic Control Supervisor. The Traffic Control Supervisor shall be certified as a worksite traffic supervisor by an authorized entity and shall have a current flagger certification from an authorized entity. A copy of the Traffic Control Supervisor's certifications shall be provided to the Engineer at the Pre-construction Conference and shall be available at all times on the worksite.

The Contractor's Superintendent, and all others serving in a similar supervisory capacity, shall have completed an approved Traffic Control Supervisor training as offered by the authorized entities. The certifications of completion or certifications of achievement for all appropriate staff shall be submitted to the Engineer at the Pre-construction Conference.

In the third paragraph, Traffic Control Supervisor's duties, (7), revise as shown

- (7) Ensuring that traffic control devices are functioning as required.

REVISION OF SECTION 630
BARRIER (TEMPORARY)

NOTICE

This is a standard special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Project Development Branch with formal instructions regarding its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by the Standards and Specifications Unit of the Project Development Branch. The instructions for use on CDOT construction projects appear below.

Other agencies that use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on projects with temporary barrier.

REVISION OF SECTION 630
BARRIER (TEMPORARY)

Section 630 of the Standard Specifications is hereby revised for this project as follows:

Delete subsection 630.08 and replace with the following:

630.08 Temporary Barrier. Temporary Barrier shall comply with the crash test requirements contained in NCHRP Report 350 (for devices manufactured prior to 2020) or MASH (acceptable for all temporary barrier). Retroreflectorization is required on all temporary barrier according to Standard Plans S-612-1 and M-606-14, and shall meet material qualities in accordance with Section 713. All barrier types shall be designed to accommodate appropriate end treatments, transitions and delineation devices. Previously damaged barrier shall not be installed and barrier damaged after installation shall be removed and replaced, or repaired (for minor damage not affecting design intent) per manufacturer.

- (a) *Concrete Barrier.* Temporary concrete barrier shall conform to precast Type 7 Concrete Barrier as detailed in Standard Plan M-606-14.
- (b) *Non-Concrete Barrier.* Temporary non-concrete barrier shall be on the Department's Approved Product List. If used, metal barrier shall be made of galvanized steel. All non-concrete barrier types shall be designed to allow for proper drainage runoff. Barrier shall be installed and maintained according to manufacturer requirements, and include all necessary components for installation. Product specific documentation pertaining to installation, maintenance, repair, removal, and inspection shall be provided by the Contractor prior to installation.

In subsection 630.17 delete the third paragraph and replace with the following:

Traffic channelizing devices consisting of vertical panels, traffic cones, or drums will be measured by the unit. Barrier (Temporary) will be measured by the linear foot. Barricades will be measured by the number used. Barricade warning lights shall be furnished as a part of this item when required by the Traffic Control Plan (TCP). Advance Warning Flashing or Sequencing Arrow Panels will be measured by the unit according to size.

In subsection 630.18 delete the following:

Pay Item	Pay Unit
Concrete Barrier (Temporary)	Linear Foot

Subsection 630.18 shall include the following:

Pay Item	Pay Unit
Barrier (Temporary)	Linear Foot

September 3, 2020

REVISION OF SECTION 709
REINFORCING STEEL AND WIRE ROPE

NOTICE

This is a standard special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Project Development Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use in projects having reinforcing steel and wire rope.

**REVISION OF SECTION 709
REINFORCING STEEL AND WIRE ROPE**

Section 709 of the Standard Specifications is hereby revised for this project as follows:

709.01 Reinforcing Steel. Reinforcing steel shall conform to the requirements of the following specifications:

Deformed and Plain Billet-Steel Bars for Concrete Reinforcement	ASTM A615
Axle-steel Deformed and Plain Bars for Concrete Reinforcement	ASTM A996
Low-Alloy Steel Deformed Bars for Concrete Reinforcement [to be Welded]	ASTM A706
Fabricated Deformed Steel Bar Mats for Concrete Reinforcement	ASTM A184
Steel Welded Wire Fabric, Plain for Concrete Reinforcement	AASHTO M 55
Steel Welded Wire Fabric, Deformed for Concrete Reinforcement	AASHTO M 221
Epoxy Coated Reinforcing Bars	AASHTO A 775
Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement	ASTM A767
Deformed and Plain Stainless Steel Bars for Concrete Reinforcement	ASTM A955
Deformed and Plain, Low-Carbon, Chromium, Steel Bars for Concrete Reinforcement	ASTM A1035
Continuous Hot-Dip Galvanized Steel Bars for Concrete Reinforcement	ASTM A1094

Unless otherwise designated, bars conforming to ASTM A615 & ASTM A996 shall be furnished in Grade 60.

In ASTM A 184, bar material conforming to ASTM A616 will not be permitted.

In ASTM A955, bar material shall be furnished in Grade 75 unless otherwise designated.

In ASTM A1035, bar material of Type CL will not be permitted unless designated in the plans or otherwise approved by the Engineer.

709.02 Wire Rope. The wire rope shall conform to the requirements of AASHTO M 30 for the specified diameter and strength class.

709.03 Dowel Bars and Tie Bars. Tie bars for longitudinal and transverse joints shall conform to AASHTO A 775 and shall be grade 40, epoxy-coated, and deformed. Bar size shall be as designated on Standard Plan M-412-1.

Dowel bars for transverse joints shall conform to AASHTO M 254 for the coating and to ASTM A615, grade 60 for the core material and shall be epoxy-coated, smooth, and lightly greased, precoated with wax or asphalt emulsion, or sprayed with an approved material for their full length. Bar size shall be as designated on the Standard Plan M-412-1.

March 30, 2021

REVISION OF SECTION 710
FENCE AND GUARDRAIL

NOTICE

This is a project special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Construction Engineering Services Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT's Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the Standard Specifications for Road and Bridge Construction to administer construction projects, may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects having either cable barrier and/or fencing.

March 30, 2021

1
REVISION OF SECTION 710
FENCE AND GUARDRAIL

Revise Section 710 of the Standard Specifications as follows:

Subsection 710.07 Fence Posts, revise the fourth paragraph to include:

Steel posts shall be galvanized in accordance with AASHTO M 111. Fittings, hardware and other appurtenances not specifically covered by the Contract shall be standard commercial grade, and in accord with current standard practice. Pipe or roll-formed steel material for fence posts shall conform to the requirements shown on the plans and to the requirements of Class 1 Pipe, Grade A and Grade B or Class 3 Formed Steel Sections, of Federal Specification RR-F-191/3E.

September 18, 2020

REVISION OF SECTION 715
LIGHTING AND ELECTRICAL MATERIALS

NOTICE

This is a standard special provision that revises or modifies CDOT's *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT's Project Development Branch with formal instructions regarding its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by the Standards and Specifications Unit of the Project Development Branch. The instructions for use on CDOT construction projects appear below.

Other agencies that use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

Instructions for use on CDOT construction projects:

Use this standard special provision on all projects with roadway lighting. This standard special provision shall be paired with CDOT's standard special provision 613 - Lighting.

REVISION OF SECTION 715
LIGHTING AND ELECTRICAL MATERIALS

Section 715 of the Standard Specifications is hereby revised for this project. Delete and replace it with the following:

715.01 General. Materials shall be of a standard line from a manufacturer that has at least three installations of the same type that have been installed and active for a minimum of one year (anywhere or for CDOT specifically? / mk). Electrical material shall be listed by the Underwriters' Laboratories, Inc. (UL), and shall conform to the current edition of the National Electrical Code (NEC).

Material shall be the same as, or compatible with, that used and accepted by the agency responsible for maintenance. The Contractor shall coordinate and conduct a final inspection with the Engineer and each Owner upon completion of construction. This inspection shall assure that all lighting and electrical materials are in compliance with these requirements. The Engineer will obtain the Owner's written approval before accepting the work.

The Engineer may inspect all lighting and electrical materials and accept or reject them at the project site. Samples may be taken, or manufacturer's certifications may be accepted in lieu of samples.

715.02 Light Standard Foundations and Concrete Foundation Pads. Concrete shall be Class BZ for cast-in-place concrete foundations. All concrete shall conform to Section 601.

Anchor bolts shall be designed by the Contractor's Engineer and shown on the working drawings, or as provided by the pole manufacturer. The threaded ends of the anchor bolts, the nuts, and the washers shall be galvanized in accordance with ASTM A153. Galvanizing on anchor bolts shall extend 2 to 4 inches beyond the threads.

Reinforcing steel shall conform to Section 602.

715.03 Light Standards.

- (a) *General.* Structural components of light standards, bases, couplers, anchor bolts, luminaires, and other attachments to be used for lighting shall be designed for a minimum of 120 MPH wind speed, in accordance with AASHTO's LRFD Bridge Design Specifications. For special wind regions, the wind speed shall be in accordance with Section 3.8.3. The CDOT Bridge Design Manual, Section 32.3 shall be used for Owner approved wind speeds.

Breakaway bases and couplers shall meet the breakaway requirements specified in AASHTO's LRFD Bridge Design Specifications Section 12. Conformance shall be verified by crash tests reviewed and accepted by FHWA. A certificate of compliance shall be provided.

- (b) *Metal Light Standards.* Metal light standards shall be fabricated of either steel or aluminum, unless otherwise specified. Whenever the light standard metal is not specified, the Contractor may furnish either steel or aluminum. Material type and shape of light standards shall be the same throughout the project, unless otherwise shown in the Contract.

Metal poles shall be tapered and shall be supplied with pole caps.

Standards shall have cable-entrance holes located in conformity with the type of arm mounting used. Metal surfaces shall be free of imperfections marring the appearance and of burrs or sharp edges that might damage the cable.

Aluminum alloys shall have a minimum yield strength of 25,000 psi. Aluminum poles, arms, and fittings shall be made of aluminum alloy conforming to the following for the material form required:

2
 REVISION OF SECTION 715
 LIGHTING AND ELECTRICAL MATERIALS

ASTM Standard	Alloy Number
B 209	6061-T6
B 211	6061-T6
B 221	6061-T6 6063-T6 6005-T5
B 241	6061-T6 6063-T6

Aluminum poles may also be made of aluminum alloy 5086-H34 conforming to ASTM B313 (excluding pressure and burst tests).

Aluminum mast arms shall be tapered unless otherwise shown on the plans.

Steel mast arms shall be made of Schedule 40 standard steel pipe conforming to ASTM A53.

Steel poles, mast arms and base flanges shall be hot-dip galvanized in accordance with ASTM A123. Units on which the spelter coating has been damaged shall be repaired as provided in AASHTO M 36, or other approved method.

Base flanges for both aluminum and steel poles shall have continuous welds both inside and outside, unless otherwise permitted. Base flanges inserted into the pole and bonded shall meet the requirements for materials and strength stated herein.

Base flanges for aluminum poles and transformer bases shall be aluminum castings of alloy ANSI 356.0-T6 or UNS A03560 T6 conforming to ASTM B26 or an acceptable equivalent.

Each metal light standard shall be wired with a breakaway, submersible fused connector of proper capacity rating. The fused connector shall be located in the transformer base. If the light standard has no transformer base, the fused connector shall be located in the pole at the hand hole.

Transformer bases shall have vandal resistant, removable access doors.

The transformer base shall be a frangible breakaway type as shown in CDOT standard S-613-1 and shall accommodate the anchorage and base flange of the light pole supplied. Each transformer base shall have a ½ inch bolt or lug fastened inside the base for grounding; the lug or bolt shall be visible from the door opening.

- (c) *Hardware.* Hardware used with steel standards shall be either cadmium plated steel, hot dip galvanized steel, or stainless steel. All hardware used with aluminum standards shall be anodized aluminum or stainless steel with anti-seize compound. Bolts to be inserted in aluminum threads shall be stainless steel with an anti-seize compound.

715.04 Luminaires and Light Sources. Luminaires shall be UL or Intertek Testing Services (ETL) listed for use in wet locations with a minimum IP66 rating. Luminaires shall be adaptable to the type of power distribution system to be used.

- (a) *General.* Luminaires shall conform to the following requirements:

- (1) *Housing.* The luminaire enclosure shall be an injection-molded or die-cast opaque housing. The

REVISION OF SECTION 715
LIGHTING AND ELECTRICAL MATERIALS

housing shall have a powder-coated, corrosion-resistant finish. The luminaires shall be gray or as specified per the project.

The housing shall have a door that provides access to all internal components. The door shall be equipped with a safety catch and a latch. The housing shall have an inner rolled flange to support the door frame. The door frame shall be an aluminum casting, hinged to the housing. The door frame shall be sealed to the housing with a molded silicone gasket and shall be secured with a minimum of four captive screws.

- (2) Optical Chamber. The luminaire distribution shall be equal to or less than an Illuminating Engineering Society (IES) TM-15-11 Backlight, Uplight, and Glare (BUG) ratings listed below in Table 715-1 based on initial luminaire lumens or light loss factor (LLF) = 1.0. Roadway luminaires with a U value greater than U0 shall not be accepted. The optical chamber shall be completely sealed from the housing, or the housing shall be completely sealed. A seamless one-piece memory-retentive gasket shall seal the optical chamber or housing against the luminaire lens door. All wires entering the optical chamber shall be gasketed at the point of entry. Socket mountings, rivets used in the construction or support of the reflector system, and all other penetrations into the optical chamber shall be completely sealed. The optical chamber shall be water tight when the luminaire door is closed.

**Table 715-1
BACKLIGHT, UPLIGHT AND GLARE (BUG) VALUES**

Luminaire Mounting Location	Minimum Initial Luminaire Lumen Range	Backlight (B) Rating Maximum	Uplight (U) Rating Maximum	Glare (G) Rating Maximum
Non median-mounted	Less than 6,000	B1	U0	G1
	6,000 – 14,000	B2	U0	G2
	14,000 – 24,000	B3	U0	G3
	Above 24,000*	B3	U0	G4
Median-mounted	Less than 6,000	B2	U0	G1
	6,000 – 14,000	B3	U0	G2
	14,000 – 24,000	B4	U0	G3
	Above 24,000*	B4	U0	G4
*By special application only.				

- (3) Lens and Lens Door. The lens shall be either micro-lens fully sealed to maintain an IP66 rating; or shall be constructed of clear, flat (for light sources over 3200 initial lumens), tempered glass. The glass shall be thermal-resistant and impact-resistant. The lens shall be sealed to the door frame with continuous silicone gasketing. The door shall have an easy-access, quick-release safety latch. The door shall have aluminum or stainless steel quick-release hinge pins for tool-less or one-hand easy and secure opening. When the door is closed, the electrical component compartment and the optical chamber shall be completely sealed.
- (4) Electrical Components. All components shall be listed for wet locations by UL, ETL, or by an Occupational Safety & Health Administration Nationally Recognized Testing Laboratory (OSHA NRTL). Luminaires shall operate from 120 to 277 VAC or be adaptable to the type of power distribution system

REVISION OF SECTION 715
LIGHTING AND ELECTRICAL MATERIALS

to be used. All internal wiring and quick disconnects shall be rated for at least 600 VAC and insulated for 302°F. The dimmable driver shall be easily removable from the luminaire housing without the use of tools. The following components shall be in accordance with corresponding sections of ANSI C136.37:

1. Wiring and grounding electrodes;
 2. Terminal blocks for incoming AC lines;
 3. 7-pin photocontrol receptacle; and
 4. Latching and hinging.
- (b) *Roadway Luminaires*. Roadway luminaires shall be a Light Emitting Diode (LED) type with integral dimming driver, lens, aluminum housing, and shall be UL or ETL listed for wet locations. All luminaires for the Project shall be the same type and design unless the plans specify otherwise.
- (1) The luminaire and all components shall be UL or ETL listed for wet location and shall have minimum ingress protection rating of IP66.
 - (2) The light source shall be composed of LED modules connected to a non-integrated driver and be ready for connection to a production line luminaire. Luminaires utilizing integrated driver LED light sources, screw-based products, or panel retrofit products shall not be used.
 - (3) The luminaire shall have a Type II, III, or IV distribution for non-median mounted luminaires, and Type II, III, IV or V distribution for median mounted luminaires.
 - (4) Transmissive optical components shall be applied in accordance with LED manufacturer's Original Equipment Manufacturer (OEM) design guidelines to ensure suitability for the environment in which the luminaire is installed.
 - (5) Luminaires shall utilize an adjustable slipfitter-type mounting system for installation on 1.25-inch (1.66-inch outer diameter (o.d.)) to 2-inch (2.375-inch o.d.) diameter pipe tenons. Slipfitter shall consist of a two-piece clamp and four 9/16 inch hex bolts. Slipfitter shall allow for a vertical tilt adjustment of at least ± 5 percent in order to mount luminaire plumb to foundation for a U0 rating (no upright). Luminaires shall be equipped with integrated leveling bubble.
 - (6) Access to all internal parts requiring replacement shall not require tools (i.e. "tool-less entry").
 - (7) The luminaire housing shall be constructed of aluminum alloy.
 - (8) The power supply and/or driver shall be provided in compliance with subsection 715.05. The dimming driver shall be internal and thermally separated from the LED compartment.
 - (9) The dimming 7-pin photocell receptacle shall conform to subsection 715.04(d) below.
 - (10) The luminaire finish shall be corrosion resistant super triglycidyl isocyanurate (TGIC) polyester powdercoat. The color shall be gray or as specified per the project.
 - (i) Powder coat: super TGIC polyester powder coat 2.5 mil nominal thickness.
 - (ii) Finish shall exceed a rating of 6 per ASTM D1654 after 1000hrs of testing per ASTM B117.
 - (iii) The coating shall exhibit no greater than 30 percent reduction of gloss per ASTM D523, after 500 hours of ultraviolet (UV) testing at ASTM G154.
 - (11) The effective projected area (EPA) for wind-loading calculations shall be no greater than 1.2 square

REVISION OF SECTION 715
LIGHTING AND ELECTRICAL MATERIALS

feet.

- (12) The luminaire weight shall not exceed 45 pounds.
 - (13) The luminaire shall be tested in accordance with IES LM-79 and IES TM-21 certifying photometric performance and rated life, respectively. IES LM-79 (performance) and IES TM-21 (predicted life at 55 °C) testing shall both be for the same luminaire's operating drive current as specified.
 - (14) The luminaire shall have a maximum backlight rating as shown in Table 715-1, an uplight rating of U0, and a maximum glare rating as shown in Table 715-1.
 - (15) The luminaire system efficacy shall not be less than 85 initial luminaire lumens per input watt.
 - (16) The luminaire shall have an external label per ANSI C136.15 and internal label per ANSI C136.22.
- (c) *Light Sources.* LED luminaires shall not be retrofit to the existing luminaire housing; the Contractor shall replace the housing along with the luminaire as a single unit. Light sources shall be compatible with dimmable drivers supplied with the luminaires in which they are to be installed. All light sources of a similar type shall be provided by the same manufacturer.

LED light sources shall meet or exceed the following requirements:

- (1) CCT, CRI and Flux:
 - (i) Correlated Color Temperature (CCT) – All LED light sources shall emit white light and have a CCT no greater than 3400K nominal in accordance with ANSI C78.277.
 - (ii) Color Rendering Index (CRI) – All LED light sources shall have a minimum color rendering index (CRI) of 70 in accordance with the IES LM-79 test results.
 - (iii) Luminous Flux – LED light sources shall not exceed the junction temperature recommended by the LED manufacturer. Luminous flux differences between LEDs shall not exceed 10 percent.
- (2) LEDs shall have a minimum rated life of 70,000 hours per IES TM-21 at 55 °C at the normal operating driver current for the specific luminaire. The lumen output shall be maintained at 70 percent of initial rated lumens (L70) or greater at the rated life of the luminaire.
- (3) LEDs shall be temperature rated for operation and storage within the range of -40°C to +50°C, and shall withstand low and high frequency vibration (ANSI C136.31 Vibration Level 3G) over the rated life of the light source.
- (4) Cooling System
 - (i) Mechanical design of protruding external surfaces (e.g. heat sink fins) shall facilitate hose-down cleaning and discourage debris accumulation.
 - (ii) The cooling system must be passive utilizing heat sinks, convection or conduction.
 - (iii) Fans, diaphragms, pumps, or liquids shall not be used.
- (d) *Photocontrol Receptacle.* Each roadway luminaire shall be furnished with a 7-pin multi-contact twist-lock outdoor lighting dimming receptacle per ANSI C136.41.

Photoelectric controls shall be listed for long life LEDs and have hermetically sealed, cadmium sulfide twist-lock type with high impact polypropylene cover with clear UV stabilized window. Photoelectric controls shall have a turn-on setting of 1.4 foot-candles ±0.2 foot-candles. The maximum ratio of the turn-

6
REVISION OF SECTION 715
LIGHTING AND ELECTRICAL MATERIALS

off to turn-on setting shall be 3:1.

715.05 LED Drivers. LED drivers shall conform to the following:

- (1) Dimming signal protocols are 0-10V direct current (DC) or digital addressable lighting interface (DALI).
- (2) The operating voltage shall be 120/277-volt at 50/60 Hz, and the driver shall operate normally with input voltage fluctuations of ± 10 percent, consistent with NEMA SSL-1, Electronic Drivers for LED Devices, Arrays or Systems.
- (3) The minimum power factor (PF) shall be 0.90 at full input power and across specified voltage range.
- (4) The maximum total harmonic distortion (THD) shall be 20 percent at full input power and across specified voltage range.
- (5) The factory-set drive current shall be 700A or less unless approved by the Project Engineer. If higher drive currents are proposed, the submittal must be accompanied with IES LM-79 and IES TM-21 test results for higher operating drive current.
- (6) Drivers shall be at a minimum Restriction of Hazardous Substances (RoHS) 1 compliant.
- (7) The rated case temperature for operation and storage shall be rated for up to $+85^{\circ}\text{C}$. The LED driver shall be rated for an ambient operating temperature within the range of -40°C to $+50^{\circ}\text{C}$.
- (8) All electronics of the power supply shall be protected from all electrical surges with an elevated (10kV) electrical immunity rating including, but not limited to, lightning strikes and stray current in rebar and concrete. Surge protection shall be integral to the LED power supply.
- (9) The luminaire, including driver, shall consume no more than four watts of power in the off state.
 - (a) Electrical immunity (including surge protection): The luminaire shall meet the "Elevated" 10kV/5kA requirements per IEEE/ANSI C136.2. The manufacturer shall indicate whether failure of the electrical immunity system can possibly result in disconnection of power from the luminaire.
 - (b) Electromagnetic interference: The driver shall comply with Federal Communications Commission (FCC) 47 Code of Federal Regulations (CFR) part 15 non-consumer radio frequency interference (RFI) and/or electromagnetic interference (EMI) standards.

715.06 Alternative Power Sources. Electrical power systems not connected to an electrical power grid shall be one of the following:

- (a) *General.* Alternative power source systems shall conform to the following:
 - (i) The assembly shall be UL or ETL listed for wet location and shall have a minimum ingress protection rating of IP66.
 - (ii) The assembly shall withstand low and high frequency vibration (ANSI C136.31 Vibration Level 3G) over the rated life the assembly.
- (b) *Battery.* All batteries shall conform to the following and shall be approved by the Project Engineer:
 - (i) *General*
 - a. The battery shall have an extended operating temperature rated for operation and storage within the range of -40°C to 85°C .
 - b. The nominal voltage shall be 12V.
 - c. Shall have no less than 80% capacity after 12 months of storage at 25°C .

REVISION OF SECTION 715
LIGHTING AND ELECTRICAL MATERIALS

- d. Batteries used for roadway luminaires shall have a minimum rated capacity for three days autonomy without charge, at full light output for the three-day duration.
 - e. Batteries shall be rated for a 5-year design life.
- (c) *Solar Panel.* Solar panels shall be n-type, mono crystalline silicon, with greater than or equal to 20 percent efficiency at 25 °C. All solar panels shall be approved by the project Engineer.
- (d) *Wind Turbine.* All wind turbines shall conform to the following and be approved by the Project Engineer.
- (i) Shall consist of an axial flux coreless permanent magnet synchronous generator.
 - (ii) Blade materials shall be reinforced polyamide.
 - (iii) Shall include anti-vibration mounts.
 - (iv) Shall include regulation to stop turbine from rotating when system is fully charged, or wind gusts are above design speeds.
 - (v) The noise generated by the entire assembly shall be less than 55dBA at the adjacent edge of right of way.

715.07 Conduit. Unless otherwise specified, conduit shall be rigid metallic or semirigid plastic electrical conduit. Metallic conduit shall be clean, free of burrs, and galvanized.

Plastic conduit shall be a semirigid type currently recommended and UL listed for the proposed use. Underground plastic conduit for street lighting shall conform to ASTM-F441 schedule 80. Fittings shall be the type used outside the conduit. Fittings shall connect the conduit in a manner that makes the joints watertight.

Junction boxes used in structures shall be galvanized steel, 6 inches square by 4 inches deep, with weatherproof covers.

Pull boxes and splice boxes shall be a minimum of 13 inches by 24 inches and 12 inches deep, and sized per NEC 314 and CDOT Standard S-613-3. Pull and/or splice boxes shall have heavy duty weatherproof covers rated for roadway applications. The housing shall be resistant to sunlight exposure, weathering, and chemicals; it shall be unaffected by freeze/thaw cycles. Covers shall fit flush to the sidewalk, turf area, or roadway surface. Hardware and inserts shall be stainless steel. The cover for street lighting circuits shall be marked "ELECTRICAL" or "STREET LIGHTING". The cover shall list the minimum HS load rating of 22,500 psi.

715.08 Lighting Circuitry and Wiring. All wiring shall be copper with 600-volt insulation, rated for outdoor use. Wire sizes #14 AWG through #10 AWG shall be solid copper. Wire sizes #8 AWG and larger shall be stranded copper; except, service ground conductors to grounding electrodes shall be #4 stranded, insulated copper. All conductor sizes shall be, at minimum, sized to the breaker amperage feeding the circuit per NEC Table 310.16.

A breakaway submersible, in-line fuse holder and fuse for each hot conductor and breakaway submersible connector shall be installed on the neutral if a neutral is required. The grounding wires shall not be fused or breakaway.

Fuse connectors shall be installed in the phase wires of their respective circuits at the junction box located as a back box to the luminaire or within the pole base or transformer base. The Contractor shall provide sufficient excess conductor length to allow withdrawal of the connected fuse holder from the hand hole. Fuses and fuse holders shall be UL listed and shall be installed in such a manner that the fuse stays with the load side when holder is separated. The Contractor shall form loops in the leads on each side of the fuse holders and so position the fuse holders that they may be easily removed or inserted through the opening of hand hole. All electrical apparatus used in the lighting system shall be rated to adequately handle the necessary loads and shall conform to power source requirements.

REVISION OF SECTION 715
LIGHTING AND ELECTRICAL MATERIALS

Bonding and grounding electrodes shall conform to the requirements of subsection 613.08.

715.09 Secondary Service Pedestals, Lighting Control Centers, and Meter Power Pedestal. Secondary Service Pedestals, Lighting Control Centers, and Meter Power Pedestals shall be metal conforming to ANSI C47.12.28 Pad Mounted Enclosure Integrity Standard and shall be the nominal size and dimensions shown in the Contract.

The cabinets shall be constructed of 12-gauge corrosion-resistant steel with hoods and covers constructed of 14-gauge corrosion-resistant steel. Cabinets shall be NEMA 3R or NEMA 4 construction and shall be UL listed as "Enclosed Industrial Control Equipment" (UL508A). Cabinets shall be vandal resistant dead-front enclosures.

The cabinet's external finish shall be polyurethane industrial grade powder paint of at least 1.7 mil thickness. The cabinet's internal finish shall be polyurethane industrial grade powder paint of at least 1.7 mil thickness or bare aluminum.

All external fasteners, rivets, screws and bolts shall be stainless steel. Fasteners, except sealing screws, shall not be removable by external access. Hinges shall be stainless steel continuous piano type hinges.

External nameplates shall be permanently attached to the cabinet. A stainless-steel handle shall be provided on the front exterior of each cabinet door or hood. Cabinet shall be equipped with a three-point latch. All handles shall be pad lockable per CDOT Maintenance requirements.

The cabinet shall have separate isolated sections for metering equipment (if required), utility termination, and CDOT equipment. All sections must be sealed and pad lockable. The metering section shall have a hinged swing back hood with an integral hinged polycarbonate sealable window for visual access to meters. The utility termination section shall be sealed and securable with a padlock. The section shall have a lift off cover with a stainless steel handle. Sufficient clearance shall be provided for a 4-inch diameter conduit for utility cables. Utility landing lugs shall be UL listed and shall accommodate 6 - #350 kcmil conductors. An optional meter fusible disconnect ahead of the meter shall be provided for utility companies that require them.

The CDOT compartment door shall be sealed and securable with a padlock. The compartment door shall be anchorable in an open position. There shall be a print pocket on the inside of the door. The print pocket shall hold all wiring schematics and instructions in a clear weatherproof sleeve with a side opening. Required UL labeling shall be located on the inside of the CDOT door. Distribution and control equipment shall be behind an internal dead-front door with a quarter-turn securing latch and be hinged to open more than 90 degrees. The dead-front door shall be hinged on the same side as the CDOT section door.

Pedestal mounting bolts shall not be visible or accessible externally. Pedestal mounting shall include pedestal mounting base and hardware. Pad mounting shall include concrete pad mounting base, anchor bolt kit and hardware.

Secondary service pedestals, lighting control centers, and meter power pedestals shall be rated for 600 VAC, installed with protection against damage from greater currents. The pedestals and centers shall be grounded with grounding electrodes in conformance with the current edition of the NEC. The following equipment is for a typical installation and may or may not be required per the project plans:

- (1) Fusible meter disconnect ahead of meter (optional per utility company requirements).
- (2) Service meter pedestal or a meter socket. Location of meter shall be confirmed by the Project Engineer per the CDOT region requirements. The meter shall conform to the utility company requirements.
- (3) Service main circuit breaker that is installed in a circuit load center as sized on the plans.
- (4) Circuit load center with an all-copper bus for CDOT loads.
- (5) Circuit breakers.

REVISION OF SECTION 715
LIGHTING AND ELECTRICAL MATERIALS

- (6) Ground fault circuit interrupter receptacle (GFCI) (20 amp, 120 VAC NEMA 5-20R).
- (7) Multiple pole light contactors.
- (8) Test switch.
- (9) Photoelectric control with exterior mounted 3-prong twist-lock receptacle.
- (10) Mounting pans or false backs for circuit breakers, contactors, relays, switches, transformers, and other types of electrical equipment mounted inside the cabinet.
- (11) 18" snow skirt (floor stand kit), optional per the Project Engineer's requirements.
- (12) Cabinet style HVAC unit (heating, ventilation, and air-conditioning), optional per the Project Engineer's requirements.

The internal wiring of cabinets shall be assembled by a UL listed facility or by a licensed master electrician using UL listed components. Cabinets shall conform to one or more of the following standards where appropriate: UL 50 Cabinets and Boxes; UL 67 Panel Boards; UL 869A Service Equipment; and UL 508A Standard for Industrial Control Panels.

Circuit breakers and equipment shall be labeled with an engraved permanent label on the dead-front panel to indicate the circuit controlled.

Multiple pole light contactors shall be "lighting" type, specifically rated for the type of lighting load specified. The contactors shall have a 600-volt rating. All multiple pole light contactors shall be unenclosed, single phase with the number of poles specified on plans; they shall be open type lighting contactors with the rating shown or specified. Contactors shall be constructed for surface mounting on a false back or bracket within a weatherproof cabinet. The contactor coil shall operate on 120 Volt for 120/240 Volt or 120/208 Volt circuits and 277 Volt, for 277/480 Volt circuits. Contact material shall be designed for LED driver loads and require no maintenance such as filing, burnishing, or dressing at any time the contactor is in service.

A 277 VAC rated test switch or hand-off-auto (HOA) switch shall be installed in the control cabinets if shown. The test switch shall be a heavy-duty single pole switch or circuit breaker rated at 20 amps and shall be installed in the control cabinet as a roadway lighting test switch. The switch shall be wired to shunt the photoelectric control relay power contactor and energize the lighting circuit contactors. The HOA switch shall be single or double pole, double throw, center off with 15A contacts. The HOA switch shall be wired to the photocell control when switch is in the Auto position, lighting contactor(s) shall close when photocell is in low light closure. HOA shall be wired to energize the lighting contactor(s) closure when the HOA is in the Hand position. The HOA's Off position will turn off the control circuit.

All components of the photoelectric control relays shall be housed in a weatherproof, locking, non-rusting container. The photoelectric control relay shall be rated for long life LED loads and attach to a three prong locking receptacle by a twisting motion.

The photoelectric control relay shall meet or exceed the requirements of ANSI C136.10. The photoelectric control shall be factory set to turn on lights when ambient lighting levels fall to 1.4 foot-candles plus or minus 0.2 foot-candles when operated at 120 VAC. When operated at 250 VAC, turn on shall not change more than plus or minus 0.3 foot-candles from the 120 VAC value. The maximum off to on ratio shall be 1.5:1. The photoelectric control shall be a cadmium sulfide photoelectric control encapsulated for humidity protection, or a silicon junction type photo transistor. The photoelectric control shall be designed for normal operation at a dual voltage of 105 V and 285 V. Power consumption shall be less than 1 watt. At the designated voltage, the photoelectric control shall be capable of controlling a minimum load of 1000 watts. Minimum operating temperature range shall be from -40 °C to 65°C. A time delay control circuit shall prevent false turn offs by transient lighting conditions. The unit shall include a failsafe circuit for the lighting load such that the lighting systems remain energized if any functional

REVISION OF SECTION 715
LIGHTING AND ELECTRICAL MATERIALS

failure of the photoelectric control circuit occurs.

715.10 Heavy Duty Safety Switch. All switches shall be heavy duty rated. Switch blades and jaws shall be fixable and plated copper. Switches shall have a pad lockable handle. Switches shall have defeatable door interlocks that prevent the door from opening when the handle is in the ON position (except for double-throw switches). Defeater mechanism shall be front accessible. Switches shall have deionizing arc chutes. Switch assembly and operating handle shall be an integral part of the enclosure base.

Switches rated 30 A to 600 A shall have reinforced, rejection type fuse clips. Switch blades shall be readily visible in the "ON" and "OFF" position. Switch operating mechanism shall be non-teasible, positive quick-make/quick-break type. Bail type mechanisms are not acceptable. Fusible switches shall be suitable for service entrance equipment (except for 4-pole switches and 1200 A when used on 480Y/277 wye systems). Switches shall have line terminal shields (except for non-fusible double throw switches).

Switches shall be suitable for systems capable of 200 kA at 480 V with Class J, L, R, or T fusing as applicable for single-throw switches; 100 kA at 600 V for double-throw switches. Embossed or engraved ON-OFF indication shall be provided. Double-make, double-break switch blade feature shall be provided. Fuse pullers shall be provided on all NEMA 3R, 4X and 12 switches through 200 A. Renewal parts data shall be shown on the inside of the door.

All enclosures shall be NEMA 3R unless otherwise noted. Other types, where noted, shall be NEMA 4X watertight corrosion-resistant 316 stainless steel or NEMA 12 dust-tight and oil-tight special industry (dual NEMA 12/3R rating through 800 A). All enclosures shall have a factory installed ground terminal block. Nameplate shall be front cover mounted, containing a permanent record of switch type, ampere rating, and maximum voltage rating. 30 A to 100 A, NEMA 4X or NEMA 12 enclosures shall be provided with draw-pull latches.