COLORADO
DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISIONS
I-70 TWIN TUNNELS CONSTRUCTION PACKAGE 2

The 2011 Standard Specifications for Road and Bridge Construction, controls construction of this project. The following special provisions supplement or modify the Standard Specifications and take precedence over the Standard Specifications and plans.

PROJECT SPECIAL PROVISIONS

COLORADO
DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISIONS
I-70 TWIN TUNNELS CONSTRUCTION PACKAGE 2

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PROJECT SPECIAL PROVISIONS

COLORADO
DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISIONS
I-70 TWIN TUNNELS CONSTRUCTION PACKAGE 2

STANDARD SPECIAL PROVISIONS

COLORADO
DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISIONS
I-70 TWIN TUNNELS CONSTRUCTION PACKAGE 2

STANDARD SPECIAL PROVISIONS

	Date	No. Pages
Revision of Section 601 – Concrete Batching	(February 3, 2011)	1
Revision of Section 601 – Concrete Finishing	(February 3, 2011)	1
Revision of Section 601 – Concrete Form and Falsework Removal	(July 28, 2011)	2
Revision of Section 601 – Concrete Slump Acceptance	(July 29, 2011)	1
Revision of Sections 603, 624 and 705 – Drainage Pipe	(April 26, 2012)	2
Revision of Section 612 – Delineators	(February 3, 2011)	1
Revision of Section 627 and 708 – Pavement Marking Paint	(January 31, 2013)	2
Revision of Section 630 – Construction Zone Traffic Control	(February 17, 2012)	1
Revision of Section 630 – Retroreflective Sign Sheeting	(February 3, 2011)	1
Revision of Section 630 - Rolling Roadblock	(November 1, 2012)	2
Revision of Section 630 – Signs and Barricades	(January 31, 2013)	1
Revision of Section 703 – Aggregate for Hot Mix Asphalt	(November 1, 2012)	2
Revision of Section 703 – Concrete Aggregate	(July 28, 2011)	1
Revision of Section 712 – Geotextiles	(November 1, 2012)	2
Revision of Section 712 – Water for Mixing or Curing Concrete	(February 3, 2011)	1
Affirmative Action Requirements – Equal Employment Opportunity	(February 3, 2011)	10
Disadvantaged Business Enterprise – Definitions and Requirements	(February 3, 2011)	14
Minimum Wages Colorado, U.S. Department of Labor General Decision Numbers CO130016 thru CO130024, Highway Construction, Statewide	(January 4, 2013)	56
On the Job Training	(July 29, 2011)	3
Partnering Program	(February 3, 2011)	1
Required Contract Provisions – Federal-Aid Construction Contracts	(July 19, 2012)	14
Special Construction Requirements, Fire Protection Plan	(November 1, 2012)	2

NOTICE TO BIDDERS

The proposal guaranty shall be a certified check, cashier's check, or bid bond in the amount of 5 percent of the Contractor's total bid.

Pursuant to subsections 102.04 and 102.05, it is recommended that bidders on this project review the work site and plan details with an authorized Department representative. Prospective bidders shall contact one of the following listed authorized Department representatives at least 48 hours in advance of the time they wish to go over the project.

Program Engineer	Jim Bemelen, P.E. 18500 E Colfax Ave. Aurora, Colorado 80011 Office Phone: 303-365- 7010
Resident Engineer	Russel Cox, P.E. 425 A Corporate Circle Golden, Colorado 80401 Office Phone: 720-497-6905
Project Engineer	Bob Smith, P.E. 425 A Corporate Circle Golden, Colorado 80401 Office Phone: 303-512-5611

The above referenced individuals are the only representatives of the Department with authority to provide any information, clarification, or interpretation regarding the plans, specifications, and any other contract documents or requirements.

COMMENCEMENT AND COMPLETION OF WORK

The Contractor shall select the date that work begins for this project. The Contractor shall notify the Engineer, in writing, at least 10 days before the proposed beginning date. The date that work begins shall be subject to the Region Transportation Director's approval. A different date may be authorized in writing by the Chief Engineer in the "Notice to Proceed."

The Contractor shall complete all work by April 1st, 2014 in accordance with the "Notice to Proceed."

Section 108 of the Standard Specifications is hereby revised for this project as follows:

Subsection 108.03 shall include the following:

The Contractor's progress schedule shall be a Critical Path Method Schedule.

Salient features to be shown on the Contractor's Critical Path Method Schedule are:

1. Mobilization
2. Public Information Program
3. Detour of I-70 Traffic
4. Temporary Stormwater Erosion Control
5. Traffic Control (Traffic Shifts, Lane Closures)
6. Asphalt Paving
7. Construction of Walls Walls C, D, G And L
8. Tunnel Construction on Structure F-15-BO
    a. Excavation
    b. Drainage System
    c. Liner
    d. Lighting System
    e. Concrete Paving
    f. Barrier
    g. Signing
    h. Striping
9. Portal Construction
10. ITS
11. Chain Station Reconstruction
12. Permanent Water Quality Features
13. Restoration of Traffic onto Interstate 70
14. Removal of Portal to Portal Access Road
15. Remove Detour Paving in Median
16. Punch List

The Contractor shall complete the following discrete portions of the work (milestones) by the dates specified. No disincentive will be assessed for failure to complete the work for each milestone by the specified completion date.

Milestone No. 1
Completion Date: November 30, 2013
Description: MP 241.5 to 242.5 – All three lanes and the full east bound tunnel structure F-15-BO must be opened by November 30, 2013.
Incentive: $300,000 Incentive on or before November 30, 2013. No incentive will be paid if completed between December 1, 2013 and December 21, 2013.
Disincentive: $14,260 a day starting on December 21, 2013. There is no maximum amount for the disincentive.

CONTRACT GOAL

The Department has determined that Underutilized Disadvantaged Business Enterprises (UDBEs) will participate by contracting for a part of the work of this Contract. The contract goal for participation in this Contract by certified DBEs who have been determined to be underutilized has been established as follows:

UDBE*12.5 Percent

The percentage will be calculated from proposals received for this project according to the following formula:

$$\text{Percentage} = 100 \times \frac{\text{**Dollar amount of work to be contracted to underutilized DBEs (UDBE's)}}{\text{Total dollar amount of the original Contract}}$$

* All DBEs will be considered to be UDBEs.
** Based on DBE contract unit prices rather than prime contract unit prices.

NOTE: Specific Good Faith Efforts required to meet the Contract Goal specified above are defined in the Standard Special Provisions. In addition, the Transportation Commission has determined an overall 10.25 annual goal for the participation of all DBEs.

OJT CONTRACT GOAL

The Department has determined that On the Job Training shall be provided to trainees with the goal of developing full journey workers in the types of trade or classification involved. The contract goal for On the Job Trainees working in an approved training plan in this Contract has been established as follows:

Minimum number of total On-The-Job Training hours required **5,120 hours**.

REVISION OF SECTION 102
PROJECT PLANS AND OTHER DATA

Section 102 of the Standard Specifications is hereby revised for this project as follows:

Subsection 102.05 shall include the following:

All information for Guaranteed Price Proposal (GMP) preparation will be available for review by the Contractor through plans, specifications, and estimates packages provided by CDOT until the date set for opening of the GMP proposal.

Computer Output Data:

1. Phase 1 Environmental Site Assessment - Dated March 2012
2. Twin Tunnels Material Management Plan- Dated September 2012
3. CDOT Mitigation Commitment Monitoring and Reporting Spreadsheet (partially completed) – Dated October 2012
4. CDPS permit, dated October 2012
5. Twin Tunnels Environmental Assessment and FONSI – Final Dated October 2012
6. Twin Tunnels Wall Structural Selection Report – Final Dated October 2012
7. Air Quality Monitoring Plan – Final Dated September 2012
8. I-70 Twin Tunnels Incident Management Plan – Final Dated September 2012
9. I-70 Twin Tunnels Final Geotechnical Data Report- Draft 8/17/2012
10. Twin Tunnels Bridge Structural Selection Report – Final Dated 10/19/2012
11. Doghouse Rail Bridge Rehabilitation Tech Memo – Final Dated 1/13/2012
12. As-built plans for Structure F-15-BG and F-15-BH (I-70 EB over Clear Creek) – Dated 09/18/1981
13. Twin Tunnels Widening Package 2 Risk Register – Dated 3/1/2013

After the GMP proposal has been opened and the GMP has been accepted by CDOT, the Contractor may obtain from CDOT's Printing and Visual Communications Center, 4201 East Arkansas Avenue, Denver, Colorado 80222, at no cost: **15** sets of plans and special provisions; and if available for the project, one set of full-size cross sections, one set of full-size major structure plan sheets, and one set of computer output data. If Contractor has not picked up the plans and other available data by 4:30 p.m. on the second Friday after bid opening, they will be sent to the Resident Engineer in charge of the project. Additional sets of plans and other available data may be purchased on a cash sale basis from CDOT's Visual Communication Center at current reproduction prices. Subcontractors and suppliers may obtain plans and other data from the successful bidder or they may purchase copies on a cash sale basis from the Visual Communication Center at current reproduction prices.

REVISION OF SECTIONS 104
CONSTRUCTION MANAGER/GENERAL CONTRACTOR
VALUE ENGINEERING CHANGE PROPOSALS

Section 104 of the Standard Specifications is hereby revised for this project as follows:

Delete subsection 104.07 and replace with the following:

104.07 Value Engineering Change Proposals. Value Engineering Change Proposals (VECP) will not be allowed during the construction of CM/GC Projects.

REVISION OF SECTIONS 104 AND 105
PAVEMENT SURFACE COURSE MAINTENANCE

Sections 104 and 105 of the Standard Specifications are hereby revised for this project as follows:

In subsection 104.04, third paragraph, delete the first sentence and replace with the following:

Portions of the roadway, excluding the pavement surface course, that are not included in the contract work will be maintained by the Department.

Subsection 105.19 shall include the following:

The Contractor shall be responsible for timely response to complete all pavement surface course maintenance for portions of the roadway that are not included in the contract work within the project limits, including the approach to project, as required. These services shall be available upon notice, and provided for at all times, including holidays and seasonal no work periods. The Contractor shall provide these services beginning when time count starts for the project through final acceptance. The Contractor shall submit a Pavement Surface Course Maintenance Plan (PSCMP) to the Engineer for acceptance at the Preconstruction Conference. The PSCMP shall include, but will not be limited to, the following:

(1) Source of materials to be used for pavement surface course repairs (PSCR).
(2) Type of materials to be used for PSCR.
(3) Equipment available to use for PSCR.
(4) Labor, including names and phone numbers, to perform PSCR.
(5) Response Time. The Contractor and the traffic control supervisor (TCS) shall respond to the project site within 2 hours of notification.
(6) Traffic Control. The Contractor shall perform traffic control as required until completion of the PSCR.
(7) Pavement Marking. Full compliance pavement markings shall be in place on all PSCRs prior to opening to traffic.

The Contractor shall complete pavement surface course maintenance in accordance with the PSCMP. To implement the PSCMP, the Contractor shall develop and submit a method for handling repairs (MHR) for each different PSCR that shows the Contractor's proposed construction methods consistent with the PSCMP. Each proposed MHR will be approved in writing by the Engineer before the PSCR will be allowed to begin.

PSCRs shall be completed in a timely manner in accordance with the approved PSCMP. Unless otherwise approved, PSCRs shall be completed within 4 hours of notification.

Pavement surface course maintenance as described above will be paid for by force account in accordance with subsection 109.04 under the planned force account item, Interim Surface Repair.

REVISION OF SECTION 105
COOPERATION BETWEEN CONTRACTORS

Section 105 of the Standard Specifications is hereby revised for this project and includes the following:

Subsection 105.07 shall be revised as follows:

The Contractor is hereby advised that other CDOT construction projects will be working concurrently within the project limits. The Contractor must cooperate fully with the Engineer's direction regarding coordination of project schedules, traffic control, public information, and any other coordination deemed necessary by the Engineer.

The Contractor is advised that work on the following CDOT projects will be taking place concurrently in and around this project site:

(1) I-70 Twin Tunnels Construction Package 1A, B
Bob Smith
425 A Corporate Circle
Golden, Colorado 80401
Office Phone: 720-512-5611

(2) Smart Work Zone Project
Clark Roberts
18500 E. Colfax Avenue
Aurora, Colorado 80011
Office Phone: 303-365-7330

(3) Georgetown Hill Rockfall
Jim Van Dyne
425 A Corporate Circle
Golden, Colorado 80401
(303)324-8408

And potentially, there are additional CDOT and Clear Creek County projects that may also be under construction within the vicinity of the project site. The Contractor shall coordinate the work with the Contractors of these and any other projects to ensure an orderly completion of work.

All cost associated with the foregoing requirements shall be incidental to the contract.

REVISION OF SECTION 106
CONFORMITY TO THE CONTRACT OF HOT MIX ASPHALT

Section 106 of the Standard Special Provisions is hereby revised for this project as follows:

Subsection 106.05 shall include the following:

For this project, Contractor process control testing of hot mix asphalt is mandatory.

REVISION OF SECTION 106
CONTROL OF MATERIAL (SAMPLING)

Section 106 of the Standard Specifications is hereby revised for this project as follows:

In subsection 106.03 delete the fifth paragraph and replace with the following:

Samples will be taken by the Department except that the Contractor shall sample the following:

(1) Asphalt cement in accordance with AASHTO T 40.
(2) Hot mix asphalt (items 403 and 405) in accordance with Colorado Procedure 41.
(3) A composite of aggregates for Hot Mix Asphalt in accordance with Colorado Procedure 30.
(4) Plastic Portland cement concrete in accordance with AASHTO T 141. The Contractor shall transport the concrete sample to the place of testing.

The Engineer will designate the sampling time, location, and sample size. The sampling will be conducted in the presence of the Engineer.

REVISION OF SECTION 107
RESPONSIBILITY FOR DAMAGE CLAIMS, INSURANCE TYPES AND COVERAGE LIMITS, OWNER CONTROLLED INSURANCE PROGRAM (OCIP) AND PROJECT INSURANCE MANUAL (PIM)

Section 107 of the Standard Specifications is hereby revised for this project as follows:

Delete subsection 107.15 and replace with the following:

107.15 Responsibility for Damage Claims, Insurance Types and Coverage Limits, Owner Controlled Insurance Program (OCIP) and Project Insurance Manual (PIM). The Contractor shall indemnify and save harmless the Department, its officers, and employees, from suits, actions, or claims of any type or character brought because of any and all injuries or damage received or sustained by any person, persons, or property on account of the operations of the Contractor; or failure to comply with the provisions of the Contract; or on account of or in consequence of neglect of the Contractor in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any act or omission, neglect, or misconduct of the Contractor; or because of any claims or amounts recovered from any infringements of patent, trademark, or copyright, unless the design, device, material or process involved is specifically required by the Contract; or from any claims or amounts arising or recovered under the Worker's Compensation Act, or other law, ordinance, order, or decree. The Department may retain as much of any moneys due the Contractor under any Contract as may be determined by the Department to be in the public interest.

(a) The Contractor shall obtain, and maintain at all times during the term of this Contract, insurance in the following kinds and amounts:

1. Workers' Compensation Insurance as required by state statute, and Employer's Liability Insurance covering all of Contractor's employees acting within the course and scope of their employment.

   A. The Contractor shall provide Workers' Compensation coverage that is in compliance with all Legal Requirements (including C.R.S. § 8-44-101, et seq.) and Employer's Liability with minimum limits of $1,000,000 by disease each person, $1,000,000 by disease aggregate, and $1,000,000 each person by accident.

   B. Subcontractors shall provide Workers' Compensation coverage that is in compliance with all Legal Requirements (including C.R.S. § 8-44-101, et seq.) and Employer's Liability with minimum limits of $500,000 by disease each person, $500,000 by disease aggregate, and $500,000 each person by accident.

2. Commercial General Liability Insurance written on ISO occurrence form CG 00 01 07/04 or equivalent, covering premises operations, fire damage, independent Contractors, products and completed operations, blanket contractual liability, personal injury, and advertising liability with minimum limits as follows:

   A. $1,000,000 each occurrence;
   B. $2,000,000 general aggregate;
   C. $2,000,000 products and completed operations aggregate; and
   D. $50,000 any one fire.
   E. Completed Operations coverage shall be provided for a minimum period of six year following final acceptance of work.

   If any aggregate limit is reduced below $1,000,000 because of claims made or paid, the Contractor shall immediately obtain additional insurance to restore the full aggregate limit and furnish to CDOT a certificate or other document satisfactory to CDOT showing compliance with this provision.

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REVISION OF SECTION 107
RESPONSIBILITY FOR DAMAGE CLAIMS, INSURANCE TYPES AND COVERAGE LIMITS, OWNER CONTROLLED INSURANCE PROGRAM (OCIP) AND PROJECT INSURANCE MANUAL (PIM)

3. Automobile Liability Insurance covering any auto (including owned, hired and non-owned autos) with a minimum limit as follows: $1,000,000 each accident combined single limit.

4. Professional liability insurance with minimum limits of liability of not less than $1,000,000 Each Claim and $1,000,000 Annual Aggregate for both the Contractor or any subcontractors when:

   A. Contract items 625 (excluding tunnel surveying), 629, or both are included in the Contract
   B. Plans, specifications, and submittals are required to be signed and sealed by the Contractor's Professional Engineer, including but not limited to:

      (1) Shop drawings and working drawings as described in subsection 105.02
      (2) Mix Designs
      (3) Contractor performed design work as required by the plans and specifications
      (4) Change Orders
      (5) Approved Value Engineering Change Proposals

   C. The Contractor and any included subcontractor shall renew and maintain Professional Liability Insurance as outlined above for a minimum of one year following final acceptance of work.

5. The Contractor shall provide Umbrella or Excess Liability Insurance with minimum limits of $10,000,000 for Package 2. Minimum limits shall be based upon estimated Construction Values in accordance with the table below. This policy shall become primary (drop down) in the event the primary Liability Policy limits are impaired or exhausted. The Policy shall be written on an Occurrence form and shall be following form of the primary. The Umbrella or Excess which will provide bodily injury, personal injury and property damage liability at least as broad as the primary coverage set forth above, including Employer's Liability, Commercial General Liability and Commercial Automobile Liability.

Estimated Construction Values	Minimum Umbrella / Excess Liability Limits
Less than $5,000,000 in CV	$1,000,000
$5,000,000 to $10,000,000	$2,000,000
$10,000,000 to $25,000,000	$5,000,000
$25,000,000 to $75,000,000	$10,000,000
Over $75,000,000	Determined by the CDOT Risk Manager

The Contractor shall ensure that their subcontractors provide Umbrella or Excess Liability Insurance with minimum limits of $1,000,000. This policy shall become primary (drop down) in the event the primary Liability Policy limits are impaired or exhausted. The Policy shall be written on an Occurrence form and shall be following form of the primary. The Umbrella or Excess which will provide bodily injury, personal injury and property damage liability at least as broad as the primary coverage set forth above, including Employer's Liability, Commercial General Liability and Commercial Automobile Liability.

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REVISION OF SECTION 107
RESPONSIBILITY FOR DAMAGE CLAIMS, INSURANCE TYPES AND COVERAGE LIMITS, OWNER CONTROLLED INSURANCE PROGRAM (OCIP) AND PROJECT INSURANCE MANUAL (PIM)

(b) CDOT and the City of Idaho Springs shall each be named as an Additional Insured on the Commercial General Liability. Automobile Liability and Umbrella / Excess Liability Insurance policies. Completed operations additional insured coverage shall be on endorsements CG 2010 07/04, CG 2037 07/04, or equivalent. Coverage required of the contract will be primary over any insurance or self-insurance program carried by the State of Colorado.

(c) Railroad Protective Insurance

In addition to the above, the Contractor shall furnish evidence to CDOT that, with respect to the operation the Contractor or any of its subcontractors perform, the Contractor has provided for and on behalf of the Railroad Company, and each Railroad Company when more than one is involved, Railroad Protective Public Liability and Property Damage Insurance provided for a combined single limit of Five Million Dollars ($5,000,000) per occurrence with an aggregate limit of Ten Million Dollars ($10,000,000) applying separately for each annual period for:

1. All damages arising out of bodily injuries to or death of one or more persons.
2. All damages arising out of injury to or destruction of property.
3. Said policy or policies of insurance shall be deemed to comply with the Railroad Protective Insurance requirements if each of said policies contains a properly completed and executed "Railroad Protective Liability Form," copies of which are available from CDOT's Agreements Engineer, Colorado Department of Transportation, 4201 E. Arkansas Ave., Denver, CO, 80222. All required policy or policies of insurance shall be submitted to the Project Director for transmittal to the Railroad Company's Insurance Department.

   The Railroad Protective Insurance shall be carried until all Work required to be performed under the terms of the Contract is satisfactorily completed as evidenced by the formal acceptance of CDOT. The Railroad Company shall be furnished with the original of each policy carried on its behalf.

(d) Each insurance policy shall include provisions preventing cancellation or non-renewal without at least 30 days prior notice to Contractor. The Contractor shall forward to the Engineer any such notice received within seven days of the Contractor's receipt of such notice.

(e) The Contractor shall require all insurance policies in any way related to the contract and secured and maintained by the Contractor to include clauses stating that each carrier shall waive all rights of recovery, under subrogation or otherwise, against CDOT, its agencies, institutions, organizations, officers, agents, employees and volunteers.

All policies evidencing the insurance lines of coverage required hereunder shall be issued by insurance companies satisfactory to CDOT.

(f) The Contractor shall provide certificates showing insurance coverage required by this contract to CDOT prior to execution of the contract. No later than 15 days prior to the expiration date of any such coverage, the Contractor shall deliver CDOT certificates of insurance evidencing renewals thereof. At any time during the term of this contract, CDOT may request in writing, and the

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REVISION OF SECTION 107
RESPONSIBILITY FOR DAMAGE CLAIMS, INSURANCE TYPES AND COVERAGE LIMITS, OWNER CONTROLLED INSURANCE PROGRAM (OCIP) AND PROJECT INSURANCE MANUAL (PIM)

Contractor shall thereupon within ten (10) days supply to CDOT, evidence satisfactory to CDOT of compliance with the provisions of this section.

(g) Notwithstanding subsection 107.15(a), if the Contractor is a "public entity" within the meaning of the Colorado Governmental Immunity Act CRS 24-10-101, et seq., as amended ("Act'), the Contractor shall at all times during the term of this contract maintain only such liability insurance, by commercial policy or self-insurance, as is necessary to meet its liabilities under the Act. Upon request by CDOT, the Contractor shall show proof of such insurance satisfactory to CDOT. Public entity Contractors are not required to name CDOT as an Additional Insured.

(h) When the Contractor requires a subcontractor to obtain insurance coverage, the types and minimum limits of this coverage may be different than those required, as stated above, for the Contractor, except for the Commercial General Liability and Automobile Liability and the subcontractor shall provide an Additional Insured endorsement for such coverage. Those that qualify as needing Professional Liability Insurance in terms of any design work shall provide such coverage as provided for in (4) above.

(i) CDOT will provide the following lines of Insurance coverage for this project in a CDOT sponsored Owner Controlled Insurance Program (OCIP):

14. Workers' Compensation.

CDOT will procure, pay for, and maintain Workers Compensation insurance in compliance with statutory limits for the Workers' Compensation Laws of the State of Colorado and Employer's Liability limits of not less than:

A. $ 1,000,000 - Each accident for Bodily Injury
B. $ 1,000,000 - Policy limit for Bodily Injury by disease
C. $ 1,000,000 - Each employee for Bodily Injury by disease.

Covered operations at the Project Site for enrolled Project Contractors. Coverage ceases for any employee of the enrolled Project Contractors when they leave the Project Site for unrelated business. Workers Compensation coverage will extend to employees' direct travel between two scheduled Project Sites when the travel is conducted for the sole purpose of executing Work. The Project Site will include adjacent or nearby tracts of land where incidental operations, such as the location of Contractor's trailers, offices, CDOT's team's offices, etc. are performed, related to the Work. The Project site will not include permanent locations of any insured party other than CDOT. The OCIP shall not apply to the operations of Project Contractors at their offices, factories, or warehouses.

CDOT will pay any policy related insurance costs for Workers' Compensation not covered because of deductibles, if any. The Contractor shall be responsible for any related Drug and Alcohol accident / incident testing or other contractual obligations as provided for in the Contract which may be related to the incident and/or injured worker.

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REVISION OF SECTION 107
RESPONSIBILITY FOR DAMAGE CLAIMS, INSURANCE TYPES AND COVERAGE LIMITS, OWNER CONTROLLED INSURANCE PROGRAM (OCIP) AND PROJECT INSURANCE MANUAL (PIM)

The Contractor shall estimate and report to CDOT the amount of money that would have been in their bid for Workers' Compensation Insurance and Employer's Liability on form OCIP-B. The Contractor shall also show the amount of money remaining in their bid for Workers' Compensation and Employer's Liability insurance for the coverage items not included in the OCIP on form OCIP-B.

15. Commercial General Liability.

Policy Limits:

- $2,000,000 per Occurrence for Bodily Injury and Property Damage
- $4,000,000 General Aggregate
- $4,000,000 Completed Operations Aggregate

The Policy limits are shared by all Project Contractors enrolled in the OCIP. Policy Exclusions – Examples could include, but are not limited to:

A. Coverage A Bodily Injury and Property Damage Liability

Exclusions:

(1) Expected or Intended Injury
(2) Contractual Liability
- Liquor Liability
- Workers' Compensation and Similar Laws
- Employer's Liability
- Pollution
- Aircraft, Auto or Watercraft
- Mobile Equipment
- War
- Damage to Property – modified or deleted by endorsement
- Damage to Your Product - modified or deleted by endorsement
- Damage to Your Work - modified or deleted by endorsement
- Damage to Impaired Property or Property Not Physically Injured
- Recall of Products, Work or Impaired Property
- Personal and Advertising Injury
- Electronic Data

B. Coverage B Personal and Advertising Injury Liability

(1) Exclusions:
- Knowing Violation of Rights of Another
- Material Published with Knowledge of Falsity
- Material Published Prior to Policy Period
- Criminal Acts

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REVISION OF SECTION 107
RESPONSIBILITY FOR DAMAGE CLAIMS, INSURANCE TYPES AND COVERAGE LIMITS, OWNER CONTROLLED INSURANCE PROGRAM (OCIP) AND PROJECT INSURANCE MANUAL (PIM)

- Contractual Liability
- Breach of Contract
- Quality or Performance of Goods – Failure to Conform to Statements
- Wrong Description of Prices
- Infringement of Copyright, Patent, Trademark or Trade Secret
- Insured's in Media and Internet Type Businesses
- Electronic Chatrooms or Bulletin Boards
- Distribution of Material in Violation of Statues
- Unauthorized Use of Another's Name or Product
- Pollution-Related
- War

C. Coverage C Medical Payments

(1) Exclusions:
- Any Insured
- Hired Person
- Injury on Normally Occupied Premises
- Workers Compensation and Similar Laws
- Athletics Activities
- Products-Completed Operations Hazard
- Coverage A Exclusions

D. Additional Policy Endorsements

(1) Endorsements:
- Limits of Insurance
- Named Insured Amended
- Limitation of Coverage to Designated Project
- Amendment Property Damage
- Extended Completed Operations
- Service of Suit
- Signature Endorsement
- Minimum Earned Premium and Premium Audit Premium Endorsement
- Additional Insured – State or Political Subdivision Permits - Blanket
- Additional Insured – Mortgagee, Assignee, or Receiver - Blanket
- Additional Insured – Lessor of Leased Equipment – Automatic Status When Required in Defense Costs and Supplementary Payments Included within the Limits of Insurance
- Deductible Liability/SIR Endorsement
- Limited Coverage Repair Work
- Trade or Economic Sanctions Endorsement

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REVISION OF SECTION 107
RESPONSIBILITY FOR DAMAGE CLAIMS, INSURANCE TYPES AND COVERAGE LIMITS, OWNER CONTROLLED INSURANCE PROGRAM (OCIP) AND PROJECT INSURANCE MANUAL (PIM)

- Disclosure Pursuant to Terrorism Risk Insurance Act
- Cancellation Provision Endorsement – Manuscript

(2) Claims Directory – Duties in Event of an Occurrence, Offense, Claim or Suit

E. Additional Policy Exclusions

(1) Exclusions:
- Nuclear Energy Liability Exclusion
- Asbestos Exclusion
- War
- Wrap-Up Cross Suits Excl. – Amendment - exception First Named Insured / Contractor
- Designated Ongoing Operations (Scheduled Location(s) excluded)
- Damage to Premises Rented to You
- Lead Exclusion
- Discrimination
- Exclusion – Coverage C – Medical Payments: Any Location or Job Site
- Employment-Related Practices Exclusion
- Fungi or Bacteria Exclusion
- Exclusion – Exterior Insulation and Finish Systems
- Silica or Silica-Related Dust Exclusion
- Total Pollution Exclusion with Hostile Fire Exception
- Exclusion – Contractors Professional Liability (CG 2279)
- Violation of Statues that Govern Emails, Faxes, Phone Calls or Other
- Methods of Sending Material Information

Standard Insurance Service Office Commercial General Liability Insurance policy or equivalent, including Bodily Injury, Property Damage, Personal Injury and Completed Operations covering operations at the Project Site for Project Contractors shall be provided. An eight-year extension of the Completed Operations Liability coverage for the Colorado Statute of Repose and the Statute of Limitations will begin upon the earlier of expiration of the OCIP policy, Substantial Completion of the Project, or the completion of Work under Contract. This insurance will not extend to products liability coverage for any product manufactured away from the Project Site. The OCIP will be primary and non-contributory as it relates to coverage provided under the OCIP.

Contractor will be responsible for repayment of any deductible for Bodily Injury or Property damage up to $25,000 per occurrence to the extent loss costs (including allocated loss adjustment expense) payable are attributable to its acts, or the acts of its subcontractors, or any other entity or person for whom it may be responsible, with no increase in the Contract amount.

To the extent losses covered and payable under the OCIP arise out of, or are the responsibility of the Contractor's subcontractors of any tier, Contractor may seek contribution from those subcontractors in an amount equal to the self-insured retention or deductible amount under the subcontractor's own conventional General Liability Insurance Policy in effect at the time of enrollment into the OCIP, but in no case may the

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Contractor collectively collect more than the per occurrence deductible of $25,000 for the occurrence which is the contractual responsibility of the Contractor.

The contractor shall estimate and report to CDOT the amount of money that would have been in their bid for Commercial General Liability Insurance on form OCIP-B. The Contractor shall also show the amount of money remaining in their bid for Commercial General Liability for insuring items not included in the OCIP on form OCIP-B.

16. Umbrella or Excess Liability Insurance.

A. Policy limits:

(1) $100,000,000 Each Occurrence
(2) $100,000,000 Aggregate

Coverage is in excess of the primary Commercial General Liability and Employer's Liability. Such Excess Liability Insurance will be primary and non-contributory as to any other excess insurance the parties hereto may have in force. An eight-year extension (for the Statute of Repose and Limitations) of the Completed Operations Liability coverage is anticipated and will begin upon the earlier of expiration of the Commercial General Liability Policy or Substantial Completion of the Project, or the completion of Work under Contract. This insurance will not extend products liability coverage for any product manufactured away from the Project Site.

These limits may be satisfied in various combinations with an Umbrella or Excess policy.

The contractor shall estimate and report to CDOT the amount of money that would have been in their bid for Excess Liability Insurance on form OCIP-B. The Contractor shall also show the amount of money remaining in their bid for Excess Liability for insuring items not included in the OCIP on form OCIP-B.

17. Builders Risk Insurance.

CDOT will procure, pay for, and maintain a builder's risk insurance policy, including coverage for in-transit and off-site storage, to protect the interests of the Insured's, including CDOT, Project Contractors and its subcontractors, against the risk of loss or damage to the Work during construction at the Project Site. Such policy will include a waiver of subrogation in favor of CDOT, CDOT's Engineer, Construction Manager, Contractors, and subcontractors.

Coverage will include all materials, supplies and equipment that are intended for specific installation in the Project while such materials, supplies and equipment are located at the Project Site, in transit or while temporarily located away from the Project Site for the purpose of storage at the risk of one of the insured parties, as agreed upon by the CDOT in writing in advance of such transit or storage.

POLICY COVERAGE FORM AND EXCLUSIONS [EXAMPLES]:

A. Commercial Inland Marine – Builders Risk Coverage Form

(1) Endorsements:

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a) Extra Expense Endorsement
b) Elite Property Enhancement: Builders Risk – sub limits apply
c) Builders Risk Warranties

This insurance will not include any coverage for tools or clothing of workers or any tools, equipment, protective fencing, scaffolding, and equipment owned, rented or used by Contractor and used in the performance of the Work, or work performed at off-site fabrication facilities. Contractor shall waive any such rights of recovery from CDOT and/or the OCIP Policies.

Contractor shall be responsible for repayment of any deductible for Property Damage up to $25,000 per occurrence to the extent loss costs (including allocated loss adjustment expense) payable are attributable to its acts, or the acts of its subcontractors, or any other entity or person for whom it may be responsible, with no increase in the Contract amount. Contractor may not seek contribution of this deductible from its subcontractors.

NOTE: The Builders Risk policy terms vary from policy to policy, and such insurance provided by the CDOT will be subject to such limits of liability, exclusions and deductibles as CDOT may negotiate in its discretion. Contractor is advised to consult the terms of the policy to ascertain its terms.

The Contractor shall estimate and report to CDOT the amount of money that would have been in their bid for Builder's Risk Insurance on form OCIP-B.

18. Contractor's Pollution Liability.

A. CDOT will procure, pay for and maintain Contractor's Pollution Liability insurance in the following limits:

(1)	$ 25,000,000	Per Claim
(2)	$ 25,000,000	Aggregate Claims Expenses (including Defense Costs) within limits.

Coverage will include Bodily Injury or Property Damage from a pollution event as defined within the policy form resulting from covered operations or completed operations of the Work performed at the Project Site.

Contractor shall be responsible for repayment of any deductible associated with the activities of the Contractor or their subcontractors up to $25,000 per occurrence to the extent loss costs (including allocated loss adjustment expense) payable are attributable to its acts, or the acts of its Project Contractors and subcontractors, or any other entity or person for whom it may be responsible, with no increase in the Contract amount.

The Contractor shall estimate and report to CDOT the amount of money that would have been in their bid for Contractor's Pollution Liability Insurance on form OCIP-B.

19. The OCIP and other insurance Contractor Obligations

A. CDOT provided Insurance shall not apply to vendors, manufacturers, suppliers, material dealers, haulers and/or independent haulers, and others who merely transport, pick up, deliver or carry materials, personnel, parts or equipment, or any other items or persons to or from the Project

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Site. Subcontractors providing on site hauling services with dedicated payroll will be considered eligible for enrollment at CDOT's discretion.

B. The cost of the OCIP Insurance specified herein to be obtained by CDOT will be paid for by CDOT, and CDOT shall receive and pay, as the case may be, all adjustments in such costs, whether by way of dividends or audits, or otherwise. CDOT shall execute such instruments of assignment as may be necessary to permit CDOT to receive such adjustments and shall cause all Contractors covered by such insurance to do the same.

C. The furnishing of insurance by CDOT shall in no way relieve, limit, or be construed to relieve Contractor or subcontractors of any responsibility or obligation whatsoever otherwise imposed by the Contract. CDOT assumes no obligation to provide insurance other than that specified herein. However, CDOT reserves the right to furnish additional insurance coverage of various types and limits.

D. The Contractor shall furnish a copy of this Revision of Section 107 to all subcontractors of every tier.

E. Prior to commencement of operations at the Project Site, each Contractor shall complete a Contractor / subcontractor Application for enrollment into the OCIP and shall furnish and cause each of its subcontractors to furnish to the CDOT or its Insurance Representative estimates for the total construction values, and estimated WC Payrolls in connection with the Work. The Insurance Representative may request, and the Project Contractor shall comply with such request for copies of rate pages from their Workers Compensation, General and Excess Liability policies, or other insurance related information deemed necessary to effect and maintain coverage, and/or to assure that CDOT has received the appropriate reduction of the total insurance cost excluded from their Contract, including any markup thereon.

F. Failure to comply with any of the above items will be considered noncompliance with the Contract and may result in remedial action, including withholding of payment, and/or removal of Contractor and/or subcontractor from the Project Site.

G. Liability policies required of the Contractor and their subcontractors in this Revision of Section 107 shall, where prudently feasible, shall name CDOT and the Contractor and their elected and appointed officials, directors, officers, employees, agents, representatives, and any additional entities as CDOT or Contractor may request, as Additional Insured. The Additional Insured Endorsement, equivalent to ISO form CG2010 (07/04) and CG2037 (07/04) edition(s), shall state that the coverage provided to the Additional Insured is primary and non-contributory with respect to any other insurance available to the Additional Insured. Contractor is responsible to ensure to the best of its ability that those entering the Project Site location have evidence of, or hold, the appropriate insurance or that those visitors are escorted while at the Project. Exceptions may be granted where mutually agreed to in advance between CDOT and the Contractor.

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H. All policies of insurance required in this Revision of Section 107 shall be endorsed to provide that the insurance company shall provide written notice to CDOT at least 30 days prior to the effective date of any cancellation of such policies.

I. All policies of insurance, as allowed by statute, that are in any way related to the Work, including those that are secured and maintained by consultants and subcontractors, shall include clauses providing that each underwriter shall waive all its rights of recovery under subrogation or otherwise, against CDOT, their Representative(s), Contractor and subcontractors.

J. Parties covered in this Revision of Section 107 shall cause to be furnished to CDOT and Contractor, or their Insurance Representative, certificates of insurance evidencing all insurance as required by this Contract. As and when CDOT or Contractor may direct, copies of the actual insurance policies or renewals or replacements thereof shall be submitted to CDOT or Contractor. All copies of policies, if any, and certificates of insurance submitted to CDOT shall be in form and content acceptable to CDOT or Contractor.

K. Nothing contained herein shall relieve Contractor, or its subcontractors of their obligations to exercise due care when performing any Work on the Project or to complete such Work in strict compliance with the Contract.

L. By enrolling in the OCIP, the Contractor acknowledges that (A) the limits of OCIP provided insurance are shared by all insured parties under the OCIP for the Project, (B) CDOT and their affiliates of every tier disclaim any responsibility whatsoever for the availability, adequacy or exhaustion of the limits of the OCIP, the present or future solvency of any OCIP insurers, or any claims or disputes by, between, or among CDOT and any Contractor and any subcontractor, or any tier, and any of the OCIP insurance carriers.

M. Any type of insurance or increase in limits not described herein which Contractor requires for its own protection or as a result of any applicable law shall be its own responsibility and expense.

(j) The Contractor and subcontractors are required to carry insurance coverages and limits listed below outside the OCIP which must be the same limits listed in (a) for the Contractor and for the subcontractor.

1. Workers' Compensation - Off-site work and exposures
2. Employer Liability - Off-site work and exposures
3. Commercial General Liability - Off-site work and exposures
4. Automobile Liability – at all times
5. Umbrella or Excess Liability - As coverage in excess of the lines of insurance above

All other insurance in Section (a) shall continue to be carried as required.

(k) CDOT will provide a Project Insurance Manual (PIM) that gives further detail on insurance and how to enroll in the OCIP. The PIM is hereby included in the Contract by reference.

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(l) General Additional Safety Requirements

(m) The Contractors and subcontractors shall within their own site specific Safety Requirements or Manuals, ensure compliance has been met with the following Safety Requirements, which are incorporated in the Contract Documents.

The Contractor shall take all necessary precautions to protect the safety and health of the Project Site and is ultimately responsible to establish and maintain a written Contractor Safety Program (CSP) for the Work. The Contractor shall establish administrative and technical means for the mitigation of risk, response to incidents, and recovery/restoration to normal operations at the Project Site. The Program shall include development of a site safety culture which supports, "best practices" for accident prevention, job specific hazard recognition and planning, training, reporting, management oversight, and implementation.

All costs, penalties, and expenses of complying with the requirements of these Safety Requirements shall be included as part of the cost of the Contract. The Contractor shall notify CDOT promptly, in writing, if a charge of non-compliance has been filed against the Contractor, or any subcontractor, in connection with its performance of the Work.

The developed CSP shall apply in all phases of the Work. The objective of the program is to eliminate or control accident risks to personnel, associated management, subcontractors, equipment, facilities, general public, and environment. Required activities include hazard identification & analysis, planning, management, dedicated resources, auditing conformance, training, communicating results and documentation.

Additionally, clear and open partnering and communications relative to the safety program between the Contractor, subcontractors and CDOT's Representatives is a key component in effectively implementing and assuring conformance.

The Contractor is solely responsible for health and safety and shall perform the Work in a safe and environmentally acceptable manner; this includes all of its subcontractors.

1. Safety Criteria

   Notice of Correction of other unsafe conditions will be conveyed in writing within 24 hours after receiving written notice from CDOT or CDOT's Safety Representative of unsafe work. Lost time and lost productivity associated with this or any safety violation will be at the sole cost of the Contractor or the subcontractor without additional compensation.

2. Contractor Site Safety Management

   Each subcontractor is required to name an individual on its payroll as a Safety Representative (SR). These SRs are not required to be full-time safety representatives. The subcontractors are required to name an individual(s) who has the experience, ability and authorization to act on the subcontractor's behalf in matters of safety on the Project.

   If at any time any subcontractor is performing one or more contracts and has fifty (50) or more employees on site for a period of 2) consecutive workdays, including cumulative workdays under multiple contracts ("high

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employment"), such subcontractor Shall have a full-time qualified safety representative on the job site to ensure the safety of its operations during the period of such high employment.

The Contractor and subcontractors are required to participate in the project's "Return To Work" program. Contractors and subcontractors shall return injured workers back to work at pre-injury wages as soon as possible through light or modified work tasks, which meet medical department's work restrictions.

The Contractor shall administer any job-site safety recognition incentive program developed for the site in an effort to maintain a safety-conscious workforce at the site.

3. OCIP Required Contractor Site Safety Requirements:

   A. The Contractors Safety Program shall conform to all aspects of this Section and be consistent with the requirements herein and the CDOT Required Contractor's Safety Management Plan.

   B. The Contractor shall conduct a project/site safety orientation for all Contractor & subcontractor employees prior to their working on the Project Site; including orientation for all full time project oversight and management personnel. Upon completion of the orientation, a uniquely project identifiable hard-hat decal shall be provided to each worker.

      The safety orientation (at a minimum) shall include the following:

      (1) A description of the extent and nature of the Project.

      (2) A description of any hazards that can typically be expected during the course of work, and means and methods for avoiding or protecting oneself.

      (3) Required work practices, job conduct, and injury reporting procedures.

      (4) Any other general information to acquaint the employee with special work and safety requirements at the Site.

4. The Contractors and subcontractors shall be prohibited from use and possession of alcoholic beverages, drugs (other than prescription), carrying weapons or ammunition onto the site, or using or carrying weapons while performing work on the Project's behalf, or attending Project sponsored activities. Contractor, at its own expense, shall adopt a policy of a drug free work site on the Project, which at a minimum shall include pre-job site and post-accident drug testing. Contractor, at its discretion, may include "for cause" and "random" testing if consistent best practices are applied.

   The Contractor shall require all workers to demonstrate a negative drug test before attending a Project Safety Orientation, and performing any work on a CDOT OCIP Sponsored Project. Previous drug test results from an accredited facility done within forty-five (45) days will be acceptable. Any employee who has not worked on a CDOT OCIP Sponsored Project during the last 12 months must retest and go through a new Project Safety Orientation as provided by the Contractor.

Current crane certification for each crane is required and must be on file at the jobsite.

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The Contractors safety enforcement activities shall be documented and/or logged and provided to the CDOT's Safety Representative upon request (without any personnel privacy sensitive information) and this information shall be on file at the jobsite.

Include Personal Protective Equipment (PPE) requirements and policy.

100 percent fall protection at working surfaces above 6ft without review and authorization from OCIP Safety Manager
100 percent eye protection with side shields required.
100 percent wearing of heavy-duty work boots/shoes required.
100 percent wearing of hardhats required.
100 percent wearing of shirt & long pants (no shorts).
100 percent wearing of high visibility vest or clothing.
Hearing protection as required.

(n) OCIP Required Reporting

1. Accident Reporting. The Contractor shall provide timely verbal notification and a written report to CDOT's Representative, and CDOT's Safety Representative of any and all accidents/incidents whatsoever arising out of or in connection with the performance of the work, whether on or adjacent to the site, which cause death, personal injury or property damage; and or had a serious potential for same. Verbal notification to the CDOT shall be immediate and under no circumstance shall notification exceed one hour from time of occurrence. Verbal notification shall include date and time, location, brief description, extent of property damage, and extent of injuries. A preliminary written accident report shall be furnished to the CDOT's Representative and CDOT's Safety Representative within 24 hours of the occurrence; final is due within 10 working days.

2. Monthly Accident/Incident Summary Reports. The Contractor shall provide a written Monthly Accident/Incident Safety Performance Summary Report for losses under their Contract to the CDOT within seven Days of the last day of the month. The report shall include the following minimum information:

   A. A summary, current year for all accidents/incidents – all Project Contractors / subcontractors.

   B. Summary of lost time for the Project to date, including total number of lost days and number of lost days accidents.

   C. Summary of accident data by Contractor and subcontractor.

   D. Summary of Property Damage, including Utility Damage incidents.

   E. Status update of any project required corrective actions.

(o) OCIP Required Contractor Safety Management Plans / Documents

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1. Job Task Hazard Analysis Program.

2. All work activities shall have a written job/task/activity Hazard Analysis (HA) associated with it appropriate for the hazards, scope, and/or complexity of the work. At a minimum this HA will cover the steps, hazards, and mitigation, required to perform the work safely.

3. Project Hazard Communication Plan.

4. Project Utility Management Plan, locates, accidental damage prevention, and incident reporting/correcting, policies, procedures, and practices.

5. The Contractor shall have an adequate utility locate, protect, and emergency response program. Any utility strike will be reported to CDOT immediately, investigation and lessons learned follow-up reporting performed, and related program performance measures provided. In addition, no corrections and/or repairs will be re-covered or otherwise made inaccessible until CDOT's Representative or designee has had the opportunity to review.

6. Project Water Intrusion Prevention and Mitigation Program.

7. Project Emergency Response Plan.

8. Project Security Plan

Special consideration and concern shall be given to the storage/protection of highly valuable (i.e., copper), finished product and/or critical materials/equipment to be protected from theft and/or vandalism.

REVISION OF SECTION 107
PROTECTION AND RESTORATION OF PROPERTY AND LANDSCAPE

Section 107 of the Standard Specification is hereby revised as follows:

Subsection 107.12 shall include the following:

The Contractor shall save existing riparian, wetlands, and other vegetation, except for those that must be removed to accommodate construction of the project. The Contractor shall fence specific areas of vegetation to be protected in the field as shown in the plans or as directed by the Engineer.

The Contractor shall perform all the work in such a manner that the least environmental damage will result. Any questionable areas or items shall be brought to the attention of the Engineer for approval prior to vegetation removal or any damaging activity. Damaged or destroyed fenced trees, shrubs, or wetlands, which could have been saved as determined by the Engineer, shall be replaced at the expense of the Contractor.

If the vegetation fence is knocked down or destroyed by the Contractor, the Engineer will suspend the work, wholly or in part, until the fence is repaired to the Engineer's satisfaction at the Contractor's expense. Time lost due to such suspension will not be considered a basis for adjustment of time charges, but will be charged as contract time.

REVISION OF SECTION 107
PERFORMANCE OF SAFETY CRITICAL WORK

Section 107 of the Standard Specifications is hereby revised as follows:

Subsection 107.06 shall include the following:

The following work elements are considered safety critical work for this project:

(1)	Construction of Cast In Place Walls	[No P.E. stamp required];
(2)	Shoring	[P.E. stamp required];
(3)	Rock Scaling and Rockfall Mitigation	[No P.E. stamp required];
(4)	Blasting and Tunnel Excavation	[No P.E. stamp required];
(5)	Work requiring the use of cranes or other lifting equipment;	[No P.E. stamp required];
(6)	Portal Canopy	[P.E. stamp required];
(7)	Girder Removal from Existing Clear Creek Bridge Structure	[P.E. stamp required]

The Contractor shall submit, for record purposes only, an initial detailed construction plan that addresses safe construction of each of the safety critical elements. When the specifications already require an erection plan, a bridge removal plan, or a removal of portion of bridge plan, it shall be included as a part of this plan. The detailed construction plan shall be submitted two weeks prior to the safety critical element conference described below. The construction plan shall be stamped "Approved for Construction" and signed by the Contractor. The construction plan will not be approved by the Engineer.

The Construction Plan shall include the following:

(1) Safety Critical Element for which the plan is being prepared and submitted.
(2) Contractor or subcontractor responsible for the plan preparation and the work.
(3) Schedule, procedures, equipment, and sequence of operations, that comply with the working hour limitations
(4) Temporary works required: falsework, bracing, shoring, etc.
(5) Additional actions that will be taken to ensure that the work will be performed safely.
(6) Names and qualifications of workers who will be in responsible charge of the work:
    A. Years of experience performing similar work
    B. Training taken in performing similar work
    C. Certifications earned in performing similar work
(7) Names and qualifications of workers operating cranes or other lifting equipment
    A. Years of experience performing similar work
    B. Training taken in performing similar work
    C. Certifications earned in performing similar work
(8) The construction plan shall address how the Contractor will handle contingencies such as:
    A. Unplanned events (storms, traffic accidents, etc.)
    B. Structural elements that don't fit or line up
    C. Work that cannot be completed in time for the roadway to be reopened to traffic
    D. Replacement of workers who don't perform the work safely
    E. Equipment failure
    F. Other potential difficulties inherent in the type of work being performed
(9) Name and qualifications of Contractor's person designated to determine and notify the Engineer in writing when it is safe to open a route to traffic after it has been closed for safety critical work.
(10) Erection plan or bridge removal plan when submitted as required elsewhere by the specifications. Plan requirements that overlap with above requirements may be submitted only once.

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A safety critical element conference shall be held two weeks prior to beginning construction on each safety critical element. The Engineer, the Contractor, the safety critical element subcontractors, and the Contractor's Engineer shall attend the conference. Required pre-erection conferences or bridge removal conferences may be included as a part of this conference.

After the safety critical element conference, and prior to beginning work on the safety critical element, the Contractor shall submit a final construction plan to the Engineer for record purposes only. The Contractor's Engineer shall sign and seal temporary works, such as falsework, shoring etc., related to construction plans for the safety critical elements, (3) Removal of Bridge, (4) Removal of Portion of Bridge and (5) Temporary Works. The final construction plan shall be stamped "Approved for Construction" and signed by the Contractor.

The Contractor shall perform safety critical work only when the Engineer is on the project site. The Contractor's Engineer shall be on site to inspect and provide written approval of safety critical work for which he provided signed and sealed construction details. Unless otherwise directed or approved, the Contractor's Engineer need not be on site during the actual performance of safety critical work, but shall be present to conduct inspection for written approval of the safety critical work.

When ordered by the Engineer, the Contractor shall immediately stop safety critical work that is being performed in an unsafe manner or will result in an unsafe situation for the traveling public. Prior to stopping work, the Contractor shall make the situation safe for work stoppage. The Contractor shall submit an acceptable plan to correct the unsafe process before the Engineer will authorize resumption of the work.

When ordered by the Engineer, the Contractor shall remove workers from the project that are performing the safety critical work in a manner that creates an unsafe situation for the public in accordance with subsection 108.05.

Should an unplanned event occur or the safety critical operation deviate from the submitted plan, the Contractor shall immediately cease operations on the safety critical element, except for performing any work necessary to ensure worksite safety, and provide proper protection of the work and the traveling public. If the Contractor intends to modify the submitted plan, he shall submit a revised plan to the Engineer prior to resuming operations.

All costs associated with the preparation and implementation of each safety critical element construction plan will not be measured and paid for separately, but shall be included in the work.

Nothing in the section shall be construed to relieve the Contractor from ultimate liability for unsafe or negligent acts or to be a waiver of the Colorado Governmental Immunity Act on behalf of the Department.

REVISION OF SECTION 107
WATER TREATMENT PROCESSING (TUNNEL)

Section 107 of the Standard Specifications is hereby revised for this project as follows:

DESCRIPTION

Subsection 107.25 shall include the following:

The Contractor shall employ means to collect and treat all captured water used in tunnel excavation and construction in order to comply with water treatment and water quality standards.

All water used in the process of tunnel excavation and construction, and all incidental groundwater that is collected along with construction water, shall be contained, collected, and treated to minimum water quality standards before being released to any water course. Alternatively, a method for collecting all water and treating off-site before being released to any water course is acceptable.

The Contractor shall submit a plan for collecting and treating all tunnel construction water (and incidental groundwater) to the Engineer for approval.

BASIS OF PAYMENT

Subsection 107.25 (c) shall include the following:

6. Water Treatment Processing (Tunnel) will be measured by the actual volume of water collected and treated, as approved by the Engineer.

   The accepted quantities will be paid for at the contract unit price for the pay item listed below.

   Payment will be made under:

Pay Item	**Pay Unit**
Water Treatment Processing (Tunnel)	MGAL

   Payment shall be full compensation for all labor, materials, and equipment required to furnish, erect, maintain, remove, and dispose of all materials required.

REVISION OF SECTION 109
CONSTRUCTION MANAGER/GENERAL CONTRACTOR FORCE ACCOUNTS

Section 109 of the Standard Specifications is hereby revised for this project as follows:

Delete subsection 109.03 and replace with the following:

109.03 Compensation for Altered Quantities.

(a) *Guaranteed Maximum Price.* On CMGC Construction projects, when the accepted quantities of work vary from the quantities in the Contract, The Contractor shall accept as payment in full, payment at the original contract unit prices for the installed and accepted quantities of work up to the original quantities shown in the Guaranteed Maximum Price proposal, except as defined in subsections 104.02, 104.03, and 108.11 as approved by the Engineer. All planned Force Account items will be paid for in accordance with subsections 104.03 as listed in the Project Special Provision, Force Account Items. Overruns approved by the Engineer on original quantities as accepted in the Guaranteed Maximum Price proposal under the planned Force Account Item, Minor Contract Revisions.

Overruns approved by the Engineer on original quantities as accepted in the Guaranteed Maximum Price proposal shall be paid for at the original contract unit prices under the planned Force Account Item, Minor Contract Revisions for the following items only: 202-Removal of Tree, 202 Removal of Pavement Marking, 203 Items, 206 Structure Backfill (Flowfill), 208 Erosion Control Items, 211 Tunnel Excavation and Support Items, 212 Landscaping Items, 213 Landscaping Items, 216 Soil Retention Blanket, 217 Herbicide Treatment, 304 Aggregate Base Course, 403 Hot Mix Asphalt, 411 Emulsified Asphalt, 420 Geotextile, 506 Riprap, 509 Steel Sets and MC12X50 Steel Sets (Install Only), 601 Concrete Patching, 602 Welded Wire Fabric, 605 Geocomposite Drain (Tunnel), 607 Fence (Temporary), 613 Electrical Items, 614 Fiber Optic Termination Panel – 6 Fiber, 614 – Fiber Optic Cable (Single Mode) (12 Strand), 625 Construction Surveying (Hourly), 626 Water Treatment Processing (Tunnel), 627 Pavement Marking Paint, 630 Traffic Control Items, and 641 Shotcrete Items.

If items and their original quantities shown in the Guaranteed Maximum Price proposal change or are modified by the Department between acceptance of the GMP proposal and issuance of the final construction plans and specifications, the Contractor shall accept as payment at the original contract unit prices for the installed and accepted quantities that have changed.

Allowance will not be made except as provided in subsections 104.02, 104.03, and 108.11, for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor resulting either directly from such alterations or indirectly from unbalanced allocation of overhead expense among the contract items or from any other cause.

(b) *Shared Risk Contingency Pool.* Differing site conditions and extra work performed that the Contactor and CDOT have agreed to share risk under will be paid for as stipulated in the order authorizing the work and compensated out of the planned Force Account Item F/A Shared Risk Contingency Pool. Compensation will be the accepted at Guaranteed Maximum Price unit price.

The shared risk compensations, components, and total amounts for each of the items agreed upon shall be defined in the Project Risk Register.

If any such alteration directly causes the loss of any work or materials already furnished by the Contractor under the terms of the original Contract, reimbursement for such work or of salvaging such materials will be

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at actual cost. Any such materials may, at the option of the Department, be purchased at the actual cost to the Contractor, as evidenced by certified invoices.

All cost savings in the Shared Risk Contingency Pool not resulting in the reduction of work or operating performance shall be shared as defined in the project Risk Register between the Contractor and CDOT.

Delete subsection 109.04 and replace with the following:

109.04 Compensation for Changes and Force Account Work.

All bid items and quantities that have the CMGC Risk Pool designation in the Summary of Approximate Quantities in the Plans will be paid for using the Shared Risk Contingency Pool. All bid items and quantities that will be paid for using the Shared Risk Contingency pool will have definitions and identify how to determine when and how to measure payment for the risk item.

Force account work shall not be eligible for the CMGC Management Price Percentage with the following exceptions. The CMGC Management Price Percentage shall only be applied to the following force account work: Minor Contract Revisions, Partnering, Fuel Cost Adjustment, Asphalt Cement Cost Adjustment, On the Job Training, Interim Surface Repair, Environmental Health and Safety Management and Obtain Power from XCEL Energy.

(a) *Labor*. For all labor and foremen in direct charge of the specific operations, the Contractor will receive the actual rate of wage normally paid for each and every hour that the labor and foremen are actually engaged in the work, as documented by certified payrolls.

The Contractor shall receive the actual costs paid to, or in behalf of, workers by reason of subsistence and travel allowances, health and welfare benefits, pension fund benefits, or other benefits, when the amounts are required by a collective bargaining agreement or other employment contract or generally applicable to the classes of labor employed on the work.

An amount equal to 67 percent of the actual wages and fringe benefits paid directly to the employees will also be paid to the Contractor. This 67 percent will not be applied to subsistence, travel allowance, or to fringe benefits paid to a third party or a trustee. The CMGC Management Price Percentage as specified in the Contract will not be added to labor costs.

(b) *Materials.* For materials accepted by the Engineer and incorporated in the work, the Contractor shall *receive* the actual cost of such materials, including transportation charges paid (exclusive of equipment rentals as hereinafter set forth) to which the CMGC Management Price Percentage will be added.

(c) *Owned or Leased Equipment.* For the use of any machinery or equipment, approved by the Engineer, which is owned or leased directly by the Contractor or subcontractors, or by entities that are divisions, affiliates, subsidiaries or in any other way related to the Contractor or subcontractors or their parent companies, the Contractor will be paid in the manner hereinafter specified. Rental rates will be from the current edition of the Rental Rate Blue Book of Rental Rates for Construction Equipment and will be used as follows:

1. Determination of the rental rate to be used will be as follows:
   Hourly rate: RR = (ADJ BB/176)(RF)+EOC
   Standby rate: SR = (ADJ BB/176)(RF)(0.5)
   Where: RR = Hourly rental rate

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SR = Standby rate
ADJ BB = Blue Book Monthly Rate adjusted for year of manufacture
RF = Regional Factor of 1.06
EOC = Estimated Hourly Operating Costs from Blue Book

2. The number of hours to be paid for will be the number of hours that the equipment is actually used on a specific force account activity.

3. Overtime shall be compensated at the same rate indicated in subsection 109.04(c)1. above.

4. The EOC will be used for each hour that the equipment is in operation on the force account work. Such costs do not apply to idle time regardless of the cause.

5. Idle time for equipment will not be paid for, except where the equipment has been held on the Project site on a standby basis at the direction of the Engineer. Such payment will be made at the standby rate established in subsection 109.04 (b) 1.

6. Incurrence of costs for standby rates for equipment shall not take place until approval has been received from the Engineer. Payment for standby time will not be made on any day the equipment operates for eight or more hours. For equipment accumulating less than eight hours operating time on any normal work day standby payment will be limited to only that number of hours that, when added to the operating time for that day, equals eight hours. Additionally, payment for standby time will not be made in any consecutive 30 day period that the equipment operates for 176 or more hours. For equipment accumulating less than 176 hours operating time in any consecutive 30 day period, standby payment will be limited to only that number of hours that, when added to the operating time for that consecutive 30 day period, equals 176 hours. Standby payment will not be made in any case on days not normally a work day.

7. The rates established above shall include the cost of fuel, oil, lubrication, supplies, incidental tools valued at less than $500, necessary attachments, repairs, overhaul and maintenance of any kind, depreciation, storage, overhead, profit, insurance, all costs (including labor and equipment) of moving equipment onto and away from the site, and all incidentals, except as allowed in subsection 109.04(c)8.

8. The rental rate for small tools shall be $2.00 per hour. Small tools are defined as any tool which would be valued between $500 and $2,000 if purchased new.

9. Transportation charges for each piece of equipment to and from the site of the work will be paid provided:

   (1) The equipment is obtained from the nearest source,
   (2) Charges are restricted to those units of equipment not already available or required on the Project, and
   (3) The equipment is used solely for the force account work.

10. Fast use expendable parts not included in the Rental Rate Blue Book will be paid at certified invoice cost to which the CMGC Management Price Percentage will be added. Such parts not totally expended on the force account work will be prorated based on actual use.

11. Payable time periods will not include:

    (1) Time elapsed while equipment is broken down;

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(2) Time spent in repairing equipment

(d) Time elapsed after the equipment is no longer needed. If a piece of equipment that is not in the Blue Book is needed, rates shall be agreed to in writing before the equipment is used.

(e) *Rental Equipment.* Use of rental equipment not owned or leased by the Contractor or subcontractors will be paid for by certified invoice cost to which the CMGC Management Price Percentage will be added. The EOC will also be paid if not included in the rental rate. The use of and rates for rental equipment shall be approved by the Engineer prior to use. Proration of rental rates to an hourly rate for equipment not used solely for the force account shall be based on 176 hours per month, 40 hours per week or 8 hours per day as applicable. The cost of moving the rental equipment onto and away from the job will also be paid when the equipment is used solely for the force account work.

(f) *Records.* The Contractor's representative and the Engineer shall, on a daily basis, agree in writing on the quantities of labor, equipment and materials used for work completed on a force account basis.

(g) *Statements.* Payment will not be made for work performed on a force account basis until the Contractor has furnished the Engineer with triplicate itemized statements of the cost of the force account work, detailed as follows:

(1) Labor classification, hours, rate, and extension for each labor class or pay rate within a class.
(2) Equipment type, hours, rate and extension for each unit of equipment.
(3) Quantities of materials, prices, extensions and transportation charges.
(4) Administrative compensation when applicable. Statements shall be accompanied and supported by certified invoices for all materials and rental equipment including transportation charges. If materials used on the force account work are not specifically purchased for the work, but are taken from the Contractor's stock, the Contractor shall furnish a written statement certifying that the materials were taken from stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor.

(h) Alternative Method of Documenting Force Account Work. The following method of documenting the amount of force account work done may be used in lieu of the method described in subsections 109.04 (e) and (f) above, when agreed to by both the Engineer and the Contractor. The Engineer will keep a daily record of the labor, equipment and material used on approved force account work. The Contractor's representative shall review and initial the record each day to ensure that the record is accurate and complete, and that the costs were actually incurred. The Contractor shall furnish certified copies of invoices for the cost of all materials used including transportation charges. If materials used on force account work are not specifically purchased for the work, but are taken from the Contractor's stock, the Contractor shall furnish a written statement certifying that the quantity claimed was actually used, and that the price and transportation charges claimed represent the actual cost to the Contractor. The Engineer will calculate the cost of the force account work each month and include payment on the monthly progress estimate.

(i) Contract modification orders that change the scope of work outside the accepted GMP documents will include the direct cost of the work and include the CMGC Management Price Percentage as specified in the contract.

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(j) The CMGC Management Price Percentage stated in (a) through (h) above constitute full compensation for all items of expense not specifically designated, including general superintendence, use of incidental tools, field and office overhead, and profit. The total payment made as provided above shall constitute full compensation for such work.

REVISION OF SECTION 202
REMOVAL OF MANHOLE

Section 202 of the Standard Specifications is hereby revised for this project as follows:

Subsection 202.01 shall include the following:

This work also includes the removal of underdrain manholes and associated asphalt mat and/or concrete pavements required to completely remove the manhole structures at the locations indicated in the Plans.

Subsection 202.02 shall include the following:

Where existing underdrain manholes are to be removed, the portions of the existing underdrain pipe designated to remain shall be prepared to fit the new construction, and shall be protected from damage. All damage to underdrain pipes designated to remain in place shall be repaired at the Contractor's expense. Method of repair shall be approved by the Engineer.

Subsection 202.12 shall include the following:

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

Pay Item	**Pay Unit**
Removal of Manhole	Each

Payment for Removal of manhole shall include all work required to remove the manhole, associated pavement, excavation, and protection of pipe to remain.

REVISION OF SECTION 202
REMOVAL OF PIPE

Section 202 of the Standard Specifications is hereby revised for this project as follows:

Subsection 202.01 shall include the following:

This work also includes the complete removal of existing eastbound tunnel underdrain pipe and partial removal of the westbound tunnel underdrain pipe, its associated bedding, backfill and access manholes at the locations indicated in the Plans.

Subsection 202.02 shall include the following:

Where the existing underdrain pipe is removed within the limits of the eastbound Twin Tunnels bore, the void shall be backfilled with the same material as used for the mudslab construction.

Backfill of pipe voids outside of the tunnel and not within the roadway prism shall be backfilled for the complete depth of the trench with Structure Backfill (Class 2) in accordance with Section 206.

Backfill of pipe voids outside of the tunnel but within the roadway prism shall be backfilled to the height equal to the finish grade minus the thickness of the asphalt patching with Structure Backfill (Class 2) in accordance with Section 206.

Where existing underdrain pipe is shown to be removed at the connections to the existing concrete box culvert (CBC), the holes shall be plugged with Concrete, Class B or other approved mix design for the complete thickness of the CBC wall and for a minimum of 12 inches behind and around the CBC wall opening. The concrete plug shall be trowel finished smooth on the interior CBC face, without voids or rock pockets. All damage to CBC caused by removing the underdrain pipe shall be repaired with a method approved by the Engineer. Upon completion of the plugging operation and before backfilling the void, the contractor shall document each plug location by date stamped, digital photographs showing the inside and outside of the CBC wall, and provide those digital files to the Engineer as a record of the closure.

Subsection 202.11 shall include the following:

Removal of pipe will be measured by the linear foot of pipe removed.

Subsection 202.12 shall include the following:

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

Pay Item	**Pay Unit**
Removal of Pipe	Linear Foot

Payment for Removal of Pipe shall include all work and materials required to remove the pipe including removal of access manholes and pavement, excavation, backfill and plugging holes at the existing CBC.

REVISION OF SECTION 202
REMOVAL OF CONCRETE PAVEMENT

Section 202 of the Standard Specifications is hereby revised for this project as follows:

Subsection 202.01 shall include the following:

This work includes removal and disposal of existing concrete pavement from within the existing eastbound tunnel as shown on the plans or at locations directed by the Engineer.

In subsection 202.02 delete the seventh paragraph and replace with the following:

The existing concrete pavement was constructed with the original eastbound tunnel and is estimated to be eight inches in thickness. It may be removed in any manner that facilitates construction of the tunnel widening, including removal in conjunction with removal of the existing asphalt overlay and tunnel invert excavation. The removed pavement shall become the property of the Contractor and shall be either disposed of outside the project site, or used in one or more of the following ways:

1. Used in embankment construction in accordance with subsection 203.06.
2. Placed in bottom of fills as approved by the Engineer.
3. Placed in the subgrade soft spots as directed by the Engineer.

Subsection 202.11 shall include the following:

The removal of the existing concrete pavement will not be measured and paid for separately but shall be included in the cost of Rock Excavation (Class F).

REVISION OF SECTION 202
REMOVAL OF ASPHALT MAT

Section 202 of the Standard Specifications is hereby revised for this project as follows:

Subsection 202.01 shall include the following:

This work includes removal and disposal of existing asphalt mat within the project limits as shown on the plans or at locations directed by the Engineer.

In subsection 202.02 delete the seventh paragraph and replace with the following:

The existing asphalt mat which varies in thickness from 2.5 inches to 6 inches shall be removed in a manner that minimizes contamination of the removed mat with underlying material. The removed mat shall become the property of the Contractor and shall be either disposed of outside the project site, or used in one or more of the following ways:

1. Used in embankment construction in accordance with subsection 203.06.
2. Placed in bottom of fills as approved by the Engineer.
3. Recycled into the hot mix asphalt.
4. Placed in the subgrade soft spots as directed by the Engineer.

Subsection 202.11 shall include the following:

The removal of the existing asphalt mat outside of the eastbound tunnel limits will be measured by the square yard of mat removed to the required depth and accepted. Asphalt mat lying within the eastbound tunnel will not be measured and for separately but shall be included in the cost of Rock Excavation (Class F).

Subsection 202.12 shall include the following:

Payment will be made under:

Pay Item	**Pay Unit**
Removal of Asphalt Mat	Square Yard

Unless otherwise specified in the Contract, the haul and disposal of the asphalt mat or its use in other locations on the project will not be measured and paid for separately, but shall be included in the work.

REVISION OF SECTION 202
REMOVAL OF BRIDGE

Section 202 of the Standard Specifications is hereby revised for this project as follows:

Subsection 202.01 shall include the following:

This work consists of removal of existing bridge F-15-BH. Bridge removal shall consist of the removal of the superstructure and the portions of the substructure as shown on the plans.

Subsection 202.02 shall include the following:

The removal of the existing bridge shall be performed in a safe manner.

Coordination with the affected 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 record purposes only, at least 20 working days prior to the proposed start of removal operations. 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 stamped "Approved for Construction" and signed by the Contractor. The Bridge Removal Plan will not be approved by the Engineer.

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

(1) The removal sequence, including staging of 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, and location of equipment during removal operations.

(3) Shoring that exceeds 5 feet in height, all falsework and bracing.

(4) Details, locations and types of any protective coverings to be used. The protective covering shall prevent any materials, equipment or debris from falling onto the property below. When removal operations are located over or in proximity to any live waterway, railroad, or pedestrian/bicycle path, additional width of protective covering sufficient to protect these facilities shall be required. Detailed methods for protection of the existing roadway facilities, including measures to assure that people, property, utilities, and improvements will not be endangered.

(5) Detailed methods for protection of live waterways including minimization of turbidity and sedimentation, and protection of existing wetlands.

(6) Detailed methods for mitigation of fugitive dust resulting from the demolition.

(7) Details for dismantling, removing, loading, and hauling steel elements.

(8) Methods of Handling Traffic, including bicycles and pedestrians, in a safe and controlled manner.

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REMOVAL OF BRIDGE

A Pre-Removal Conference shall be held at least seven days prior to the beginning of removal of the bridge. The Engineer, the Contractor, the removal subcontractor, the Contractor's Engineer, and the Traffic Control Supervisor (TCS) shall attend the Pre-Removal Conference. The Bridge Removal Plan shall be finalized at this Conference.

The Contractor's Engineer shall sign and seal (1) and (3) listed above in the final Bridge Removal Plan. Calculations shall be adequate to demonstrate the stability of the structure remaining after the end of each stage of removal, before traffic is allowed to resume in its normal configuration.

The final Bridge Removal Plan shall be stamped "Approved for Construction" and signed by the Contractor. The Contractor shall submit a final Bridge Removal Plan to the Engineer prior to bridge removal for record purposes only. The Contractor shall not begin the removal process without the Engineer's written authorization.

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.

Unless otherwise directed, the Contractor's Engineer need not be on site when bridge removal operations are in progress, but shall be present to conduct daily inspection for written approval of the work. The Contractor's Engineer shall inspect and provide written approval of each phase of the removal 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. A copy of the certification shall be submitted to the Engineer.

The Contractor's Engineer shall inspect the bridge removal site and report in writing on a daily basis the progress of the operation and the status of the remaining structure. A copy of this daily report shall be available at the site of the work at all times, and a copy of the previous day's inspection report shall be submitted to the Engineer daily.

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. While the lanes are closed to public traffic, work shall be pursued promptly and without interruption until the roadway is reopened to traffic.

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

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

Should an unplanned event occur or the bridge removal operation deviate from the submitted bridge removal plan, the bridge removal operations shall immediately cease after performing any work necessary 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 shall submit his Engineer's report in writing, within 24 hours of the event, summarizing the details of the event and the procedure for correction.

Bridge removal may be suspended by the Engineer for the following reasons:

(1) Final Bridge Removal Plan has not been submitted, or written authorization has not been provided by the Engineer to begin the removal.

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REMOVAL OF BRIDGE

(2) The Contractor is not proceeding in accordance with the final Bridge Removal Plan, procedures, or sequence.

(3) The Contractor's Engineer is not on site to conduct inspection for the written approval of the work.

(4) Safety precautions are deemed to be inadequate.

(5) Existing neighboring facilities are damaged as a result of bridge removal.

Suspension of bridge removal operations shall in no way relieve the Contractor of his responsibility under the terms of the Contract. 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 24 hours in advance of 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, night time 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, all debris, protective pads, materials, and devices shall be removed and the roadways swept clean.

Explosives shall not be used for removal work without the written approval of the Engineer.

Removal of the substructure shall be taken 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 in the plans.

Existing structures, facilities, and surrounding roadways shall not be damaged by the removal operations. Damage that does occur shall be repaired immediately at the Contractor's expense.

Subsection 202.12 shall include the following:

Payment will be made under:

Pay Item	**Unit**
Removal of Bridge	Lump Sum

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, 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.

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REVISION OF SECTION 202
REMOVAL OF BRIDGE

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

REVISION OF SECTION 202
REMOVAL OF PORTIONS OF PRESENT STRUCTURE

Section 202 of the Standard Specifications is hereby revised for this project as follows:

Subsection 202.01 shall include the following:

This work shall include the removal of portions of the eastbound I-70 tunnel portal structures and headwalls and attached appurtenances as shown in the plans. Where applicable, removal operations shall be conducted so that there will be the least interference with public traffic using the structure.

Subsection 202.02 shall include the following:

At least 20 days before beginning removal of each portal structure, the Contractor shall submit to the Engineer details of the removal operations showing the methods and sequence of removal and equipment to be used.

The existing concrete shall be removed as shown on the plans or as directed by the Engineer. If additional removal of unsound concrete is required, it shall be included in the work.

All methods and equipment used to accomplish this item shall be approved by the Engineer.

Within 24 hours before new concrete is placed, the entire surface upon which new concrete bonds shall be sandblasted to roughen the surface and remove all fractured or loose particles in order to promote good bond with the new concrete.

In subsection 202.02 delete the sixth paragraph and replace with the following:

A one inch deep saw cut shall be made along the limits of removal on all faces of monolithic concrete elements which may be visible in the completed work.

Subsection 202.12 shall include the following:

Payment will be made under:

Pay Item	**Pay Unit**
Removal of Portions of Present Structure	Each

Payment for Removal of Portions of Present Structure will be full compensation for all labor and materials required to complete the work, including haul and disposal.

REVISION OF SECTION 202
REMOVAL OF EXISTING TUNNEL LINER

Section 202 of the Standard Specifications is hereby revised for this project as follows:

Subsection 202.01 shall include the following:

This work shall include the removal of all of the existing concrete lining on the eastbound tunnel, including the portal walls, foundations, lighting fixtures, pipes, and all related construction between the outer faces of the existing tunnel portal.

Subsection 202.02 shall include the following:

At least 20 days before beginning bridge removal the Contractor shall submit to the Engineer details of the removal operations showing the methods and sequence of removal and equipment to be used. Work shall not begin on this item until approval has been received from the Engineer.

Subsection 202.11 shall include the following:

Removal of Existing Tunnel Liner will be measured by the linear foot of concrete removed from the inside tunnel portal face to the inside. All attached incidental materials such as lights, pipes, facing, curbs, guardrails, etc. will not be measured for payment but shall be included in the cost of the work. Removal of pavement within the tunnel as well as excavations and removals outside the portals will be measured and paid for separately.

Subsection 202.12 shall include the following:

Payment will be made under:

Pay Item	**Pay Unit**
Removal of Existing Tunnel Liner	Linear Foot

Payment for Removal of Existing Tunnel Liner will be full compensation for all labor and materials required to complete the work, including haul and disposal.

REVISION OF SECTION 203
EMBANKMENT MATERIAL

Section 203 of the Standard Specifications is hereby revised for this project as follows:

In subsection 203.03(a), first paragraph, after the second sentence add the following:

Embankment material shall have an R-value value of at least 78 when tested by the Hveem Stabilometer.

REVISION OF SECTION 203
COMBINATION LOADER AND DUMP TRUCKS

Section 203 of the Standard Specifications is hereby revised for this project as follows:

Subsection 203.01 shall include the following:

This work consists of furnishing Combination Loader and Dump Trucks with operators, to be used for their intended purpose as directed by the Engineer.

Subsection 203.04 shall include the following:

Combination Loader shall be standard loader bucket S.A.E. rated 0.765 cubic meter and backhoe up to 0.2 cubic meter, 4-wheel industrial, utility, or general purpose, with loader front and backhoe, in the 80-100 HP range, either gasoline or diesel engine, or an acceptable equivalent.

Dump Truck shall be of at least 10 cubic yard capacity and shall be in acceptable condition to accomplish the intended work.

The above-described equipment shall be furnished and maintained in good operating condition. Equipment that, in the opinion of the Engineer, is inadequate to produce the required results, shall not be used. All equipment shall be operated by experienced operators, approved apprentices or approved competent trainees. The equipment shall be used as directed by the Engineer.

Subsection 203.12 shall include the following:

Combination Loader and Dump Trucks will be measured by the number of hours that it is actually used as ordered. Time involved in moving onto or off the project will not be measured and paid for under this item. Time will be paid for moving combination loaders, motor grader, and dump trucks from one location on the project to another, if directed, but time will not be allowed for moving equipment considered to be idle or for moves which are made for the convenience of the Contractor. Time will be allowed for combination loaders, motor grader, and dump trucks considered to be on stand-by as part of scaling operations.

Truck (Dump) hours used to haul material off site to dump locations will be paid. The Contractor shall keep a log of hours and mileage to track hours used for hauling off site.

Subsection 203.13 shall include the following:

The accepted quantities will be paid for at the contract price for each of the pay items listed below.

Payment will be made under.

Pay Item	**Unit**
Truck (Dump)	Hour
Combination Loader	Hour

SECTION 203B
UNDERGROUND BLASTING AND USE OF EXPLOSIVES

Section 203B is hereby added to the Standard Specifications for this project as follows:

DESCRIPTION

203B.01 General. This work consists of rock excavation and demolition of existing reinforced concrete tunnel lining by blasting and the use of explosives, to widen the existing eastbound bore of the I-70 Twin Tunnels.

Permits for transportation, handling, storage and usage of explosives shall be in accordance with Explosives Regulations of the Colorado State Division of Oil and Public Safety: 7 CCR 1101-9.

203B.02 References.

(a) Code of Federal Regulations (CFR): U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), Construction Standards and Interpretation, 29 CFR Part 1926

(b) Bureau of Alcohol Tobacco and Firearms (BATF): Title XI, Regulation of Explosives (18 U.S.C. Chapter 40; 84 Statute 952), of the Organized Crime Control Act of 1970 (84 Statute 922) and 27 CFR 55.

(c) Department Of Transportation (DOT): Title 49 (49 CFR), Parts 106, 107, 171-179, 383 and 390-399

(d) Appendix B, of the United States Bureau of Mines Report of Investigations, RI 8507, 1980

203B.03 Special Considerations. The Contractor shall utilize Controlled Blasting techniques for all excavations. Perimeter Control Blasting methods shall be used to reduce overbreak. The Contractor shall conduct all blasting in a manner that; prevents flyrock beyond the defined work areas, minimizes damage to installed ground support measures and instrumentation, and ensures the safety of employees, CDOT personnel, and the public.

Protection of Westbound Bore. Blasting techniques employed for widening the Eastbound tunnel shall be designed and implemented so as to not produce vibration levels in the Westbound tunnel in excess of the values specified herein or impair normal traffic operations in the Westbound tunnel. Westbound tunnel lining shall be viewed for damage or loosened concrete following each blast until it can be demonstrated to the satisfaction of the Engineer through vibration level records and observations that the Westbound tunnel is responding well to construction operations in the Eastbound tunnel. In addition, blasting operations shall include provisions to record the existing condition and monitor the Scott Lancaster Bridge, Idaho Springs Wastewater Treatment Plant, the nearest residence and the old US40 Doghouse Rail Bridge for vibration levels caused by the blasting excavations.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect or misconduct in the execution of the work, or in consequence of the non-execution thereof by the Contractor, the Contractor shall restore or repair, such property in accordance with the provisions of the OCIP for this project. Damage to the Westbound tunnel lining or roadway that affect traffic or that may affect public safety shall be repaired immediately.

203B.04 Definitions.

(a) *Peak Particle Velocity (ppv):* The maximum of any one of the three ground vibration velocities measured in vertical, longitudinal and transverse directions. Unit of measurement for this velocity is inches per second.

(b) *Excavation Line.* The Excavation Line is defined in Subsection 211A.03 Underground Excavation and Initial Support.

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SECTION 203B
UNDERGROUND BLASTING AND USE OF EXPLOSIVES

(c) *Overbreak.* Rock excavated beyond the indicated Excavation Line.

(d) *Controlled Blasting*. Controlled Blasting is excavation in rock in which the various elements of the blast (hole size, depth, spacing, burden, charge size, distribution, delay sequence) are carefully designed and controlled to provide a distribution of charges that will fracture the rock to the required lines and minimize overbreak and fracturing of the rock beyond the Excavation Line. Controlled Blasting is a general term for many different techniques developed for the above purposes of limiting vibrations, rock movement, air overpressure and damage to the surrounding rock not to be excavated.

(e) *Perimeter Control Blasting*. The use of specialized techniques to control the blast limit, condition of the rock face after the blast, and condition of the remaining rock. Perimeter control blasting includes the designed use of channel and/or line drill holes, charge type, loading details, blasting sequence, and delays.

(f) *Cushion Blasting*. Cushion Blasting is a perimeter control blasting technique involving the drilling of a single row of holes along the Excavation Line which are loaded with light, well-distributed charges and are fired either after the main excavation is removed or in the last delay of a single blast.

(g) *Smooth Wall Blasting.* Smooth Wall Blasting is a technique similar to Cushion Blasting used in tunnel blasting. Smooth Wall Blasting techniques involve perimeter holes drilled along the excavation limits which are lightly loaded to remove the final burden, and are fired on the last delay of the detonation sequence. The objective is to obtain smooth walls with minimum overbreak and minimal damage to the rock outside the excavation line.

(h) *Perimeter Hole*. A perimeter hole is any hole, loaded or not, at or near the excavation line used to cause the rock to break to the excavation line.

(i) *Burden.* The distance from explosive charge to the nearest free or open space.

(j) *Sub-drilling.* The portion of a blast hole that is drilled beyond the desired excavation depth or limit.

(k) *Stemming.* Crushed stone or other earth material placed in collar of a blast hole for purpose of confining explosive charges and limiting vibrations.

(l) *Production hole.* A blast hole in the main body of the rock mass to be removed by drill and blast.

(m) *Trial or Test Blast*. A Trial Blast is a blast or series of blasts designed to assist in determining the combination of blast parameters that are most appropriate to achieve the desired result as described in this special provision.

MATERIALS

203B.05 Explosives. The explosive storage facility or facilities shall be located on the surface, in an area that meets with all Federal, State, and local laws and regulations, and as approved by the Engineer. They shall meet the applicable requirements of Class A magazines.

203B.06 Delays. Non-electric or electronic detonation systems shall be used on this project unless another detonation system is approved by the Engineer. Cap and fuse or safety fuse is prohibited. The Contractor will be allowed to use one electric blasting cap per round to initiate the shot. The electric blasting cap shall not be tied into the blasting circuit until traffic has been stopped and the area has been secured.

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UNDERGROUND BLASTING AND USE OF EXPLOSIVES

203B.07 Seismograph. Blast vibrations shall be monitored using one or more seismographs complying with International Society of Explosives Engineers (ISEE) Guidelines for Field Practice and meeting the requirements stated below. A minimum of three geophones shall be installed in the westbound tunnel and monitored for the duration of the blasting operations; one at each portal and one at the approximate midpoint of the tunnel; and one each at the Scott Lancaster Memorial Bridge, Idaho Springs Wastewater Treatment Plant, the nearest residence and the old US40 Doghouse Rail Bridge. Geophones should be secured to the surface, horizontal, if possible, with anchor bolts.

(a) Equipped with a self-triggering device.

(b) Capable of measuring vibrations in three orthogonal planes (vertical, transverse, and longitudinal).

(c) Directly measure peak particle velocity.

(d) Seismic range: 0.01 to 20 inches per second accurate to ±5 percent of the measured peak particle velocity or better at frequencies between 2 Hertz and 200 Hertz, and with a resolution of 0.01 inches per second or less.

(e) Acoustic range: 110 to 140 dB with an accuracy and resolution of ±1 dB.

(f) Frequency response (±3 dB points): 2 to 200 Hertz.

(g) Two power sources: internal rechargeable battery and charger. Battery must be capable of supplying power to monitor vibrations continuously for not less than 24 hours.

(h) Capable of internal dynamic calibration.

(i) Have adequate memory to digitally record the entire duration of the blast-induced motion

(j) System capable of saving back-up copies of all event files to a solid state memory device or external hard drive

CONSTRUCTION REQUIREMENTS

203B.08 Preliminary Submittals. The following shall be submitted to the Engineer no less than three weeks prior to beginning any work involving excavation or explosives.

(a) *General Excavation Plan*. This submittal shall be a general narrative containing at least the following information for underground work (tunnels) :

1. A list of equipment, which will be available at each portal on the site for performing the blasting work.

2. A listing of the blasting materials which the Contractor will have available on site to perform blasting work. The list shall include the types, sizes and strengths of explosives proposed for the work, a description of the types of detonation systems to be employed.

3. Manufacturers' data sheets for all explosives, primers and initiators to be employed.

4. Description of exclusion zones in tunnel and surrounding areas during blasts from operations at each portal

5. A description of the pre-blast warning system, sign locations and sign design to be used.

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UNDERGROUND BLASTING AND USE OF EXPLOSIVES

6. Proposed method for limiting overbreak and rock damage beyond the Excavation Line through means of controlled blasting

7. Monitoring Plan with locations, equipment, and schedule.

(b) *Preliminary Blast Plan*. This shall be a brief description and drawing of the planned blasts for each blast type to be used throughout the project and shall be submitted to the Engineer no later than 3 weeks prior to commencement of the initial blast. All blast designs shall include the following:

1. Blast type designation (for example, Heading I slash, existing lining demolition, Heading II Slash, Bench , etc.)

2. Identification of perimeter control blasting and smooth wall blast areas and techniques including presplitting, Cushion Blasting, and other controlled blasting techniques to be used.

3. Plan and section views, to scale, of proposed drilling pattern, including diameters, spacing, depth and orientation of drill holes, free faces, burden and sub-drilling.

4. Types and quantities of explosives proposed for use in each hole and for each total blast.

5. Distribution of the charge in the holes, priming of each hole and stemming of holes.

6. Hole charging method, including method on how to secure detonators until blast.

7. Type, sequence and number of delays, delay pattern, diagram for blast and type and capacity of initiation devices.

8. Method for drilling and description of equipment.

9. Method for preventing spill of explosives, oil, drilling fluids and other pollutants.

10. Disposal of explosive packaging materials.

11. Estimated peak induced vibration level at nearest point in Westbound tunnel

12. Signature of blasting supervisor.

(c) *Blasting Safety Plan.* This plan shall be prepared in detail and not only state “all regulations will be followed”. The Blasting safety plan shall include:

1. Description of clearing and guarding procedures to ensure the safety of personnel, staff, visitors and the general public during blasting operations.

2. Description of inspections for and handling of misfires in excavated material.

3. Description of how the explosive materials will be safely transported and stored.

4. Material Safety Data Sheets.

5. Contingency measures in case of lightning storm.

6. Proposed powder magazine locations.

7. Emergency response plan to be approved by the Engineers and further submitted to the local response agency before explosives are allowed on site.

(d) *Traffic Control*. Traffic control procedures shall be in accordance with the requirements of Sections 104 and 630.

(e) *Identification and Qualification of Personnel*. Names and qualifications of persons who will be directly responsible for planning, supervising, loading and firing of blasts including the following:

1. Names and Experience of Blasting Supervisors. Blasting supervisors shall have a minimum of five years experience in supervising the loading and firing of charges of rock excavation or other directly related experience in drill and blast production and shall have all necessary licenses and permits required by the state and other agencies having jurisdiction.

2. Name and experience record of the Contractor's blasting engineer or consultant retained to develop all controlled blasting designs and details. This person shall have at least ten years of experience in monitoring blasting operations, preparing controlled blasting designs and interpreting ground vibrations, air overpressure and impulse amplitudes, from similar projects. It is also important that this person has experience of partial heading excavation and enlargement of existing tunnels.

3. All blasters and supervising shift foremen shall be properly qualified and licensed in accordance with applicable federal, state and local regulations.

203B.09 Construction Submittals. The following shall be submitted as noted herein:

(a) *Individual Blast Plan*. The Contractor shall furnish an individual blast plan for each blast no later than 24 hours before the blast. This plan shall include.

1. Proposed date and time for blast

2. Plan drawing or other documentation of stationing, length of drilling

3. Scaled cross section drawings of the face showing the location, orientation, spacing and number of blast holes

4. Table or other documentation showing linear loading specifics per blast hole, maximum weight of explosive per hole, total weight of explosives used and maximum charge weight per delay.

(b) *Blast Report*. The Contractor shall furnish an as-built drawing of each blast no later than 24 hours after the shot is fired. This shall be a complete description of the blast and shall include as a minimum the same information as the Individual Blast Plan with any modifications to it. The Blast report shall also include :

1. The names and signatures of the persons responsible for designing, loading and firing of the shot.

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2. A description of any overbreak and unusual occurrences including unanticipated rock fall, misfires, remaining unstable ground, and equipment malfunctions.

3. Recorded peak vibration level at nearest seismograph in Westbound tunnel.

Comment by the Engineer on blast designs and techniques shall not relieve the Contractor of responsibility for adequacy, accuracy, safety, proper supervision, and compliance with these Specifications and applicable federal and state regulation that govern the use of explosives.

203B.10 General Excavation Requirements.

The Contractor shall use every precaution and blast design measure to avoid excessive overbreak or damage to the rock surfaces beyond the intended excavation.

The Contractor shall remove loose or unstable rock that cannot be otherwise safely supported in the area surrounding the excavation line. All loose material shall be removed from the face. The cost of removing and supporting and backfilling with shotcrete as required to meet indicated substrate smoothness criteria for geocomposite drainage systems any material beyond the defined allowed overbreak limits shall be in accordance with the requirements of Section 109.

203B.11 Blasting Requirements.

Excavation to final rock surfaces shall be carried out using Smooth Wall Blasting techniques or similar controlled blasting technique. If a blast or blasts show damage along final rock surfaces unacceptable to the Engineer, the Engineer may require changes to the blast design.

The first production blast in each ground support class shall be designed as a Trial / Test Blast to verify planned round length, initiation sequence, induced vibration levels, the interaction with existing lining, and overbreak behavior. An assessment of the Trial Blast shall be made and submitted to the Engineer. If the Trial Blast is not satisfactory to the Contractor or the Engineer, modifications shall be made changing one or more blast parameters. Unsatisfactory conditions include excessive overbreak, inadequate fragmentation, undetonated explosives, and excessive vibrations.

Decoupled perimeter hole explosives shall be used in perimeter holes. The perimeter hole spacing shall be no more than 2 feet. The holes shall be loaded with light, uniformly-distributed decoupled charges. The collar of the hole shall be unloaded and stemmed.

Unless otherwise specified, ground vibrations shall not exceed a maximum peak particle velocity (largest single component) of 1 inch per second measured 200 feet from the blast. Blasts shall not damage any existing structures. Furthermore, at the existing structures in the vicinity of the site, the maximum vibration and airblast limits shall not exceed the values indicated in the following tables and Figure B 1, Appendix B, of the United States Bureau of Mines Report of Investigations, RI 8507, 1980.

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UNDERGROUND BLASTING AND USE OF EXPLOSIVES

Ground Vibration Limits		
Type of Structure[1]	**Peak Particle Velocity (inches per second)**	
	At Low Frequency[2] (<40 Hertz)	**At High Frequency (>40 Hertz)**
Modern structures, drywall interiors	0.75	2.0
Older structures, plaster on wood lath construction for interior walls	0.5	2.0

[1] *For precarious structures not listed in the table, use the limits for older structures; for all other structures not listed in the table, use the limits listed for modern structures.*
[2] *All spectral peaks within 50 percent amplitude of the predominant frequency must be analyzed.*

Airblast Limits		
Instrumentation	**Residential Structures**	**All Other Structures**
0.1 hertz high-pass system	**115**	**134**
2 hertz high-pass system	**113**	**133**
5 or 6 hertz high-pass system	**110**	**129**
C-slow (for events not exceeding 2 seconds' duration)	**85**	**105**

Blasting in the vicinity of concrete shall be limited to prevent damage to CIP concrete. The Contractor shall take special care when blasting in the vicinity of concrete that has not achieved full strength. As a minimum, conform with the following limitations:

Ground Vibration Limits for Green Concrete	
Time After Pour	**Peak Particle Velocity (inches per second)**
0 – 4 hours	2.0
4 – 24 hours	0.25
1 – 3 days	1.0
3 – 7 days	2.0
7 28 days	5.0

Blasts shall be designed and initiated so as to limit measured vibrations in the Westbound tunnel to a peak particle velocity (PPV) of not more than 10 inches per second. Occasional higher PPV levels up to 12 inch/sec may be used as approved by Engineer based on submitted evidence of no observable or measurable damage to the Westbound tunnel. For purposes of initial blast designs and estimating induced vibrations in the westbound tunnel, a minimum distance of 45 feet from blast to nearest surface of westbound tunnel lining may be used.

Blasts shall be conducted in conformance with the above limitations and consistent with levels demonstrated through calculation of vibration levels versus scaled distance and visual monitoring of the Westbound tunnel to not be damaging to the structural lining. These limitations shall remain in effect unless it is demonstrated through Trial/Test Blasts that the desired results can be achieved when said limitations are exceeded.

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203B.12 Blast Warning. The Contractor shall establish a system of blast warning signals. As a minimum, warning signals shall be given at five minutes and at one minute prior to each blast, and an all clear signal shall be given once the blast area has been inspected for misfires. Warning signals shall be audible throughout the work area and for a distance of at least 200 feet from each portal.

The Contractor shall implement all necessary restrictions on access to the area including but not limited to pedestrians, vehicles, bicyclists, and equestrians. Coordinate with law enforcement officials and other agencies as necessary for closure of public roads and lands.

203B.13 Blast Monitoring. Blast induced vibrations in the Westbound tunnel shall be monitored by the Contractor for every blast as specified in Paragraph 203B.11 above. All other structures are to be monitored for blast vibrations, overpressure and noise as required to demonstrate compliance with Colorado blasting regulations specified in Paragraph 203B.11. Furthermore, if there is a structure within 1000 feet of the blast, a seismograph shall be placed at the structure located in a line between the blast and the structure, unless approved otherwise by the Engineer.

BASIS OF PAYMENT

203B.16 Blasting, Blast Monitoring, and the use of explosives will not be measured and paid for separately but will be considered incidental to cost of Tunnel Excavation.

REVISION OF SECTIONS 207 AND 304
AGGREGATE BASE COURSE (CLASS 6) (SPECIAL)

Sections 207 and 304 of the Standard Specifications are hereby revised for this project as follows:

DESCRIPTION

Subsection 304.01 shall include the following:

This work consists of furnishing and placing an aggregate-topsoil course on a prepared surface to provide maintenance access for removing sediment from capture ponds.

MATERIALS

Subsection 304.02 shall include the following:

Aggregate for the aggregate-top soil course shall meet the gradation requirements of Concrete Aggregate No. 57 as listed in Table 703-2.

Subsection 207.02 shall include the following:

Imported Topsoil shall be a loam or sandy loam. At least ten (10) days prior to topsoil delivery, notify the Engineer of the source(s) from which topsoil is to be furnished. Topsoil shall be furnished by the Contractor and shall be a natural, friable soil representative of productive soils and shall meet the following conditions.

1. Imported topsoil shall be certified weed free and pest free.
2. It shall be obtained from the top twelve inches (12") of well drained areas.
3. Fertile, friable, loamy soil, reasonably free from subsoil, refuse, roots, heavy or stiff clay, stones larger than one inch (1”), coarse sand, noxious seeds, sticks, brush, litter, and other deleterious substances; suitable for the germination of seeds and the support of vegetative growth. The PH value shall be between seven and eight (7.0 and 8.0).
4. Soil Texture: Sand, thirty to fifty percent (30% - 50%); silt, thirty to fifty percent (30% - 50%) percent; clay, five to thirty percent (5% - 30%).
5. Percent Organic Content: two point nine percent (2.9%) minimum five percent (5%) maximum.
6. Soluble Salts: Electric conductivity shall be less than three point three (3.3) mmhos/cm for dryland areas and less than five (5.0) mmhos/cm for irrigated lands.

CONSTRUCTION REQUIREMENTS

Subsections 304.04 through 304.06 shall include the following:

Placing, Mixing, Shaping and Compacting shall comply with the following:

1. Furnish a mixture of 50±10 percent aggregate and 50±10 percent topsoil by volume with sufficient water for compaction.
2. Mix the components into a uniform mixture. Spread the mixture on the prepared surface in a uniform layer to a depth of 6 inches. Shape the mixture to the line, grade, and cross-section. Remove all clods and stones greater than 2 inches in diameter.
3. Uniformly compact the mixture so that it does not exhibit heaving, pumping, rutting, or shearing. Compaction tests may be waived by the Engineer if acceptable compaction is demonstrated.
4. Remove all material from the pavement surface upon completion.

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REVISION OF SECTIONS 207 AND 304
AGGREGATE BASE COURSE (CLASS 6) (SPECIAL)

METHOD OF MEASUREMENT

Subsection 304.07 shall include the following:

Aggregate Base Course (Class 6) (Special) will be measured by the cubic yard compacted in place and accepted.

BASIS OF PAYMENT

Subsection 304.08 shall include the following:

The accepted quantities will be paid for at the contract unit price for the pay item listed below.

Payment will be made under:

Pay Item	**Pay Unit**
Aggregate Base Course (Class 6) (Special)	Cubic Yard

Payment shall be full compensation for all labor, materials, and equipment required to supply, mix, place, and compact the base course.

REVISION OF SECTION 210
RESET LIGHTING STRUCTURES

Section 210 of the Standard Specifications is hereby revised for this Project as follows:

Subsection 210.01 shall include the following:

This work also includes the complete removal of associated light standards and lighting control centers, their respective foundations and appurtenances and resetting them on new concrete foundations at the locations indicated in the Plans.

Subsection 210.03 shall be deleted in its entirety and replaced with the following:

210.03 Light Standard and Lighting Control Center. Light standards and lighting control center shall be reset on new concrete foundation pads complete with conduit, wiring, and grounding in accordance with the Department's Standard Plans at locations indicated in the Plans.

Subsection 210.12 shall include the following:

Reset Light Standard will be measured by each light standard reset at its new location, in service, complete and accepted.

Reset Lighting Control Center will be measured by each control center reset at its new location, in service, complete and accepted.

Subsection 210.13 shall include the following:

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

Pay Item	**Pay Unit**
Reset of Light Standard	Each
Reset of Lighting Control Center (LCC)	Each

Payment for Reset Light Standard and Reset Lighting Control Center shall include all materials and work required to reset the item at its new location including salvage of the reset materials and equipment, removal of the existing foundations, excavation and backfill.

New light standard foundations and concrete foundation pads for reset light standards and lighting control centers will not be paid for separately but shall be included in the cost of the reset item.

REVISION OF SECTION 210
MODIFICATIONS TO EXISTNG PORTALS

Section 210 of the Standard Specifications is hereby revised for this project as follows:

Subsection 210.01 shall include the following:

This work shall include the modifications to the existing portal headwalls, as shown on the plans.

Subsection 210.12 shall include the following:

Modifications to existing portals will be measured by each portal structure modified and accepted.

Subsection 210.13 shall include the following:

Payment will be made under:

Pay Item	**Pay Unit**
Modifications to Existing Portals	Each

Payment shall be full compensation for all incidental items and materials necessary to complete the work in accordance with the details shown in the plans.

REVISION OF SECTION 210
RESET CCTV CAMERAS

Section 210 of the Standard Specifications is hereby revised for this project as follows:

Subsection 210.01 shall include the following:

DESCRIPTION

This work consists of resetting a Closed Circuit Television (CCTV) camera and related materials to be mounted on new pole as indicated on the plans. The work also includes pulling back the existing fiber optic lateral cable and re-connecting it to the reset location. All CCTV cameras shall be carefully removed, stored, and reinstalled in a manner that avoids loss or damage. Any down-time for the CCTV camera shall occur Monday – Friday and shall not exceed 48 hours. All infrastructure shall be in place for the reset CCTV location before the existing CCTV is taken out of service.

Subsection210.02 shall include the following:

MATERIALS

The contractor shall use a new pole to mount the reset CCTV.

CONSTRUCTION REQUIREMENTS

CCTV cameras designated to be reset shall be removed along with communications and electrical equipment. New CCTV poles shall be installed as noted on the plans along with any new electrical and communications necessary to restore the CCTV service at the new location. Equipment and materials shall be cleaned prior to being reset. Contractor shall verify CCTV functionality prior to reset. The Contractor shall contact Jill Scott with CDOT ITS, 303-512-5805, 48 hours prior to relocating the CCTV for verification that the CCTV is functioning properly. If the CCTV is not functioning before it is relocated, CDOT will provide a replacement.

CCTV camera shall be installed in accordance with these specifications, the details shown in the Plans, and in accordance with manufacturer's recommendations. The Contractor shall make all arrangements for a qualified manufacturer's representative to be on-site to ensure proper installation of the CCTV camera. The manufacturer of the CCTV is Panasonic and the local contact is Mike Aukamp, MSN Communications 303-347-8303.

For the attachment of the adapter bracket to the pole, a 3/4 inch type 201 stainless steel strap used in conjunction with type 201 stainless steel buckles at a mounting height shown on the detail. The attachment shall be banded to the pole at an orientation to achieve the optimal view of both the main roadway and crossroad or as directed by the Engineer.

A maximum one inch hole shall be drilled in the mounting pole to allow passage of the composite cable. The hole shall be free of burs and sharp edges prior to the installation of the composite cable. The cable shall be attached to the reverse side of the mounting bracket to ensure proper strain relief or damage caused to the camera or housing. The cable shall run down the interior of the pole and exit through non-metallic flexible conduit to the communication cabinet. The non-metallic flexible conduit shall be weather sealed on each end to eliminate exterior liquid entry. The Contractor shall also provide a weather seal for the adapter bracket at the one inch hole at the top of the pole per the manufacturer's recommendations.

Subsection 210.12 shall include the following:

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REVISION OF SECTION 210
RESET CCTV CAMERAS

METHOD OF MEASUREMENT

Reset Closed Circuit Television shall be measured by the actual number of closed circuit television cameras reset and accepted, including all associated hardware, materials, cabling, device connection and configuration, re-pulling of fiber lateral, and power conductors from the power source to the CCTV camera unit.

Subsection 210.13 shall include the following:

The accepted quantity for Reset CCTV Camera, measured as provided above, will be paid for at the contract price for each of the pay items listed below that appear in the bid schedule.

Payment will be made under:

Pay Item	**Pay Unit**
Reset CCTV Camera	Each

Payment for resetting CCTV cameras will be full compensation for all labor, materials, and equipment required to complete the work.

REVISION OF SECTION 210
RESET MICROWAVE VEHICLE RADAR DETECTOR

Section 210 of the Standard Specifications is hereby revised for this project as follows:

Subsection 210.01 shall include the following:

DESCRIPTION

This work consists of resetting a microwave vehicle radar detector (MVRD) and related materials to be co-located on an existing light pole with the reset CCTV camera as indicated on the plans. The work also includes furnishing and installing a WX-CLK-301 module, along with any cabling, to convert communications from Serial to Ethernet. Any down-time for the MVRD shall occur Monday – Friday and shall not exceed 48 hours. All infrastructure shall be in place for the reset MVRD location before the existing MVRD is taken out of service.

Subsection210.02 shall include the following:

MATERIALS

The contractor shall use a new pole to mount the reset MVRD.

A WX-CLK-301 module shall be furnished and installed, along with any cabling, to convert communications from Serial to Ethernet.

CONSTRUCTION REQUIREMENTS

The Contractor shall reset and mount all existing MVRD equipment. The Contractor shall contact Jill Scott with CDOT ITS, 303-512-5805, 48 hours prior to relocating the MVRD. The Contractor shall supply power to the power supply and both duplex receptacles. The duplex GFCI receptacle shall be wired such that in the event of a ground fault, both the power supply and duplex NEMA 5-15R receptacle remain energized.

The access hole on the bottom of the communications cabinet for power wiring and radar detection unit power/communication cabling shall be reused for entry. 3/4 inch Type 201 stainless steel strap used in conjunction with Type 201 stainless steel buckles shall be used to mount the communications cabinet to the light pole so that the top of the cabinet is approximately 5-7 feet above surrounding grade and the location shall be confirmed by Matthew Becker with CDOT ITS at 303-512-5856. The communications cabinet shall be oriented such that anyone working in the cabinet has direct line of sight with traffic. The Contractor shall be responsible for any necessary modifications or additions needed to mount the communications cabinet to the structure.

0.75 inch Type 201 stainless steel strap used in conjunction with Type 201 stainless steel buckles shall be used to mount the radar detection unit at a height and angle determined by roadway off-set and detection distance in accordance with manufacturer's recommendations.

The manufacturer's recommended power/communication cable shall run on the interior of the mounting structure from the radar detection unit to the communications cabinet. A hole not to exceed 1.5 inches shall be made 12 inches below the radar detection unit to allow passage of the power/communications cable into the structure. The Contractor shall ensure strain relief and drip loops in the power/communication cable before the cable enters the structure in accordance with manufacture's recommendations. A hole not to exceed 1.5 inches shall be made below the communications cabinet to allow the power/communications cable and communications cabinet supply power cable to pass from the interior of the structure to the interior of the communications cabinet. Flexible conduit shall be used to run cables from the structure to the communications cabinet.

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REVISION OF SECTION 210
RESET MICROWAVE VEHICLE RADAR DETECTOR

The Contractor shall run and connect existing power from the interior of the structure to the 10A circuit breaker in the communications cabinet. The communications cabinet power shall be connected through a 10A in-line waterproof fused disconnect and shall be labeled "Radar Detector Power". The Contractor shall wire supply power, power supply, surge suppressor, and radar detection unit in accordance with the manufacture's recommendations. The six outlet power strip shall be plugged into the duplex NEMA 5-15R.

All holes shall be free of burs and sharp edges prior to the installation of all cable, conduit, and conduit nipples. All cable entrances in structures, conduits, and cabinets shall be sealed and waterproofed. All wiring and electrical connections shall be performed in conformance with the latest version of the NEC.

Subsection 210.12 shall include the following:

METHOD OF MEASUREMENT

The Reset Microwave Vehicle Radar Detector will be measured by the actual number of units and all associated materials and work reset and accepted, and will include testing to ensure an accurate data collection and reporting.

Subsection 210.13 shall include the following:

BASIS OF PAYMENT

The accepted quantity for Reset Microwave Vehicle Detector, measured as provided above, will be paid for at the contract price for each of the pay items listed below that appear in the bid schedule.

Payment will be made under:

Pay Item	**Pay Unit**
Reset Microwave Vehicle Radar Detector (MVRD)	Each

Payment will be full compensation for all labor, materials, and equipment required to complete the work.

REVISION OF SECTION 210
RESET OVERHEAD SIGN STRUCTURE

Section 210 of the Standard Specifications is hereby revised for this project as follows:

Subsection 210.01 shall include the following:

This work consists of resetting the existing cantilever structure located at project STA 325+50 onto a new 42" diameter caisson.

Subsection 210.08 shall be replaced with the following:

A new 42" diameter caisson shall be constructed for the placement of the existing cantilever structure. The caisson shall be constructed per current M&S Standard S-614-50 requirements. The existing cantilever structure shall be painted with Federal Standard Color 20059 or Sherwin Williams Color SW2838 by a method approved by the Engineer. If during the resetting process, splice plate bolts or other materials necessary to reset the structure are damaged, the Contractor shall replace these materials at no cost to the project.

The Contractor shall obtain new caisson anchor bolts for placement of the reset cantilever structure.

Section 210.12 shall include the following:

Reset Overhead Sign Structure shall be measure by the actual number of cantilever structures reset and accepted, including all associated hardware and materials.

Section 210.13 shall include the following:

Payment shall be made under:

Pay Item	**Pay Unit**
Reset Overhead Sign Structure	Each

REVISION OF SECTION 210
RESET TRAVEL TIME INDICATOR

Section 210 of the Standard Specifications is hereby revised for this project as follows:

Subsection 210.01 shall include the following:

DESCRIPTION

This work consists of resetting a Travel Time Indicator (TTI) and related materials to be mounted on a sign cantilever west of the Hidden Valley interchange in accordance with the plans, these special provisions, and manufacturer's recommendations. It shall also include furnishing and installing a CAT5e cable and any connectors necessary to connect the TTI to the CCTV cabinet as shown in the plans.

Subsection 210.02 shall include the following:

MATERIALS

The contractor shall use a sign cantilever to mount the reset TTI. Reset TTI shall include resetting the existing IDentity reader, directional 42 degree antennas, corresponding antenna mounts, antenna signal cables, waterproofing mastic, related mounting hardware, device configuration software, and any other associated cabling and adaptors. It shall also include reconfiguring the optical transceivers in the field cabinet and at the Hidden Valley node building. The Contractor is responsible for installing and aligning the ANTENNA-013-K directional antenna and antenna mounts as shown on the plans and per manufacturer's recommendations.

The CAT5e cable shall have an outdoor-rated PE jacket to withstand outdoor weather elements and conform to the following requirements:

1. 4-pair UTP cable
2. 24 AWG solid bare copper conductor
3. Sweep tested to 350 MHz
4. Meet or exceed CAT5e specifications per ANSI, EIA, and TIA
5. Outdoor-rated PE jacket
6. Verified compliant with EIA/TIA standards by UL and ETL
7. UL listed

CONSTRUCTION REQUIREMENTS

The Contractor shall contact Jill Scott with CDOT ITS, 303-512-5805, 48 hours prior to relocating the TTI. The existing Travel Time Indicator reader shall be mounted inside a new communications cabinet allowing room for all communication cable connections. A hook & loop fastening system shall be used to mount the reader to the cabinet for ease of removal.

The power supply shall be mounted to DIN rail inside the communications cabinet. All wiring shall conform to the most current version of the NEC.

The Contractor shall supply and install one-inch type 201 stainless steel strap used in conjunction with type 201 stainless steel buckles shall be used to band the antenna mount to the structure at the mounting height directed by the Engineer per guidance from Matthew Becker at 303-512-5856. The Antenna shall be mounted horizontally polarized using the included stainless hardware. The antenna shall be oriented such that it intersects with the oncoming traffic at a 45 degree angle, and is aimed to the center of lane 2. Mounting heights will vary per location.

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REVISION OF SECTION 210
RESET TRAVEL TIME INDICATOR

Holes made in mounting structures shall be the minimum size necessary to secure the conduit connectors and shall not exceed two inches in diameter. All holes shall be free of burs and sharp edges prior to the installation of all cable, conduit, and conduit nipples. All cable entrances in structures, conduits, and enclosures shall be sealed and waterproofed. All wiring and electrical connections shall be performed in conformance with the latest version of the NEC.

The signal cable shall connect RF input/output channels from the telemetry master (toll tag reader) to the telemetry (antenna) units – one cable per antenna. The contractor shall route signal cable through existing structures or through new flexible or rigid PVC conduit mounted to existing structures as shown on the plans. Each signal cable shall be a continuous cable, with no splices, terminated with male N-type crimp on straight plugs on both ends. Installed length of any one signal cable shall not exceed 100 linear feet. (*** Installations that require lengths in excess of ~100 feet should utilize lower loss cable as to not exceed 3-4dB of loss per run. All signal cables shall be labeled on both ends with UV resistant colored tape before installation. The same color label shall be used on both ends of one cable and label colors shall not repeat at the same installation site. Labels shall be installed such that they are distinguishable from the ground.

The Contractor shall ensure strain relief and drip loops in coaxial antenna cable. The Contractor shall provide full support to all coaxial cable not in conduit and/or wiring trays. All cable entrances in conduits, conduit entrances in structures and cabinets shall be sealed and waterproofed. Conduit/signal cable shall not enter the top of the cabinet housing the telemetry master device. Entering through the bottom of the cabinet is preferred, although side entrances will be permitted. It is suggested that the signal cables be cut longer than needed and installed with the terminated end on the telemetry (antenna) side. Cables can then be re-labeled, cut to length, and terminated once they are run into the telemetry master enclosure. Waterproofing mastic shall be applied at all antennas to signal cable connections following manufacturer's recommendations.

The Contractor shall connect antenna signal cables to the Travel Time Indicator such that:
1. Northbound vehicle detection corresponds to Port 1,
2. Southbound vehicle detection corresponds to Port 2,
3. Eastbound vehicle detection corresponds to Port 3, and
4. Westbound vehicle detection corresponds to Port 4.

The Contractor shall configure the Travel Time Indicator in accordance with manufacturer's recommendations.

The unit shall be configured for serial communication with the following:
1. 19,200 bits per second
2. 8 data bits
3. No parity
4. 1 stop bit
5. No flow control

The following shall be set to run in the TPS script:
1. Interval: 60s
2. Reader ID: as per plan sheet
3. Heartbeat: 10s

Subsection 210.12 shall include the following:

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REVISION OF SECTION 210
RESET TRAVEL TIME INDICATOR

METHOD OF MEASUREMENT

The Reset Travel Time Indicator (TTI) will be measured by the actual number of units reset and accepted, and will include testing to ensure an accurate data collection and reporting. Each Reset TTI shall include aiming the antenna, complete in place, in accordance with the plans and these special provisions. Reset TTI shall include reader connections, testing, all necessary cabling, all equipment and labor necessary for installation, and all other items necessary to complete the work. Testing will be measured as 90% vehicle transponder detection. Testing shall include a full data path to the Travel Time Indicator and acceptance by the Department.

Subsection 210.13 shall include the following:

BASIS OF PAYMENT

The accepted quantity for Reset Travel Time Indicator, measured as provided above, will be paid for at the contract price for each of the pay items listed below that appear in the bid schedule.

Payment will be made under:

Pay Item	**Pay Unit**
Reset Travel Time Indicator	Each

Payment will be full compensation for all labor, materials, and equipment required to complete the work.

SECTION 211A
UNDERGROUND EXCAVATION AND INITIAL SUPPORT

Section 211A is hereby added to the Standard Specifications for this project as follows:

DESCRIPTION

211A.01 General. This work shall consist of demolition of existing tunnel lining and excavation and disposal of all material in accordance with these specifications and the lines, grades, and stations shown on the Plans or as established in the field by the Engineer. Rock shall be excavated by drill and blast methods unless where able in some places to be excavated by mechanical methods.

211A.02 Special Considerations. Due to the narrow rock pillar between the Tunnel and the existing West Bound tunnel, care shall be exercised in the excavation of the Tunnel to not compromise the rock pillar between the two tunnels. Excavation shall be to the limits shown in the plans, minimize overbreak, minimize flying rock, and avoid damaging the rock mass around the Tunnel.

211A.03 Definitions.

(a) *Tunnel.* The Tunnel to be widened is the Eastbound tunnel of the I-70 Twin tunnels.

(b) *Initial Support.* Initial Support is rock dowels, rock bolts, spiles, steel channels, welded wire mesh, mine straps, fiber reinforced shotcrete, steel sets or other measures installed near the face and soon after excavation for the purpose of stabilizing the opening, preserving strength of the rock arch and providing for a stable opening and worker safety for the period of time from initial excavation until installation of the final lining.

(c) *Excavation Line.* The line shown on the Plans to represent the theoretical minimum excavation boundary within which ground of any kind will not be permitted to remain.

(d) *Design Line.* The line shown on the Plans that defines the nominal dimensions to the exterior surface of the final cast-in-place structural lining inside which no rock, soil, shotcrete or elements of geocomposite drainage strips or panels shall protrude. Ends of dowels, spiles or other bare steel components of the initial support systems may encroach up to six inches within the design line shown on the Plans.

(e) *Geocomposite Drain*. Geotextile-wrapped, dimpled plastic drainage sheet installed intermittently in strips or as overlapping panels to form a continuous sheet to collect and convey groundwater to formation subdrain pipes along the sidewalls of the tunnel.

(f) *Smoothing shotcrete.* Plain shotcrete placed to fill overbreak and cover rough excavated surfaces and initial support elements shall be as defined in Section 641A, Shotcrete.

(g) *Steel Fiber Reinforced Shotcrete (SFRS).* SFRS placed to stabilize the excavation and control raveling as defined in Section 641A, Shotcrete. Flashcrete is SFRS applied immediately following excavation to control raveling and provide rapid support to allow installation of additional support measures.

(h) *Excavation and Support Sequence*. Prescribed excavation and support procedure shown on Plans for particular ground class based on ground conditions exposed during excavation.

(i) *Partial Face Excavation.* Excavation of large tunnel cross sections using multiple smaller headings or drifts to limit span or face area of exposed ground in any one drift or heading and allow initial support to be installed in the smaller drifts before the cross section is enlarged, as a means of reducing ground disturbance.

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SECTION 211A
UNDERGROUND EXCAVATION AND INITIAL SUPPORT

(j) *Convergence monitoring.* Monitoring of deformations of supported ground along excavation boundary using optical survey methods for purpose of confirming adequacy of installed support elements and demonstrating a stable opening. Monitoring methods, equipment and frequency shall be as defined in Section 211C, Instrumentation.

MATERIALS

211A.04 Initial Support.

(a) *Rock Bolts.* Rock bolts shall be as specified in Section 211B, Rock Reinforcement.

(b) *Rock Dowels.* Rock dowels shall be as specified in Section 211B Rock Reinforcement.

(c) *Welded Wire Fabric.* For welded wire fabric material, size and spacing see Plans and standard specifications.

(d) *Steel Channel.* Steel channel shall conform to ASTM A36 or A572 Grade 50, and as specified in subsection 509.03 and dimensioned as shown on the Plans. Bolted connections shall develop the full strength of the steel section. The number and location of connections shown on the Plans may be adjusted by Contractor to suit erection equipment, subject to approval by the Engineer. Connections shall be such as to allow segments of steel channels to be installed piecewise as the tunnel is progressively widened in accordance with the excavation support sequences shown in the Plans.

(e) *Spiling:* Grade 60 or Grade 75 steel rebar or self-drilling steel anchors drilled and grouted into the ground surrounding excavation line beyond the face, as a means of increasing stand-up time of ground for excavation and support of next round or turning under at portals.

(f) *Shotcrete.* Shotcrete shall be as specified in Section 641A, Shotcrete.

(g) *Steel Fiber Reinforced Shotcrete (SFRS).* SFRS shall be as specified in Section 641A, Shotcrete.

(h) *Steel Sets.* Steel sets shall conform to ASTM A36 or ASTM A992 Grade 50, and as specified in subsection 509.03 and dimensioned as shown on the Plans. The number and location of connections shown on the Plans may be adjusted by Contractor to suit equipment requirements, subject to approval by the Engineer. Connections shall be such as to allow segments to be installed piecewise by drift as the tunnel is progressively widened. Stabilization of partially-erected arches shall be Contractor designed.

(i) *Footings.* Steel set footings shall be sack concrete or steel and shall provide adequate bearing capacity for the transfer of load from the steel sets and steel channels to the rock invert on the south sidewall and to the sawcut remnant of the existing tunnel lining on the north sidewall.

(j) *Blocking.* Blocking for steel sets shall be sound, hard wood as defined by Commercial Standard CS60, shotcrete or other measures at the Contractor's option and as approved by the Engineer.

(k) *Wood Lagging.* Wood Lagging for steel sets shall be sound, hard wood as defined by Commercial Standard CS60

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UNDERGROUND EXCAVATION AND INITIAL SUPPORT

211A.05 Drainage Materials. A fully functioning water management system including piping, mastics, fixing hardware and sealing compounds shall be placed after establishing a stable opening and before placement of final lining and shall be as shown on the Plans and as directed by the Engineer. Materials for the tunnel drainage system shall conform to Section 605.

CONSTRUCTION REQUIREMENTS

211A.06 Shop Drawings. The following shall be submitted in accordance with the requirements of Subsection 105.02:

(a) A plan of proposed tunneling operations at each portal. The plan shall show details of proposed methods, equipment and sequence for: saw cutting and demolition of existing lining, excavating and disposing of materials, drilling and blasting, ventilation, illumination, drainage, Initial Support installation on all exposed surface, and types of equipment.

(b) Blast designs in accordance with Section 203B, Underground Blasting and Use of Explosives.

(c) Layout of Contractor's staging area including all buildings, plants, storage areas, parking areas, and stockpiles.

211A.07 Working Drawings. The following shall be submitted in accordance with Subsection 105.02:

(a) Drawings and details of Initial Support of excavation for each support category, including rock reinforcement, plans and details of steel channel connections, installation and erection, and method of protecting connection butt plates of steel channel sections during blasting.

(b) Drawings and details for steel sets, footings and connections to be used at each portal including installation and erection sequence, collar braces, blocking, lagging and connections to temporary worker protection canopies at each portal.

(c) Methods and procedures for cutting, demolition and removal of existing tunnel lining in sections as indicated in Excavation Sequence Plans.

(d) Procedures for the control and disposal of water during tunneling.

(e) Methods and equipment for measuring and recording water flow out of the Tunnel as specified herein.

(f) Instruments for monitoring air quality.

211A.08 Qualifications. Contractor personnel responsible for blasting designs and supervision shall be qualified as specified in Section 203B, Underground Blasting and Use of Explosives.

The Contractor shall have daily on site during construction a safety officer with at least 2 years of experience in tunnel safety.

211A.09 Reports and Records. Daily records of Tunnel excavation work shall be maintained and submitted to the Engineer as specified in Section 203B, Underground Blasting and Use of Explosives. In addition, the following data shall be included in the daily records:

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(a) Type, quantity, and location of Initial Support elements installed including SFRS (in thicker layers and as flashcrete) , steel channels, steel sets, dowels, spiles, geocomposite or geotextile drains placed for panning to allow shotcrete placement, welded wire fabric, and lagging.

(b) Location and rate estimates of groundwater seepage into the Tunnel.

(c) Status of stabilization and structures at both portals if work was performed in the vicinity of the portals.

(d) Position of the face of all Tunnel headings and benches at start and end of each day's work.

(e) Number and classification of workers and equipment engaged in tunneling.

(f) Unusual occurrences, including rock falls, ground water problems, unstable ground, work delays and equipment malfunctions and the station and location of such occurrences.

(g) Lining demolition limits including sawcut locations, steel sets and volumes of associated ground fall and overbreak.

(h) Blast data including: Round lengths drilled and pulled in each heading, blast hole pattern(s) and explosives used by hole type (e.g., perimeter, relievers, lifters), powder factor and initiation sequence, and resulting vibration measurement records as required in Section 203B

(i) All survey records as specified herein.

211A.10 Initial Requirements.

(a) Tunnel excavation shall not commence until the following requirements have been met:

1. All required submittals have been reviewed and accepted by the Engineer.

2. A prejob safety conference has been conducted by the safety officer. Arrange this conference and inform the Engineer of the time and place of the conference at least 7 days in advance.

3. A pre-construction meeting scheduled by the Engineer and attended by all key Subcontractors and members of Contractor and CDOT teams is held.

4. The installation and initial reading of survey benchmarks and backsights outside the tunnel has been completed as specified in Section 211C, Instrumentation.

(b) Care shall be exercised to minimize overbreak; to prevent immediate and subsequent rock falls within the Tunnel and portal areas, and other rock slopes outside the Tunnel; and to preserve the integrity of the rock outside the limits of Tunnel excavation, particularly the rock pillar between the Tunnel and the existing Westbound tunnel.

(c) Clean working conditions shall be maintained at all times inside the Tunnel. All muck, slush, grout spills, and other material not required for tunneling shall be removed from the Tunnel in a timely manner.

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211A.11 Safety Requirements. The Contractor shall be responsible for support of the ground, the erection and maintenance of worker protection canopies at each portal, maintaining the stability of the exposed ground at the face and around the periphery of the Tunnel excavation, and safety during excavation and installation of initial ground support. Safety within the tunnels, portal areas and at all ancillary staging and worksites shall be the sole responsibility of the Contractor.

As a minimum, all work shall conform to the requirements of OSHA. The safety officer shall administer an accident prevention program, prepare a code of safe practices and an emergency plan, provide the Engineer with a copy of each prior to starting tunnel excavation, hold safety meetings, and provide safety instruction for new employees. The Contractor shall supply to the Engineer six sets of self rescuers and cap lamps with associated hard hats and belts. The Contractor shall also supply to the Engineer six headlamp rechargers or shall allow the Engineer access to rechargers. The Contractor shall provide safety training in the use of self rescuers and other specific site safety issues to CDOT's personnel.

211A.12 Ventilation and Illumination. All ventilation and illumination for tunneling work shall be performed in accordance with applicable State, Federal, and local laws, regulations, and guidelines.

The Contractor shall provide sufficient illumination in the vicinity of all active faces for the Engineer to observe the Work, map the rock mass, and write notes. As a minimum, the Contractor shall provide 50 foot-candles of illumination at the tunnel crown, face, and side walls for a distance of at least 50 feet from the face for all active headings.

Provide, operate, and maintain for the duration of tunnel operations, a temporary ventilation system and air quality monitoring system, which conforms to the requirements of all federal, State, and local regulations. Remove system(s) from the Site when work is complete.

Drilling and tunneling operations shall be performed by methods and with equipment, which will positively control dust, fumes, vapors, gases, fibers, fogs, mists and other atmospheric impurities. Following each blast and prior to mucking and installation of rock support, the muck pile shall be wetted sufficiently to prevent excessive dust during mucking operations.

Separate both power and lighting circuits; thoroughly insulate and protect them by ground fault circuit interrupters.

211A.13 Communications. The Contractor shall maintain contact with the Engineer at all times when Contractor personnel are onsite. If radio is used for the purposes of contact with the Engineer, the Contractor shall utilize the same frequency as used by the Engineer. The communication system chosen by the Contractor shall be compatible with the blasting method used.

211A.14 Instrumentation. Install required instrumentation as specified under Section 211C, Instrumentation. The Contractor shall read instrumentation on a regular schedule as presented in Section 211C, Instrumentation and shall submit these readings to the Engineer. The Contractor shall install additional instrumentation and make additional readings as necessary to monitor and control the Work.

211A.15 Surveying.

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(a) *Personnel Qualifications for Construction Surveying in Tunnel*. In accordance with Section 625 Construction Surveying, the setting out of the reference benchmarks and backsights outside of the tunnel, and profile grade line shall be supervised by a Professional Land Surveyor (PLS). All other construction layout work may be self-performed by the Contractor without direct supervision by a PLS.

Reading of in-tunnel instrumentation and survey of face advancement stationing may be carried out by Instrumentation Specialist in accordance with Section 211C.

(b) *Construction Surveying*. The Contractor shall survey or scan, and photograph the excavated Tunnel perimeter (actual excavation surface) at the face after each blast. Installation of optical survey prisms for convergence monitoring in accordance with Section 211C, Instrumentation, shall follow as close as practicable the installation of Initial Support and establishment of a stable, safe opening. Surveys shall be completed and results submitted to the Engineer no more than two weeks after the full cross section is achieved and Initial Support is installed at each location

(c) *Perimeter Surface Survey*. Following completion of excavation and initial support of the tunnel, the Contractor shall provide a surveying specialist to laser scan the perimeter surface of the Tunnel. Laser scan survey (LiDAR) of supported tunnel perimeter can be performed as the tunnel is excavated and supported but must be performed before surfaces are obscured by geocomposite panels. This survey will be used as the basis for evaluating Contractor performance in achieving the contractual requirements including, but not limited to: tunnel geometry; Design Line; tights; smoothness characteristics of the excavation boundary for purposes of installing geocomposite drainage panels; and determination of overbreak volumes.

Final lining as-built survey shall be completed and results submitted to the Engineer no less than two weeks before Contract completion.

The perimeter surface laser scan survey shall meet the following requirements:

1. All points shall have an accuracy of one inch or better relative to the true surfaces.

2. There shall be no shadows in the surveyed/imaged cross sections. The base point (instrument location) for surveying/imaging each cross section shall be in the plane of the cross section, not a point remote from the cross section to avoid shadows from out-of-section features.

3. Cross sections shall be for the entire surface perimeter including crown, sidewalls, and invert.

Submit the following to the Engineer:

1. Plotted cross-sections: Cross sections shall be plotted at a true scale (without vertical/horizontal exaggeration) of 1 inch = 2 feet, unless approved otherwise by the Engineer. Plots shall show the final supported surface, the intended Excavation Line, and the Design Line.

2. Point Listing: Tabular listing of required points presenting: point location; locations of the excavation line and Design Line; and differences between the point location and excavation and Design Lines. Point listings can, at the Contractor's option, be submitted in electronic form in Microsoft Excel compatible format. For situations, such as photographic imaging, in which discrete point locations are not applicable, the Contractor shall submit comparable data, plots, or images that present the position of the perimeter surfaces relative to the Excavation and Design Lines with an accuracy of one inch or less.

3. As an alternative to discrete cross-sections, the Contractor may at the Contractor's option, submit a three-dimensional digital surface of the tunnel perimeter surface meeting the same requirements as presented above for discrete cross-sections in electronic format compatible with Microstation CAD software.

211A.16 Blast Monitoring. The Contractor shall monitor Tunnel blasting and submit the data to the Engineer as specified in Section 203B, Underground Blasting and Use of Explosives.

211A.17 Tunnel Access. The Contractor shall provide access for the Engineer to inspect and observe the work, to perform independent line and grade surveys, for geologic mapping, and for monitoring of instrumentation, as deemed necessary by the Engineer.

211A.18 Scaling. A program of frequent inspection and scaling shall be maintained by the Contractor in all portions of the Tunnel. Immediately after each blast, the roof and walls of rock excavations shall be inspected by experienced and suitably equipped scalers who shall dislodge and scale down all loose rock. Subsequent inspections of excavated and supported portions of the tunnel shall be performed to confirm continued integrity and effectiveness of installed support measures to maintain a stable and safe tunnel opening.

211A.19 Geologic Mapping. The Engineer may perform geologic mapping and photographing of the face and exposed surfaces of excavation. Operations shall be adjusted to permit such mapping. Mapping time will be limited to 5 minutes per round. Time beyond 5 minutes per round will be paid in accordance with Section 109, Measurement and Payment.

211A.20 Excavation Sequence for Tunnel. The portals and first 100 feet at each end of the Tunnel shall be advanced from the outside toward the center of the Tunnel. Lining demolition and tunnel excavation shall be advanced in accordance with the excavation sequence drawings for each of the four Ground Classes defined in the drawings.

Excavation sequences shown on the Plans for the three defined ground classes define:

1. Maximum face dimensions
2. Maximum round lengths
3. Minimum and maximum longitudinal distances between headings

The demolition of the existing lining of the original East bound tunnel shall be incorporated efficiently into the excavation sequence and performed in a fashion so as to limit raveling and overbreak. Plans show portion of existing tunnel north sidewall lining to be left in place. Remainder of existing lining shall be demolished with the excavation of the widened Tunnel. Estimated as-built locations of steel sets embedded within the existing lining are tabulated for baseline purposes in the GBR.

The proposed excavation sequences shown on the Plans and specified herein reflect procedures necessary to meet the technical requirements of the Contract. The Contractor may propose, subject to the approval of the Engineer, modifications to the excavation sequence or initial support, which the Contractor believes would accomplish the desired results. Alternatives will be evaluated based on submitted instrumentation data and observational records of how the ground and installed support perform for the defined support types.

211A.22 Installation of Support. The Contractor shall install Initial Support as shown on the Plans and as required to establish a stable condition. Initial support shall be maintained as close as practicable to the face to maintain a safe working environment. Initial support in the form of spot bolts, channels and shotcrete (or flashcrete) shall be applied

to the temporary sidewalls as required to maintain stability of temporary rock surfaces to be excavated with adjacent subsequent headings.

Steel sets shall be installed at the portals as shown on the Plans. Steel sets shall be blocked with shotcrete or timber blocking spaced 3 feet or closer and braced using collar braces. Steel or concrete footings shall be installed to provide adequate bearing capacity for the loaded steel set. SFRS shall serve as lagging for the steel sets. Wood may be used as lagging for any portions of steel sets that are outside turn-under point of tunnel.

Supplemental support measures (dowels, spiles, and SFRS) shall be used as required and as approved by the Engineer to supplement the defined support systems. The Contractor shall be ready at all times to install supplemental support measures as described in the Contractor's contingency plans to supplement the specified support measures shown on the Plans.

Geotechnical instrumentation as specified in Section 211C, Instrumentation, shall not be covered by Shotcrete or SFRS and shall be recessed or shielded with steel plates as shown on the Plans.

211A.23 Ground Classes. Four ground classes are defined for the Tunnel. Each level of support is intended to be applied following the corresponding excavation sequence shown on the Plans at the approximate locations shown on the Plans as confirmed by observations and mapping of the exposed surfaces by the Contractor and the Engineer.

The Plans and Geotechnical Baseline Report provide estimates of the expected linear footage of each of the levels of support. Bids shall be made based on these quantities. Actual support requirements will likely vary from those estimated.

The Contractor is solely responsible for installing Initial Support as necessary to maintain the stability of the opening and provide for the safety of personnel in the Tunnel.

The Contractor and Engineer shall jointly determine the level of support to be installed in the excavations and excavation sequence based on the ground classes as presented in the GBR and Plans and actual ground behavior and support performance observed and indicated by the installed instrumentation.

211A.24 Tolerances. The Tunnel shall be excavated in accordance with the Excavation Line dimensions shown on the Plans. No rock material will be permitted to remain inside the Excavation Line.

No Initial Support material will be permitted to remain inside the Design Line except for rock dowel heads and steel hardware as described herein. At all locations, SFRS shall be at least as thick as indicated on the Plans for the support level being used.

Additionally, the Contractor shall apply smoothing shotcrete in accordance with Section 641A Shotcrete for Tunneling Operations to meet the indicated smoothness requirements for the type of initial support and geocomposite drainage being installed at a particular location.

211A.25 Excavation for Drainage Trenches and Inlets. Excavation for drainage trenches and inlets shall be constructed to the dimensions shown on the Plans.

211A.26 Control of Water.

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SECTION 211A
UNDERGROUND EXCAVATION AND INITIAL SUPPORT

(a) The Contractor is responsible for control of water in the Tunnel during construction and shall take all means necessary for such control and prevention of untreated flows into the river. Control of water shall include but not be limited to:

1. Furnishing, installing, operating, and maintaining pumps and other equipment;
2. Constructing temporary ditches and sumps;
3. Keeping ditches and drains free to carry all water to sumps and other disposal areas; and
4. Disposal of water draining or pumped from the Tunnel. Disposal of water shall conform to all applicable Federal, State, and local laws and the provisions set forth in Subsection 107.25.

(b) A Parshall flume, weir, or another approved flow measuring device shall be furnished by the Contractor to measure the flow rate of water coming out of the East Portal. Treatment and disposal of groundwater shall be in accordance with Section 626, Mobilization (Tunnel) (Water Treatment).

211A.27 Material Disposal. All excess excavated material on this Contract shall become the property of the Contractor and disposed of off Site or as approved by the Engineer.

METHOD OF MEASUREMENT

211A.28 The Tunnel Excavation and Support will be measured by the units as shown below. The pay items will be measured and paid for by minimum theoretical quantities as shown on Plans. Overbreak and other types of spill factors shall be in accordance with terms of Risk Pool as defined in Section 109..

Rock Excavation will be measured and paid for according to the following table:

Design Excavation Class	Pay Item Class
TTP	A
TT1	B
TT2	C
TT2S	D
TT3	E
Invert	F

Steel Sets will be measured and paid for in accordance with Section 509 Steel Sets (Install Only).

Welded Wire Fabric will be measured and paid for in accordance with Section 602 Welded Wire Fabric.

Surveying for tunnel work as specified herein will be measured and paid for in accordance with the Revision of Section 625 Construction Surveying (Tunnel).

BASIS OF PAYMENT

211A.30 The accepted quantities measured as specified above will be paid for at the unit price bid for the pay items listed below:

Excavation and Initial Support items here below are specified herein and in sections 211B, 641A, and 607A. Payment will be made under:

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SECTION 211A
UNDERGROUND EXCAVATION AND INITIAL SUPPORT

Pay Item	**Pay Unit**
Rock Excavation (Class A)	Cubic Yard
Rock Excavation (Class B)	Cubic Yard
Rock Excavation (Class C)	Cubic Yard
Rock Excavation (Class D)	Cubic Yard
Rock Excavation (Class E)	Cubic Yard
Rock Excavation (Class F)	Cubic Yard
Mine Strap	Each
Spile #9 X 14 Foot Grade 60 Grouted	Each
Spile #11 X 20 Foot Grade 60 Grouted	Each
Arch #9 X 16 Foot Grade 75 Dowel, Resin Grouted	Each
Sidewall #9 X 12 Foot, Grade 75 Dowel, Resin Grouted	Each
Sidewall #9 X 16 Foot, Grade 75 Dowel, Resin Grouted	Each
Supplemental Rock Reinforcement (Dowels)	Linear Foot
Supplemental Support #9 X 14 Foot, Grade 75 Spile, Grouted	Linear Foot
Pillar #9 X 16 Foot, Grade 75 Dowel Cement or Resin Grouted	Each

Payment for Tunnel excavation shall constitute full compensation for all excavation, scaling, blasting, removal, disposal, and haul of excavated materials, construction ventilation and illumination, control of water including ditch excavation, and all other work necessary to complete the item as specified herein.

SECTION 211B
ROCK REINFORCEMENT

Section 211B is hereby added to the Standard Specifications for this project as follows:

DESCRIPTION

211B.01 General. This work shall consist of furnishing and installing Rock Reinforcement in the tunnel attack areas, within the tunnel as shown on the Plans and as established in the field by the Engineer.

211B.02 Definitions.

(a) *Rock Reinforcement.* Rock Reinforcement is defined as any type of structural member that reinforces and stabilizes the rock mass.

(b) *Rock Dowel*. Rock Reinforcement bar which is not tensioned at installation other than securely tightening accessories.

(c) *Pattern Rock reinforcement*. Steel members installed into rock in a repeating pattern.

(d) *End Hardware*. End Hardware are accessories to the dowels for end fastening. It is defined as a *bearing* plate, one or more beveled washers, a flat washer, and a hexagonal nut.

(e) *Embedded Length*. The embedded length is defined as the portion of a rock dowel which is fully *surrounded* by resin in the surrounding rock.

(f) *Spiling*. A spile is a steel bar installed in a close-spaced pattern above the crown in advance of the excavation for the purpose of controlling raveling and increasing the standup time of the ground ahead of the face beneath the spiles. The direction of a spile array is parallel to the tunnel alignment with a slight outward angle. Portal spiles installed from the surface shall be parallel to the excavation line of the tunnel.

MATERIALS

211B.03 Materials. Materials shall conform to the following.

(a) *Steel Bars for Rock Reinforcement*. Except for Spiling, bars shall be AASHTO M31 (ASTM A 615), grade 75 or stronger, threaded reinforcement bars.

(b) *Mine Straps*. Straps shall be ASTM A 569

(c) *Spot Bolts*. Bolts shall be of type “split set” or “Swellex” friction bolts, or resin anchored steel or glassfiber reinforced plastic bars, or approved equal. Length of spot bolts shall be as required for span of excavation and dimensions of rock blocks where used to stabilize face, arch and temporary sidewalls.

(d) *Spiling*. Spiles shall be ASTM A 615, grade 60

(e) *Rock Reinforcement*.

1. Arch and Sidewall Dowels shall be No. 9 bars or greater, fully encapsulated in resin grout. The drill hole shall be according to manufacturer’s recommendations.

2. Pillar Dowels shall be No.9 bar or greater, fully encapsulated in resin or cement grout.

3. The drill hole shall be according to dowel or grout manufacturer's recommendations.

4. Brow Dowels/Portal Spiles shall be No. 11 bars or greater, fully encapsulated in cement grout. The drill hole shall be according to manufacturer's recommendations.

5. Spiling shall be No. 9 bar or greater, encapsulated in resin or cement grout. The drill hole shall be according to manufacturer's recommendations.

(f) *Bearing Plates.* Steel bearing plates shall conform to ASTM A 36 or higher grade and shall be 1/2 inch flat steel, or equal, providing not less than 64 square inches for each plate. All plates shall be square in shape.

(g) *Washers.* Washers shall conform to the requirements of ASTM A 325 quenched and tempered to a Rockwell hardness of C38 to C45. Washers may be flat, beveled, or spherical seat washers as required, and shall be placed between the plate and the nut.

(h) *Nuts.* The nuts shall be heavy duty, conforming to the requirements of ASTM A 325 Grade B. Nuts shall develop an ultimate strength of not less than 125 percent of the minimum yield strength of the bar.

(i) *Resin grout.* The resin shall be Dywidag Systems Inc. FASLOC T-Resin, Minova USA Inc. Lokset, Williams Form Engineering Corp-Polyester Resin or equivalent. Resins used shall reach 80% of their ultimate strength in a time interval no to exceed five times the gel time. Physical properties of the cured resin shall be as a minimum: 12,500 psi compressive strength, 2500 psi tensile strength and 4,800 psi shear strength. Resin shall be supplied in cartridge form. The gel time and expiration date shall be clearly labeled on each cartridge. Cartridges exceeding the expiration date shall not be used. The resin shall be unaffected by mild acids or mild alkalis. Fast set resin shall have minimum set time of five minutes. Slow set resin shall have minimum set time of 30 minutes.

(j) *Reinforcing Bar Couplings.* Couplings of bars, if used, shall result in an ultimate tensile strength at the coupling of not less than 125 percent of the specified yield strength of the bar.

CONSTRUCTION REQUIREMENTS

211A.04 Shop Drawings. The following shall be submitted in accordance with subsection 105.02 no less than three weeks prior to the start of any rock excavation:

(a) *Manufacturer's information*. Applicable literature for Rock Reinforcement, End Hardware, and grout, including the manufacturers' recommended installation procedures, and temperature and storage requirements.

(b) *Description* of Rock Reinforcement installation procedures.

(c) *Description* of Rock Reinforcement testing procedures and equipment.

211B.05 Working Drawings. The following shall be submitted in accordance with subsection 105.02 no less than two weeks prior to the start of rock excavation:

(a) The following certificates shall be submitted:

1. Certificates stating that samples for testing are from normal stock which will be used in the work.

2. Manufacturer's certified test results of gel or cure time, shelf life, and compression, tensile, and shear strengths for each type of grout to be used.

(b) Description of drilling equipment and methods.

(c) Description of installation methods and equipment for grouting dowels and spiles.

(d) Certificates and calibration charts for direct pull test equipment. Calibration charts shall indicate the relationship between the hydraulic pressure of the pump and the tensile load applied by the ram.

211B.06 Samples. A sample of each type of Rock Reinforcement and End Hardware to be used shall be submitted to the Engineer from the normal stock of the Rock Reinforcement manufacturer. Samples shall be submitted with mill reports indicating tensile yield point and elongation results, at no additional expense to the Owner. Samples of resin cartridges shall be submitted for each manufacturer and gel time to be used.

211B.07 Reports and Records. Records of pull tests performed as specified herein and shall be submitted to the Engineer within 24 hours of each test.

211B.08 General.

(a) Rock Reinforcement shall be installed where shown on the Plans and as established in the field by the Contractor and approved by the Engineer.

(b) Grouted Rock Reinforcement, using cement or resin, shall be allowed to reach at least 95% of the grout strength prior to commencing any excavation that, in the opinion of the Engineer, will increase the stress level in the Rock Reinforcement.

(c) Dowels shall maintain continuous contact with the rock throughout their embedded length.

(d) At the Contractor's option, dowel ends protruding from the nut that extend beyond the Design Line may be cut off by means other than a cutting torch.

(e) If Installation of rock reinforcement according to pattern shown in plans or supplemental rock reinforcement as approved conflicts with rock reinforcement installed at an earlier time, the cost for re-drilling rock reinforcement shall not be billed to the client but born by the contractor. This provision does not apply to the cost of re-drilling for rock reinforcement that encounters rock bolts that were installed for the original construction of the Eastbound Tunnel.

211B.09 Placement of Bearing Plates, Washers, and Nuts. The bearing plate shall be placed tight against the rock, concrete, shotcrete or steel channel surface as indicated, where possible.

211B.10 Storage And Handling of Materials.

(a) Bars and grout cartridges shall be maintained at temperatures in accordance with the grout cartridge manufacturer's recommendations. All bars to be used in the tunnel shall be kept clean. Grout cartridges shall be stored in accordance with the manufacturer's recommendations.

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SECTION 211B
ROCK REINFORCEMENT

(b) A supply of Rock Reinforcement materials shall be maintained on site. The supply shall include bars, End Hardware, grout, spot bolts and mine strap with accessories.

211B.11 Preparation of Rock Reinforcement for Installation. All reinforcing bars shall be free of sludge, grease, or any other matter which would inhibit the bonding ability.

211B.12 Installation Tolerances. Collar locations of drilled holes for rock reinforcement shall be located within a 12-inch radius of the nominal locations shown on the plans except for Arch Dowels placed through steel channels for support categories TT2S and TT3, which shall be drilled to allow placement of the dowels through the steel channels at the indicated transverse spacing.

211B.13 Drill Holes For Rock Reinforcement.

(a) The hole for each installation shall be straight and of uniform diameter for the entire length of the hole. The hole diameter shall conform with the manufacturer's recommendations. Over-drilling beyond the final installed position of the bar shall not exceed 6 inches.

(b) Holes for the installation of Rock Reinforcement shall be drilled at orientations as shown on the Plans. Deviation from those orientations shall not exceed five degrees.

(c) Each hole shall be cleaned of all drill cuttings, sludge, and debris by means of compressed air introduced at the back of the hole upon completion of drilling. In addition, any horizontal and downwardly inclined holes shall be blown clean immediately before installation of the Rock Reinforcement.

211B.14 Testing Of Rock Reinforcement.

(a) The Contractor shall furnish at least one set of pull test equipment to be used by the Contractor and Engineer. The pull test equipment shall remain the property of the Contractor.

(b) Before the required Rock Reinforcement installations are begun, two trial pull tests shall be conducted by the Contractor for each type of Rock Reinforcement bar and Spot Bolt as established by the Engineer. The tests shall be conducted at the site using the Contractor's proposed Dowel and Spot Bolt materials and installation methods. The location of tests will be established by the Engineer.

The intent of trial pull tests is to determine the adequacy of the installation methods and equipment. The tests shall be performed in the presence of the Engineer and records of each test shall be made. Anchorage failure will be determined to have occurred when the end of the bar has displaced 0.5 inch at a load less than the load corresponding to the yield strength of the bar.

Rock Reinforcement shall be tested throughout the course of the work as follows. The Engineer shall select not more than 2 percent of the Arch, Sidewall and Pillar Dowels for testing.

1. Testing for Dowels. The required pull tests shall be conducted on the selected dowel in the presence of the Engineer, and records of each test shall be made. If the anchorage of any bar fails to develop 3/4 of the yield strength of the bar before the end of the bar has displaced 0.5 inches, three additional dowels shall be selected by the Engineer from the same group for testing. These three shall be tested to a maximum of 3/4 of the yield strength of the bar.

2. Dowel Test Failure. If the average load at 0.5 inch extension from the three tests is less than 3/4 of the yield strength of the bar, the Engineer may reject the entire group of dowels and direct installation of additional dowels as required. The term "group" as used in this specification refers to those Rock Reinforcement elements installed in a localized area during an eight-hour shift. The Contractor may elect to test the remaining bars in the group to determine the acceptability of each bar. The additional bars installed shall be tested as a new group.

(c) All tests shall be performed using laboratory-certified testing equipment approved by the Engineer.

METHOD OF MEASUREMENT

211B.15 All Rock Reinforcement (dowels and spiles) will be measured by each unit, in place, and accepted. Trial pull tests will be considered incidental to the individual item.

211B.16 The accepted quantities measured as specified above will be paid for at the unit price bid for the pay items listed in section 211A.

Upon completion of the work, Rock Reinforcement on hand shall remain the property of the Contractor.

SECTION 211C
INSTRUMENTATION

Section 211C is hereby added to the Standard Specifications for this project as follows:

DESCRIPTION

211C.01 General. This work shall consist of geotechnical instrumentation for monitoring ground and structure displacement within the Tunnel. The work includes furnishing, installing, monitoring and reporting data for all instrumentation. Instrumentation includes, but is not limited to, optical survey targets placed in the Easbound Tunnel.

211C.02 Westbound Tunnel Existing Instrumentation. Instrumentation installed in prior contracts shall be taken over, monitored and maintained by the Contractor. Monitoring requirements for the Westbound tunnel instrumentation is described in the Draft Geotechnical Instrumentation Plan – West Bound Tunnel, dated the 7th of September 2012.

211C.03 Definitions.

(a) *Convergence monitoring.* Measurement of position of optical survey targets installed along the excavated perimeter of tunnel to confirm adequacy of installed support measures and overall stability of the tunnel.

(b) *Optical Survey Targets.* Mirror reflectors which are attached to the rock or shotcrete perimeter of tunnel to monitor rock movement and convergence.

(c) *Bench mark.* A point for coordinates reference.

(d) *Backsight*. Point outside of Tunnel which is used for coordinates reference.

(e) *Action Level.* The instrumentation reading levels requiring an action on the part of the Contractor, including Threshold Values and Limiting Values.

(f) *Threshold Value.* The instrumentation reading level that signifies a significant and cautionary response.

(g) *Limiting Value.* The instrument reading level that signifies potentially abnormal conditions that may require action to address potentially unsatisfactory conditions.

(h) *Accuracy.* The level of uncertainty associated with the instrument reading relative to the true value of the quantity measured. Also known as the degree of correctness.

(i) *Repeatability.* The uncertainty or scatter associated with the range of readings from multiple instrument readings of a unique baseline condition. Also known as precision and reproducibility.

(j) *Resolution.* The finest division in the instrument readout scale. Interpolation between divisions shall *n*ot *be* used to justify a finer resolution.

211C.04 Division of Responsibilities. All instrumentation in the Eastbound Tunnel shall be furnished and installed by the Contractor. Minimum instrumentation requirements are presented in this specification. The Contractor shall furnish and install additional instrumentation as necessary to control the work, assure project safety and to replace instruments damaged or lost. Bench marks and backsights required for monitoring optical targets within the tunnels shall be established in accordance with standard specifications, section 625 Construction Surveying.

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SECTION 211C
INSTRUMENTATION

All instrumentation shall be monitored by the Contractor. Minimum monitoring frequency is presented in this specification. The Contractor shall monitor more frequently as necessary to control the work and assure project safety.

The Engineer may monitor instrumentation independent of the Contractor. Instrumentation monitoring data by the Engineer will be available to the Contractor but does not relieve the Contractor of his monitoring requirements. Access to all instrumentation shall be provided to the Engineer at all times by the Contractor. The Engineer will endeavor to access instrumentation so as to avoid construction conflicts, when and where possible.

The Contractor shall designate an Instrumentation Specialist to install and monitor optical survey targets as specified herein and as shown on the Plans.

MATERIALS

211C.05 Materials. Materials for instrumentation shall conform to the following.

(a) *Optical Survey Targets.* Reference points attached to excavation boundary after installation of indicated initial ground support measures to monitor movements using optical survey methods.

1. Survey targets shall be optical reflectors capable of reflecting a signal from a theodolite or Automated Motorized Total Station (AMTS) to allow direct measurement of angles and distance from the instrument to the target.

2. Survey targets shall be firmly anchored with a bolt to the rock or shotcrete and shielded with steel plates or other approved means to protect target from fly rock damage.

3. The Contractor shall establish a network of stable bench marks near each portal to support the convergence monitoring of each tunneling operation. Bench marks shall be positioned in a protected but accessible location for surveying all targets. The bench mark shall be firmly anchored to a depth of 5 feet or greater and grouted into place.

4. For each bench mark, the Contractor shall establish at least two backsight points to verify the bench mark location. The backsight points shall be stable locations and shall be separated by an angle of between 30 and 150 degrees from the bench mark. Backsight points shall be reflectors similar to or identical with the Survey Targets with a clearly defined center point.

211C.06 Shop Drawings. The following shall be submitted in accordance with Subsection 105.02:

(a) Qualifications of the Contractor's Instrumentation Specialist.

(b) Instrumentation Installation Procedures.

1. Proposed schedule for drilling holes and installing instruments.

2. Manufacturer's applicable literature for instrumentation including recommended installation procedures.

(c) Proposed locations of AMTS, if used, optical survey targets, bench marks, and backsight points.

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SECTION 211C
INSTRUMENTATION

211C.07 Working Drawings. The following records of work accomplished shall be submitted to the Engineer within one day of the installation of any instrumentation:

(a) A list of instruments installed, including instrument identification numbers, elevation, orientation, stationing, offset, and initial coordinates as applicable to each instrument or installation.

(b) Drawings showing details of installed instruments. All dimensions and materials used shall be fully identified. Description of drilling equipment and methods.

211C.08 Monitoring Data.
Daily monitoring logs shall be submitted to the Engineer for the survey targets. The information in the log shall include:

1. Identification and stationing of points measured
2. Date and time for the reading
3. Measured coordinates of all survey targets (raw data)
4. Cumulative movement since initial reading of each point shall be plotted against time in a graph.

211C.09 General Tolerances. The instruments shall be installed as close as practicable to the approximate locations shown on the plans or as established in the field by the Engineer. The Engineer will approve in advance all final instrument locations.

211C.10 Personnel Qualifications.

(a) *Qualifications for Instrumentation Specialist.* A specialist in using optical survey methods to monitor tunnel excavation stability and convergence with a minimum of 1 year experience in the installation, monitoring and maintenance of optical instrumentation for tunnel convergence monitoring similar to that specified herein.

211C.11 Supervision and Oversight. The Instrumentation Specialist shall supervise installation, monitoring, and data processing of all instrumentation. The Project Surveyor shall supervise and oversee the setup, installation, and monitoring of bench marks and backsight points.

211C.12 Availability of Data. The Contractor shall monitor all instrumentation and make his own interpretations of instrument monitoring data to confirm tunnel stability and adequacy of installed support for his own purposes.

The Engineer may independently monitor all instruments. Data obtained by the Engineer will be made available to the Contractor within one working days after taking the readings.

The Engineer may make an independent interpretation of instrument monitoring data. Such interpretations will be made available to the Contractor.

211C.13 Instrument Installation Sequence. Optical survey targets for convergence monitoring shall be installed concurrent with or immediately after installation of initial ground support at the required stationing. All such devices shall be installed within 5 feet of the face and after the last planned layer of shotcrete.

211C.14 Instrumentation Identification. Instruments shall be clearly identified in the field, and recorded on all data sheets and correspondence with unique Identification Numbers.

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SECTION 211C
INSTRUMENTATION

211C.15 Installation of Instruments. Optical survey targets shall be installed as shown on the Plans and at locations proposed by the Contractor based on actual face positions and field conditions and approved by the Engineer. The reflective elements on the target shall be oriented as established in the field by the Instrumentation Specialist.

211C.17 Protection of Instruments. Steel plate protectors shall be devised and installed to protect optical targets from flyrock damage from advancing headings. The Contractor shall be responsible for maintaining these protective devices and making sure they are properly secured before working around them.

Full responsibility shall be borne by the Contractor for protecting the instruments from damage caused by construction operations. Damaged instruments shall be promptly replaced or repaired as directed by the Engineer, at the expense of the Contractor.

The instruments shall be clearly marked and protected to avoid being obscured by shotcrete. Access shall be maintained to permit reading of instruments. Shotcrete applied around any instrument shall be removed immediately.

211C.18 Monitoring. The Contractor shall monitor all instrumentation. Presented herein are minimum monitoring requirements. The Contractor shall monitor more frequently as necessary to control the work and assure project safety.

Table 211C-1
MINIMUM INSTRUMENTATION MONITORING REQUIREMENTS

Location	Instrument	Initial Readings	Minimum Monitoring Frequency
Eastbound Tunnel	Optical Targets	Heading advance of less than 15 ft. (1)	Every 6 hours for 1 day after initial installation, then daily for 1 week, then weekly or at lesser frequency as approved by Engineer.

Notes: (1) Initial readings shall be made before the pertinent heading advances 5 ft. beyond the instrument. The pertinent heading shall be the heading or bench that first exposes the rock of the instrument location.

211C.19 Action Levels. The following action levels shall be used as a guideline for evaluating ground and structure response to construction activities.

Table 211C-2
ACTION LEVELS

Location	Instrument	Action Level	
		Threshold Value	Limiting Value
Eastbound Tunnel			
	Survey Targets	1.0 inch inward movement	2.0 inch inward movement

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SECTION 211C
INSTRUMENTATION

211C.20 Interpretation of Monitoring Data. The data shall be used by the Contractor and the Engineer to assess and confirm the adequacy of the excavation sequence, round length and installed initial support measures.

The Contractor shall notify the Engineer within 24 hours when an Action Level for any instrument is reached or exceeded. Upon reaching or exceeding the Action Level for any instrument, the Contractor shall meet with the Engineer to determine the appropriate action, if any. The Threshold Value shall be used as an indication of a significant measurement that potentially warrants closer monitoring or revised construction methods. The Limiting Value shall be used as an indication of a potentially unacceptable ground or structural condition that may require action to improve.

METHOD OF MEASUREMENT

211C.21 Instrumentation for the tunnel will be measured as follows:

(a) Optical Survey Targets will be measured by the number installed and accepted. This pay item shall include the targets, bench marks, witness points, necessary survey instruments, and all other items necessary for a working system. Each bench mark and backsight point will be paid in accordance with Section 625 Construction surveying.

BASIS OF PAYMENT

211C.22 The accepted quantities measured as specified above will be paid for at the unit price bid for the pay items listed below.

Payment will be made under:

Pay Item	**Pay Unit**
Optical Survey Targets	Each

Payment will be full compensation for all work necessary to complete the designated pay items, including, but not limited, to furnishing, items used by and furnished to the Engineer, installation, monitoring, maintenance, demolition in accordance with subsection 109.02. Payment will be made only for those instruments required by the contract documents, or approved for payment by the Engineer in writing prior to installation.

SECTION 211D
PORTAL PROTECTION CANOPY (FURNISH AND INSTALL)

Section 211D is hereby added to the Standard Specifications for this project as follows:

DESCRIPTION

211D.01 This work shall consist of procurement, installation, use, and removal of a protective canopy at each tunnel portal to provide for the safety of construction personnel during tunnel construction activities. The portal protection canopy shall conform to the requirements of shoring as specified in Section 206 of the Standard Specifications.

MATERIALS AND CONSTRUCTION REQUIREMENTS

211D.02 The Contractor shall locate, size, design and construct the portal protection canopy which provides all necessary rigidity, and supports the loads imposed, including impact loads from rockfall, to facilitate construction as shown on the plans.

Salient features and performance requirements of the canopy include, but are not limited to, the following:

1. The canopy shall be compatible with the portal structure support system and the orientation/configuration of the portal rock face.

2. Shall not restrict contractor means and methods for portal establishment nor tunnel excavation and construction.

METHOD OF MEASUREMENT

211D.03 Portal Protection Canopy shall be measured by each complete unit furnished, installed, removed and accepted.

BASIS OF PAYMENT

211D.04 Payment shall be made at the contract unit price for the quantity shown in the plans. Payment shall include all incidental items necessary for a complete and functional portal protection canopy.

Payment will be made under:

Pay Item	**Pay Unit**
Portal Protection Canopy (Furnish and Install)	Each

REVISION OF SECTION 250
ENVIRONMENTAL, HEALTH AND SAFETY MANAGEMENT

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

Subsection 250.03 shall include the following:

Contractor shall be aware of the Project specific Environmental Site Assessment (March 2012) and Materials Management Plan. This report's preliminary analysis did not anticipate encountering known hazardous materials in the area of disturbance. However, there is a small potential for the presence of mine waste in soil and/or groundwater in the vicinity of the project area. The Contractor shall be responsible for the required worker health and safety, materials management, analysis and materials disposal according to state regulations. If contaminants are encountered, the Contractor Health and Safety Officer and/or Monitoring Technician shall be on site as necessary during the excavations to ensure the safety of workers and proper management, analysis and disposal of potentially contaminated materials, as detailed in the CDOT Standard Specification 250-Environmental, Health and Safety Management and the Materials Management Plan. The characterization of all materials for proper transport and disposal shall be performed with the approval of the Engineer.

In subsection 250.05, third paragraph, deleted the first sentence and replace with the following:

Specific areas of known or potential contamination have been identified in the Materials Management Plan.

Subsection 250.05 (b) shall include the following:

The Contractor shall be responsible for obtaining the authorization for solid waste disposal, and if necessary, hazardous waste disposal, and shall obtain the necessary transport and disposal manifests with approval of the Engineer. The disposal facility shall be fully compliant with state and federal regulations. The Contractor shall perform all necessary material characterization, reporting requirements, agency coordination and material disposal as required by the Materials Management Plan. For solid waste suitable for non-hazardous landfill disposal, the Contractor shall prepare and submit a "Request to Dispose" with a description and characterization of the material to: Mr. David Singer, CDOT Environmental Manager in Golden, 303-512-5872. It is the Contractor's responsibility to identify and perform the appropriate analyses for waste disposal.

Subsection 250.05 (c) shall include the following:

If potential mine tailings are encountered the Contractor shall follow the steps and procedures detailed in the Materials Management Plan. The MMP Supervisor, in conjunction with CDOT Environmental Manager and the CDPHE RP, will arrange for disposal of the material at the Church Placer Repository, or another approved location. The Church Placer Repository will accept only mining-related materials such as waste rock, mill tailing or metals-contaminated sediment. Repository use may not be available in winter/freezing months. The Church Placer Repository will accept no more than 10,000 cubic yards for compaction.

METHOD OF MEASUREMENT

If contamination is encountered, its management, analysis and disposal will be paid for under a planned force account item.

BASIS OF PAYMENT

Payment will be made under F/A Health and Safety Management

REVISION OF SECTION 304
AGGREGATE BASE COURSE

Section 304 of the Standard Specifications is hereby revised for this project as follows:

Subsection 304.02 shall include the following:

Materials for the subbase shall be Aggregate Base Course (Class 6) as shown in subsection 703.03.

Materials for the base course shall be Aggregate Base Course (Class 6) as shown in subsection 703.03

The aggregate base course (Class 6) must meet the gradation requirements and have a resistance value of at least 78 respectively when tested by the Hveem Stabilometer method.

REVISION OF SECTION 304
AGGREGATE BASE COURSE (SPECIAL)

Section 304 of the Standard Specifications is hereby revised for this project as follows:

Section 304.02 shall include the following:

(a) *Aggregate Base Course (Special).* Aggregates for Aggregate Base Course (Special) shall meet the following gradation and requirements:

Mass Percent Passing Square Mesh Sieves	
Sieve Size	**ABC (Special)**
50 mm (2”)	100
37.5 mm (1.5”)	90-100
25 mm (1”)	
19 mm (3/4”)	50-90
4.75 mm (#4)	30-50
2.36 mm (#8)	
75 um (#200)	0-3

The liquid limit shall be not greater than 30, and the plasticity index shall not exceed 6 when the aggregate is tested in accordance with AASHTO T89 and T90, respectively.

Subsection 304.08 shall include the following:

The accepted quantities of Aggregate Base Course (Special) will be paid for at the contract price bid per ton as shown in the bid schedule.

Payment will be made under:

Pay Item	**Pay Unit**
Aggregate Base Course (Special)	Ton

REVISION OF SECTION 401
HOT MIX ASPHALT COMPACTION (PNEUMATIC TIRE ROLLERS)

Section 401of the Standard Specifications is hereby revised for this project as follows:

In subsection 401.17, first paragraph, delete the second sentence and replace with the following:

Both steel wheel and pneumatic tire rollers will be required on this project. If the Contractor has demonstrated that all of the manufacturer's recommendations were followed and the pneumatic tire roller is detrimental to the finished surface of the HMA, the Engineer, in cooperation with the Contractor and the Region Materials Engineer, may waive the pneumatic tire roller requirement.

REVISION OF SECTION 403
HOT MIX ASPHALT

Section 403 of the Standard Specifications is hereby revised for this project as follows:

Subsection 403.02 shall include the following:

The design mix for hot mix asphalt shall conform to the following:

Table 403-1

Property	Test Method		Value For Grading		
			SX(100)	SX(75)	Patching
Air Voids, percent at: N (design)	CPL 5115		3.5 – 4.5	3.5 – 4.5	3.5 – 4.5
Lab Compaction (Revolutions): N (design)	CPL 5115		100	75	75
Stability, minimum	CPL 5106		30	28	28
Aggregate Retained on the 4.75 mm (No. 4) Sieve with at least 2 Mechanically Induced fractured faces, % minimum	CP 45		70	70	70
Accelerated Moisture Sus-ceptibility Tensile Strength Ratio (Lottman), minimum	CPL 5109 Method B		80	80	80
Minimum Dry Split Tensile Strength, kPa (psi)	CPL 5109 Method B		205 (30)	205 (30)	205 (30)
Grade of Asphalt Cement, Top Layer			PG(64-28)		PG(58-28)
Grade of Asphalt Cement, Layers below Top				PG(58-28)	
Voids in the Mineral Aggregate (VMA) % minimum	CP 48		See Table 403-2	See Table 403-2	See Table 403-2
Voids Filled with Asphalt (VFA), %	AI MS-2		65-75	65-80	65-80
Dust to Asphalt Ratio Fine Gradation Coarse Gradation	CP 50		0.6 – 1.2 0.8 – 1.6	0.6 – 1.2 0.8 – 1.6	0.9 – 2.0 1.1 – 2.2

Note: AI MS-2 = Asphalt Institute Manual Series 2
Note: The current version of CPL 5115 is available from the Region Materials Engineer.
Note: Mixes with gradations having less than 40% passing the 4.75 mm (No. 4) sieve shall be approached with caution because of constructability problems.
Note: Gradations for mixes with a nominal maximum aggregate size of one-inch or larger are considered a coarse gradation if they pass below the maximum density line at the #4 screen.
Gradations for mixes with a nominal maximum aggregate size of ¾ inch or smaller are considered a coarse gradation if they pass below the maximum density line at the #8 screen.

All mix designs shall be run with a gyratory compaction angle of 1.25 degrees and properties must satisfy Table 403-1. Form 43 will establish construction targets for Asphalt Cement and all mix properties at Air Voids up to 1.0 percent below the mix design optimum.

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REVISION OF SECTION 403
HOT MIX ASPHALT

Table 403-2

Minimum Voids in the Mineral Aggregate (VMA)			
Nominal Maximum Size*, mm (inches)	***Design Air Voids **		
	3.5%	**4.0%**	**4.5%**
37.5 (1½)	11.6	11.7	11.8
25.0 (1)	12.6	12.7	12.8
19.0 (¾)	13.6	13.7	13.8
12.5 (½)	14.6	14.7	14.8
9.5 (⅜)	15.6	15.7	15.8

***** The Nominal Maximum Size is defined as one sieve larger than the first sieve to retain more than 10%.
****** Interpolate specified VMA values for design air voids between those listed.
*** Extrapolate specified VMA values for production air voids beyond those listed.

The Contractor shall prepare a quality control plan outlining the steps taken to minimize segregation of HMA. This plan shall be submitted to the Engineer and approved prior to beginning the paving operations. When the Engineer determines that segregation is unacceptable, the paving shall stop and the cause of segregation shall be corrected before paving operations will be allowed to resume.

CDOT approved Warm Mix Asphalt (WMA) may be allowed on this project in accordance with CP 59. Unique requirements for WMA design, production and acceptance testing as documented during CDOT WMA approval shall be submitted and approved prior to creation of the Form 43 and before any WMA production on the project. Delays to the project due to WMA submittal and review will be considered within the Contractor's control and will be non-excusable.

Hot mix asphalt for patching shall conform to the gradation requirements for Hot Mix Asphalt (Grading SX).

A minimum of 1 percent hydrated lime by weight of the combined aggregate shall be added to the aggregate for all hot mix asphalt.

Delete subsection 403.05 and replace with the following:

403.05 The accepted quantities of hot mix asphalt will be paid for in accordance with subsection 401.22, at the contract unit price per ton for the bituminous mixture.

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REVISION OF SECTION 403
HOT MIX ASPHALT

Payment will be made under:

Pay Item	**Pay Unit**
Hot Mix Asphalt (Grading SX) (75) (PG 58-28)	Ton
Hot Mix Asphalt (Grading SX) (100) (PG 64-28)	Ton
Hot Mix Asphalt (Patching) (Asphalt)	Ton

Aggregate, asphalt recycling agent, additives, hydrated lime, and all other work necessary to complete each hot mix asphalt item will not be paid for separately, but shall be included in the unit price bid. When the pay item includes the PG binder grade, the asphalt cement will not be measured and paid for separately, but shall be included in the work. When the pay item does not include the PG binder grade, asphalt cement will be measured and paid for in accordance with Section 411. Asphalt cement used in Hot Mix Asphalt (Patching) will not be measured and paid for separately, but shall be included in the work.

Excavation, preparation, and tack coat of areas to be patched will not be measured and paid for separately, but shall be included in the work.

REVISION OF SECTIONS 403
HOT MIX ASPHALT TICKET COLLECTION

Section 403 of the Standard Specifications is hereby revised for this project as follows:

Subsection 403.05 shall include the following:

The Contractor shall collect the scale ticket on each load when it is delivered to the project site, and ensure that the information required in subsection 109.01 is shown on each ticket:.

The scale tickets shall be available on site for CDOT personnel to inspect.

Each day the Contractor shall provide to the Engineer envelopes which contain the previous day's signed tickets and the following:

1. On each envelope: Project number, date of paving, type of material, daily total and cumulative total.

2. One of the following:

   A. Two adding machine tape tabulations of the weight tickets with corresponding totals run and signed by different persons,
   B. One signed adding machine tape tabulation of the weight tickets that has been checked and signed by a second person,
   C. Signed check tape of computer scale tickets that have a cumulative total. These scale tickets must be consecutive and without voids adjustments.

3. A listing of any overweight loads on the envelope, including ticket numbers and amount over legal limit.

4. A comparison of the actual yield for each day's placement to the theoretical yield. Theoretical yield shall be based on the actual area paved, the planned thickness, and the actual density of the mixture being placed. Any variance greater than +2.5% shall be indicated on the envelope and a written explanation included.

The Contractor shall provide a vehicle identification sheet that contains the following information for each vehicle:

1. Vehicle number
2. Length
3. Tare weight
4. Number of axles
5. Distance between extreme axles
6. All other information required to determine legal weight.
7. Legal weight limit.

REVISION OF SECTION 504
GROUND NAIL WALL

Section 504 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

504.06 This work consists of constructing a permanent ground nailed wall as specified herein and as shown on the plans. The work includes excavating in staged lifts in accordance with the drawings and approved submittals for drilling ground nail holes to the diameter and length required to develop the specified capacity; grouting the nails; providing and installing the specified drainage features; providing and installing bearing plates, washers, nuts, and other required miscellaneous materials; and constructing the required shotcrete face and constructing the final structural facing.

MATERIALS

504.07 Concrete shall be Class D, conforming to the requirements of Section 601.

Reinforcing Steel shall conform to the requirements of Section 602.

Shotcrete shall conform to the requirements of Section 641 as revised for this project.

Forms and falsework shall conform to the requirements of subsections 601.09 and 601.11.

504.08 Ground Nails.

(a) *Solid Bar Ground Nails.* Bars shall conform to AASHTO M31, Grade 60 or 75 or ASTM A 722 for Grade 150. Bars shall be deformed, continuous without splices or welds, new, straight, undamaged, epoxy-coated, and encapsulated as shown on the plans. Bars shall be threaded a minimum of 6 inches on the wall anchorage end to allow proper attachment of bearing plate and nut. Threading may be continuous spiral deformed ribbing provided by the bar deformations (continuous thread bars) or may be cut into a reinforcing bar. If threads are cut into a reinforcing bar, the next-larger bar number designation from that shown on the plans shall be provided at no additional cost.

(b) *Bar Coupler.* Bar couplers shall develop the full ultimate tensile strength of the bar as certified by the manufacturer.

(c) *Fusion Bonded Epoxy Coating.* Epoxy coating shall conform to ASTM A 934. The minimum thickness shall be 0.012 inch. (d)*Encapsulation.* Encapsulation shall be minimum 0.04-inch thick, corrugated, HDPE tube conforming to AASHTO M252 or corrugated PVC tube conforming to ASTM D1784, Class 13464-B.

(d) *Hot Dipped Galvanizing*. Hot dipped galvanizing shall conform to ASTM A 153. The minimum thickness shall be 3 mils applied to cleaned steel bars.

504.09 Ground Nail Appurtenances.

Centralizer. Centralizers shall be manufactured from Schedule 40 PVC pipe or tube, steel, or other material not detrimental to the nail steel; wood shall not be used. Centralizers shall be securely attached to the nail bar; sized to position the nail bar within 1 inch of the center of the drill hole; sized to allow tremie pipe insertion to the bottom of the drill hole; and sized to allow grout to freely flow up the drill hole.

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(a) *Nail Grout.* Grout shall be a neat cement or sand/cement mixture with a minimum 3 day compressive strength of 1,500 pounds per square inch and a minimum 28-day compressive strength of 3,000 pounds per square inch conforming to AASHTO T106.

(b) *Fine Aggregate.* Fine aggregate shall conform to AASHTO M6.

(c) *Portland Cement.* Portland Cement shall conform to AASHTO M85, Type I, II, III, or V.

(d) *Admixtures.* Admixtures shall conform to AASHTO M194. Admixtures that control bleed, improve flowability, reduce water content, and retard set may be used in the grout subject to review and acceptance by the Engineer. Accelerators are not permitted. Expansive admixtures may be used only in grout used for filling sealed encapsulations. Admixtures shall be compatible with the grout and mixed in accordance with the manufacturer's recommendations.

(e) *Grout Containment Device (GCD).* The GCD shall be a commercially available product manufactured specifically for use with soil nails. It shall be constructed from a geotextile of sufficient strength to survive installation into the drill hole without damage and of sufficient volume to conform to the actual hole size. The GCD shall allow some grout to infiltrate through the geotextile to provide a maximum bond. In addition, the geotextile shall conform to ASTM D-4491 with a minimum permittivity of 0.7 per second.

(f) *Film Protection.* Polyethylene film shall conform to AASHTO M171.

504.10 Bearing Plates, Nuts, and Welded Stud Shear Connectors.

(a) *Bearing Plates.* Bearing plates shall conform to AASHTO M183.

(b) *Nuts*. Nuts shall conform to AASHTO M291, grade B, hexagonal, fitted with beveled washer or spherical seat to provide uniform bearing.

(c) *Shear Connectors*. Shear connectors shall conform to AASHTO Construction Specifications, Section 11.3.3.1.

504.11 Welded Wire Fabric. Welded Wire Fabric shall conform to AASHTO M55 or ASTM A497.

504.12 Reinforcing Steel. Reinforcing Steel shall conform to AASHTO M31, Grade 60, deformed.

504.13 Geocomposite Strip Drain. Geocomposite Strip Drain shall be manufactured with a drainage core (e.g., geonet) and a drainage geotextile attached to or encapsulating the core. The drainage core shall be manufactured from long chain synthetic polymers composed of at least 85 percent by mass of polypropylenes, polyester, polyamine, polyvinyl chloride, polyolefin, or polystyrene and having a minimum compressive strength of 40 pounds per square inch when tested in accordance with ASTM D 1621 Procedure A. The drainage core with the geotextile fully encapsulating the core shall have a minimum flow rate of 5 gallons per minute per foot of width tested in accordance with ASTM D 4716. The test conditions shall be under an applied load of 10 pounds per square inch at a gradient of 1.0 after a 100-hour seating period.

504.14 Underdrain and Perforated Pipe.

(a) *Pipe.* Pipe shall conform to ASTM 1785 Schedule 40 PVC solid and perforated wall; cell classification 12454-B or 12354-C, wall thickness SDR 35, with solvent weld or elastomeric joints.

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(b) *Fittings*. Fittings shall conform to ASTM D3034, Cell classification 12454-B or C, wall thickness SDR 35, with solvent or elastomeric joints.

504.15 Shotcrete. The Contractor shall submit for approval, all materials, methods, and control procedures for this work.

CONSTRUCTION REQUIREMENTS

504.16 Contractor Qualifications. The ground nailing contractor shall have completed at least 3 permanent ground nail retaining wall projects during the past 3 years totaling at least 10,000 square feet of wall face area and at least 500 permanent ground nails.

The ground nailing contractor shall provide a Registered Professional Engineer with experience in the construction of permanent ground nail retaining walls on at least 3 completed projects over the past 3 years. The ground nailing contractor shall not use consultants or manufacturer's representatives to meet the requirements of this section. The ground nailing contractor shall provide on-site supervisors and drill operators with experience installing permanent ground nails on at least three projects over the past 3 years.

504.17 Submittals. The ground nailing contractor shall submit a brief description of at least 3 completed projects, including the owning agency's name, address, and current phone number; location of project; project contract value; and scheduled completion date and actual completion date for the project.

At least 60 calendar days before starting ground nail work, the ground nailing contractor shall identify the Engineer, on-site supervisors, and drill operators assigned to the project, and submit a summary of each individual's experience. Only those individuals designated as meeting the qualifications requirements shall be used for the project. The ground nailing contractor shall not substitute for any of these individuals without written approval of the Engineer. The Engineer will approve or reject the ground nailing contractor qualifications and staff within 15 working days after receipt of the submission. Work shall not be started on any ground nail wall or materials ordered until the ground nailing contractor's qualifications have been approved by the Engineer. The Engineer may suspend the work if the ground nailing contractor substitutes unqualified personnel for approved personnel during construction. If work is suspended due to the substitution of unqualified personnel, the Contractor shall be fully liable for additional costs resulting from the suspension of work and no adjustment in contract time resulting from the suspension of the work will be allowed.

The Contractor shall provide the necessary survey and alignment control during the excavation for each lift, locating drill holes and verifying limits of wall installation. At least 30 days before starting ground nail work, the ground nailing contractor shall submit a Construction Plan to the Engineer that includes the following:

(1) The start date and proposed detailed wall construction sequence.
(2) Drilling and grouting methods and equipment, including the drill hole diameter proposed to achieve the specified pullout resistance values shown on the plans and any variation of these along the wall alignment.
(3) Nail grout mix design, including compressive strength test results (per AASHTO T106) supplied by a qualified independent testing lab verifying the specified minimum 3-day and 28-day grout compressive strengths. Previous test results for the same grout mix completed within one year of the start of grouting may be submitted for verification of the required compressive strengths.
(4) Nail grout placement procedures, equipment and grout containment device's dimensions and material properties (manufacturer's cut sheets).

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(5) Shotcrete materials and methods.
(6) Ground nail testing methods and equipment setup.
(7) Identification number and certified calibration records for each test jack and pressure gauge and load cell to be used. Jack and pressure gauge shall be calibrated as a unit. Calibration records shall include the date tested, the device identification number, and the calibration test results and shall be certified for an accuracy of at least 2 percent of the applied certification loads by a qualified independent testing laboratory within 90 days prior to submittal.
(8) Manufacturer Certificates of Compliance for the ground nail yield or ultimate tensile strength, nail bar steel type, Portland cement, centralizers, bearing plates, epoxy coating, and encapsulation.

The Engineer will approve or reject the ground nailing contractor's Construction Plan within 30 working days after the submission. Approval of the Construction Plan does not relieve the Contractor of responsibility for the successful completion of the work.

504.18 Storage and Handling. Ground nail bars shall be stored and handled in a manner to avoid damage or corrosion. Bars exhibiting abrasions, cuts, welds, weld splatter, corrosion, or pitting shall be replaced. Bars exhibiting damage to encapsulation or epoxy coating shall be replaced. Repaired epoxy coating areas shall have a minimum 0.012-inch thick coating.

504.19 Excavation. The Contractor shall complete the excavation to neat line and grade in a series of lifts. The height of the exposed unsupported excavation lifts shall not exceed the vertical nail spacing plus the required reinforcing lap or the short-term stand-up height of the ground, whichever is less. The Contractor shall only excavate that portion of each lift where reinforced shotcrete can be applied in the same work shift, unless otherwise approved by the Engineer. Application of the shotcrete may be delayed up to 24 hours if the ground nailing contractor can demonstrate that the delay will not adversely affect the excavation face stability. The contractor shall take precautions to prevent water from ponding near or infiltrating the face of the exposed excavation. Such precautions shall include temporary surface drainage measures and covering the exposed face of the excavation to prevent water infiltration.

The Contractor shall be prepared to manage overbreaks, soil sloughing from the cut face, and trimming or removing protrusions of cobbles and/or boulders beyond the line of the cut face. Soil sloughing out from behind the excavation neatline, thereby creating voids behind the finished shotcrete and/or undermining the ground nail wall shall not be allowed. The Contractor shall modify their means and methods to minimize or eliminate sloughing soil by placing an incidental lift of reinforced shotcrete prior to drilling ground nails or drilling ground nails through a temporary stabilizing berm or other methods approved by the Engineer. Overbreaks shall be backfilled with incidental shotcrete placed at the same time as the facing shotcrete or backfilled with flowfill contained behind the shotcrete with forms. Voids that may develop behind the shotcrete shall be filled with grout or shotcrete at no additional cost to the department.

Finished excavation and cut face exposures that will not receive shotcrete facing within the specified time limit must be stabilized by placing a temporary soil berm against the exposed face, placing a temporary shotcrete flash-coat, or other methods approved by the Engineer.

Excavation of the next-lower lift shall not proceed until nail installation, reinforced shotcrete placement, attachment of bearing plates and nuts, expansion joints, contraction joints and nail testing have been completed and accepted in the current lift. Nail grout and shotcrete shall have attained 1,500 pounds per square inch and 2,000 pounds per square inch compressive strength, respectively, before excavation of the next underlying lift.

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504.20 Nail Installation. Nail length and drill hole diameter used shall be that necessary to develop the load capacity to satisfy the acceptance criteria for the allowable bond strength required, but not less than the lengths or diameters shown on the plans. Holes shall be drilled for the ground nails at the locations, elevations, orientations, and lengths shown on the plans. Drilling equipment and methods shall be suitable for the ground conditions and conform to the accepted installation methods submitted by the ground nailing contractor. Drilling muds or other similar temporary fluids shall not be used to remove cuttings. If caving ground is encountered, cased drilling methods shall be used to support the sides of the drill holes. Nail bars shall be as shown on the plans. Centralizers sized to position the bar within 1 inch of the center of the drill hole shall be used. Centralizers shall be used as shown on the plans so that their maximum center-to-center spacing does not exceed 8 feet. Centralizers shall also be used within 1.5 feet from the top and bottom of the drill hole.

504.21 Grouting. The drill hole shall be grouted after installation of the nail bar and within 2 hours of completion of drilling. The complete ground nail installation, including drilling, nail placement and grouting shall occur within the same work shift. Drill holes shall not be left open overnight for completion during a subsequent shift. The grout shall be injected at the lowest point of each drill hole through a grout tube or casing. The outlet end of the conduit shall be kept from delivering grout below the surface of the grout as the conduit is withdrawn to prevent the creation of voids. The drill hole shall be completely filled in one continuous operation. Cold joints in the grout column are not allowed except at the top of the test bond length of proof tested production nails. GCD's shall be used to prevent the loss of grout in the hole and to reduce the need for placing additional grout to fill the drill hole (topping off). GCD's may be eliminated in some areas, if the Contractor can demonstrate to the satisfaction of the Engineer that full grout levels are maintained in the drill holes without the need for topping off.

Nail grout shall be tested according to AASHTO T106 at a frequency of one test per mix design and a minimum of one test for every 52 cubic yards of grout placed. Grout cube test results shall be provided to the Engineer within 24 hours of testing.

504.22 Nail Testing. Both verification and proof testing of designated test nails shall be performed by the Contractor. Verification tests shall be performed on sacrificial test nails at locations selected by the Engineer near the approximate locations indicated on the Plans. The overall length of a given verification test nail shall be the same as the longest production nail adjacent to the test location. Proof tests shall be performed on production nails at locations selected by the Engineer or as shown on the plans. Testing of a nail shall not be performed until the nail grout and shotcrete facing have attained 1,500 pounds per square inch and 2,000 pounds per square inch compressive strength, respectively.

Testing equipment shall include 2 dial gauges, independent dial gauge reference beam, hydraulic jack with pressure gauge, electronic load cell, a reaction load frame, steel cribbing and timber cribbing. The pressure gauge shall be graduated in 100 pounds per square inch increments or less. The nail head movement shall be measured with a minimum of 2 dial gauges capable of measuring to 0.001 inch. The dial gauges and loading jack shall be capable of extending a sufficient length to complete the entire test without having to reset the gauges or jack. The reaction load frame and cribbing must be adequate to sustain the applied test loads without excessive deformation and shall be configured to apply no more than 3000 pounds per square foot reaction to the soil as uniformly as possible throughout the test (maximum test load). The testing equipment must be free from excessive hydraulic leaks. Frequent adjustments of hydraulic pressure, necessary to maintain the applied testing loads, as a result of reaction frame deformation, cribbing deformation or hydraulic leaks may be cause for suspending the ground nail test and retesting. Adjustments to the reaction frame, cribbing and/or repairs to the hydraulic equipment to prevent oil leaks will be required prior to retesting. All costs (including time) associated with these adjustments and repairs will be at the Contractor's expense.

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504.23 Verification Testing Of Sacrificial Nails. Verification testing shall be performed prior to installation of production nails to confirm the appropriateness of the Contractor's drilling and installation methods, and verify the required nail pullout resistance.

Verification test nails shall have both bonded and unbonded lengths. Along the unbonded length, the nail bar shall not be grouted. The unbonded length of the test nails shall be at least 3 feet. The bonded length of the ground nail during verification tests, L_{BVT}, shall be at least 10 feet but not longer than a maximum length, $L_{BVT\ max}$, such that the nail load does not exceed 90 percent of the nail bar tensile allowable load during the verification test. Therefore, the following requirements shall be met:

L_{BVT} shall be within the limits for L_{BVTmax} computed with $2.5 \leq FS_{Tver} \leq 3$, but never less than 10 feet minimum.

The length L_{BVTmax} is defined as:

$$L_{BVTmax} = (C_{RT} \bullet A_t \bullet f_y)/(Q_{ALL} \bullet FS_{Tver})$$

where,

C_{RT} = Reduction coefficient. Use $C_{RT} = 0.9$ for Grade 60 and 75 bars. If the Engineer allows Grade 150 bars on the project, use $C_{RT} = 0.8$;

A_t = Nail bar net cross-sectional area after threading;

f_y = Nail bar yield tensile strength for Grade 60 and 75 bars or ultimate tensile strength if Grade 150 bars;

Q_{ALL} = Allowable pullout resistance per unit length ($Q_{ALL} = Q_u/FS_P$), as specified on the plans with $FS_P = 2.0$ for static loads and 1.5 for seismic loads; and

FS_{Tver} = Factor of safety against tensile failure during verification tests (use 2.5 or, preferably, 3).

The maximum bonded length shall be based on production nail maximum bar grade. Larger bar sizes shall be provided at no additional cost if required to meet the 10 foot minimum test bonded length requirement.

The Design Test Load (DTL) shall be determined as follows:

$$DTL = L_{BVT} \bullet Q_{ALL}$$

The DTL shall be calculated based on the test nail's as-built bonded lengths.

Verification tests shall be performed by incrementally loading the verification test nails to failure or a maximum test load of 300 percent of the DTL in accordance with the following loading schedule. The ground nail movements at each load increment shall be recorded.

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Verification Test Loading Schedule

Load	Hold Time
0.05 DTL max.(AL)	1 minute
0.25 DTL	up to 10 minutes
0.50 DTL	up to 10 minutes
0.75 DTL	up to 10 minutes
1.00 DTL	up to 10 minutes
1.25 DTL	up to 10 minutes
1.50 DTL (Creep Test)	60 minutes
1.75 DTL	up to 10 minutes
2.00 DTL	up to 10 minutes
2.50 DTL (or pullout failure)	up to 10 minutes max.
3.0 DTL (or pullout failure)	up to 10 minutes max.
0.05 DTL max. (AL)	1 minute (record permanent set)

The alignment load (AL) shall be the minimum load required to align the testing apparatus and shall not exceed 5 percent of the DTL. Dial gauges shall be set to "zero" after the alignment load has been applied. Following application of the maximum load (3.0 DTL) the load shall be reduced to the alignment load (0.05 DTL maximum) and the permanent set recorded.

Except for alignment and creep test load stage, each load increment shall be held for up to 10 minutes. Except for the alignment and creep test load stages, the ground nail movement indicated on the dial gauges shall be recorded at 1 and 5 minutes after full application of load. If the recorded movement between 1 and 5 minutes is stable (less than 0.01 inches) the test may proceed to the next load stage; otherwise, maintain the load until 10 minutes, record the ground nail movement and then proceed to the next load stage. The verification test nail shall be monitored for creep at the 1.50 DTL load increment. Nail movements shall be measured and recorded during the creep portion of the test in increments of 1 minute, 2, 3, 5, 6, 10, 20, 30, 50, and 60 minutes. The load shall be maintained during the creep test within 2 percent of the intended load by use of the load cell.

504.24 Proof Testing Of Production Nails. Successful proof testing shall be performed on 5 percent of the production soil nails in each nail row or a minimum of 1 per row. The Engineer will determine the locations and number of proof tests prior to nail installation in each row unless otherwise shown on the plans. Production proof test nails shall have both bonded and temporary unbonded lengths. The temporary unbonded length of the test nail shall be at least 3 feet. The bonded length of the soil nail during proof production tests, L_{BPT}, shall be the least of 10 feet and a maximum length, $L_{BPT\ max}$, such that the nail load does not exceed 90 percent of an allowable value of the nail bar tensile load during the proof production test. Therefore, the following requirements shall be met:

L_{BPT} shall be between 10 feet, minimum, and $L_{BPT\ max}$.

The length $L_{BPT\ max}$ is defined as:

$$L_{BPT\ max} = (C_{RT} \bullet A_t \bullet f_y) / (Q_{ALL} \bullet FS_{Tproof})$$

Where,

C_{RT} = Reduction coefficient. Use $C_{RT} = 0.9$ for Grade 60 and 75 bars. If the engineer allows Grade 150 bars on the project, use $C_{RT} = 0.8$;

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A_t = Nail bar net cross-sectional area after threading;

f_y = Nail bar yield tensile strength;

Q_{ALL} = Allowable pullout resistance per unit length ($Q_{ALL} = Q_u/FS_P$), as specified on the plans with $FS_P = 2.0$ for static loads and 1.5 for seismic loads; and

FS_{Tproof} = Factor of safety against tensile failure during proof production tests (use 1.5).

The maximum bonded length shall be based on production nail maximum bar grade. Production proof test nails shorter than 12 feet in length may be constructed with less than the minimum 10 foot bond length.

The Design Test Load (DTL) shall be determined as follows:

$DTL = L_{BPT} \times Q_{ALL}$

The DTL shall be calculated based on as-built bonded lengths.

Proof tests shall be performed by incrementally loading the proof test nail to 150 percent of the DTL in accordance with the following loading schedule. The soil nail movements shall be recorded at each load increment.

Proof Test Loading Schedule.

Load	Hold Time
0.05 DTL max. (AL)	1 minute
0.25 DTL	Until Movement Stabilizes
0.50 DTL	Until Movement Stabilizes
0.75 DTL	Until Movement Stabilizes
1.00 DTL	Until Movement Stabilizes
1.25 DTL	Until Movement Stabilizes
1.50 DTL	Creep Test (see below)
0.05 DTL max. (AL)	1 minute (record permanent set)

The alignment load (AL) should be the minimum load required to align the testing apparatus and shall not exceed 5 percent of the DTL. Dial gauges shall be set to "zero" after the alignment load has been applied.

The creep period shall start as soon as the maximum test load (1.50 DTL) is applied and the nail movement shall be measured and recorded at 1 minute, 2, 3, 5, 6, and 10 minutes. Where the nail movement between 1 minute and 10 minutes exceeds 0.04 inch, the maximum test load shall be maintained for an additional 50 minutes and movements recorded at 20 minutes, 30, 50, and 60 minutes. All load increments shall be maintained within 5 percent of the intended load.

504.25 Test Nail Acceptance Criteria. A test nail shall be considered acceptable when all of the following criteria are met:

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(1) For verification tests, the total creep movement is less than 0.08 inch between the 6 and 60 minute readings and the creep rate is linear or decreasing throughout the creep test load hold period.

(2) For proof tests, the total creep movement is less than 0.04 inch during the 10-minute readings or the total creep movement is less than 0.08 inch during the 60-minute readings and the creep rate is linear or decreasing throughout the creep test load hold period.

(3) For verification and proof tests, the total measured movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the test nail unbonded length.

(4) A pullout failure does not occur at 2.0 DTL under verification testing and 1.5 DTL test load under proof testing. Pullout failure is defined as the inability to further increase the test load while there is continued pullout movement of the test nail. The pullout failure load shall be recorded as part of the test data.

The Contractor shall maintain the stability of the hole for the temporary unbonded test length for subsequent grouting. If the unbonded test length of production proof test nails cannot be satisfactorily grouted subsequent to testing, the proof test nail shall become sacrificial and shall be replaced with an additional production nail installed at the Contractor's expense.

504.26 Test Nail Rejection. If a test nail does not satisfy the acceptance criterion:

(1) For verification test nails, the Engineer will evaluate the results of each verification test. Installation methods that do not satisfy the nail testing requirements will be rejected. The Contractor shall propose alternative methods and install replacement verification test nails. Replacement test nails shall be installed and tested at the Contractor's expense.

(2) For proof test nails, the Engineer may require the Contractor to replace some or all of the installed production nails between a failed proof test nail and the adjacent passing proof test nail. Alternatively, the Engineer may require the installation and testing of additional proof test nails to verify that adjacent previously installed production nails have sufficient load carrying capacity. Installation and testing of additional proof test nails or installation of additional or modified nails as a result of proof test nail failures shall be at the Contractor's expense.

504.27 Wall Drainage Network. All elements of the wall drainage network shall be installed and secured as shown on the plans. The drainage network shall consist of installing geocomposite drain strips and a 6 inch perforated pipe underdrain as shown on the plans. Exclusive of the 6-inch perforated pipe underdrain all elements of the drainage network shall be installed prior to shotcreting.

(a) *Geocomposite Drain Strips.* Geocomposite drain strips shall be centered between the columns of nails as shown on the Plans. The drain strips shall be at least 12 inches wide and placed with the geotextile side against the ground. The strips shall be secured to the excavation face and shotcrete prevented from contaminating the geotextile. Drain strips shall be vertically continuous. Splices shall be made with a 12 inch minimum overlap such that the flow of water is not impeded. Drain plate and connector pipe shall be installed at the base of each strip as shown on the plans. Damage to the geocomposite drain strip which may interrupt the flow of water shall be repaired.

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(b) *Footing Drains.* Footing drains shall be installed at the bottom of each wall as shown on the plans. The drainage geotextile shall envelope the footing drain aggregate and pipe and conform to the dimensions of the trench. The drainage geotextile shall overlap on top of the drainage aggregate as shown on the plans. Damaged or defective drainage geotextile shall be repaired or replaced.

504.28 Shotcrete Facing. Construction shotcrete facing and permanent shotcrete facing (if required) shall be installed in accordance with Section 641. Where shotcrete is used to complete the top ungrouted zone of the nail drill hole near the face, the nozzle shall be positioned into the mouth of the drill hole to completely fill the void.

(a) *Overspray*. All surrounding features, including grading and vegetation shall be protected from shotcrete overspray. Any overspray applied to these features, including grading and vegetation shall be removed at the Contractor's expense.

(b) *Final Face Finish.* Shotcrete finish shall be either an undisturbed gun finish as applied from the nozzle or a rod, broom, wood float, rubber float, steel trowel or rough screeded finish as shown on the Plans.

(c) *Attachment of Nail Head Bearing Plate and Nut.* Bearing plate, washers, and nut shall be attached to each nail head as shown on the plans. While the shotcrete construction facing is still plastic and before its initial set, the plate shall be uniformly seated on the shotcrete by hand-wrench tightening the nut. Where uniform contact between the plate and the shotcrete cannot be provided, the plate shall be set in a bed of grout. After grout has set for 24 hours, the nut shall be hand-wrench tightened. Bearing plates shall be located within the tolerances shown on the Plans.

(d) *Shotcrete Facing Tolerances.* Construction tolerances for the shotcrete facing from plan location and plan dimensions are as follows:

Horizontal location of welded wire mesh; reinforcing bars, and headed studs: ½ inch

Location of headed studs on bearing plate: ¼ inch

Spacing between reinforcing bars: 1 inch

Reinforcing lap, from specified dimension: 1 inch

Complete thickness of shotcrete: If troweled or screed: 0.6 inch; If left as shot: 1.2 inch

Planeness of finish face surface-gap under 10 foot straightedge: If troweled or screed: 0.6 inch; If left as shot: 1.2 inch

Nail head bearing plate deviation from parallel to wall face: 10 degrees

504.29 Forms And Falsework. Forms and falsework shall conform to subsections 601.09 and 601.11 respectively.

504.30 Reinforcing Steel. Reinforcing steel shall be installed in accordance with Section 602.

504.31 Structural Concrete. Structural concrete shall be placed in accordance with Section 601.

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504.32 Architectural Surface Finishes. The Contractor shall design and furnish textured form liners, install form liners, and apply a surface finish (color or stain application) that will duplicate the pattern shown on the plans. Detailed drawings of the form liner shall be submitted for approval by the Engineer in accordance with Subsection 105.02. Before production work begins, a 3 foot high, by 1.5 foot wide, 10 foot long test panel shall be constructed on site using the same forming methods, procedures, form liner, texture configuration, expansion joint, concrete mixture and color or stain application proposed for the production work. Production work shall not begin until the Engineer has approved the test panel.

504.33 Backfilling Behind Wall Facing Upper Cantilever. Backfill shall be relatively free draining granular material compacted within 3 feet behind the wall facing upper cantilever using light mechanical tampers.

504.34 Acceptance. Material for the ground nail retaining wall will be accepted based on the manufacturer production certification or from production records. Construction of the ground nail retaining wall will be accepted based on visual inspection and the relevant production testing records.

METHOD OF MEASUREMENT

504.35 Ground nail retaining walls will be measured by the quantity installed and accepted. Verification testing of ground nails will not be measured separately but shall be considered incidental to construction of the ground nailed wall. The final pay quantity will be the design quantity increased or decreased by any changes authorized by the Engineer.

For purpose of measurement, ground nails must be installed, tested and accepted to be considered complete.

BASIS OF PAYMENT

504.36 The accepted quantity, measured as provided above, will be paid for at the contract unit price per each for the pay items listed below that are shown on the bid schedule.

Payment will be made under:

Pay Item	**Pay Unit**
Ground Nail (10 Foot)	Each
Ground Nail (15 Foot)	Each

Payment for Ground Nail Wall will be full compensation for all work and materials required to complete the item exclusive of any facing items that may be tabulated on the plans. Accordingly, this work shall include, but is not limited to, structure backfill within six feet of the wall layout lines, drilling, grouting, ground nails, verification tests, proof tests, grout containment devices, bearing plates, end hardware (nuts, washers), survey and incidentals necessary to acceptably fabricate and construct the ground nail walls.

All excavation work, including structure excavation and rock excavation required to construct the ground nails and reinforced shotcrete to the lines and grades indicated on the plans will be paid for in accordance with Section 203 Unclassified Excavation.

Geocomposite strip drains, shotcrete, incidental shotcrete to fill overbreak, incidental flowfill to fill overbreak and all shotcrete steel reinforcement delineated in the plans will be paid for in accordance with Section 641 Shotcrete.

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The 6 inch perforated pipe underdrain will be paid for in accordance with Section 605.

Reinforced Concrete (Class D) shown on the plans will be paid for in accordance with Section 601 Concrete (Class D) (Wall) and Section 602 Steel Reinforcement.

REVISION OF SECTION 509
STEEL SETS (INSTALL ONLY)

Section 509 of the Standard Specifications is hereby revised for this project as follows:

Subsection 509.01 shall include the following:

This work shall also include the installation of steel sets and steel channels previously furnished for this project for the purpose of providing initial ground support for tunnel excavation operations.

Subsection 509.26 shall include the following:

Steel sets shall be installed in accordance with the requirements of Section 211A Underground Excavation and Initial Support.

Subsection 509.32 shall include the following:

MC12X50 Steel Sets will be measured by the linear foot of steel set installed and accepted including laps. Anchors, bolts and all connecting hardware will not be measured for payment but shall be included in the linear foot cost of the steel set.

Steel Sets will be measured by each complete set, installed and accepted.

Subsection 509.33 shall include the following:

Payment will be made under:

Pay Item	**Pay Unit**
MC12X50 Steel Set (Install Only)	Linear Foot
Steel Set (Install Only)	Each

SECTION 519A
HOT DIP GALVANIZING AND DUPLEX COATING

Section 519A is hereby added to the Standard Special Specifications for this project as follows:

DESCRIPTION

519A.01 This work consists of preparing, galvanizing, and powder coating steel, aluminum and stainless steel products in accordance with these specifications.

MATERIALS

519A.02 Materials for hot dip galvanizing shall be as follows:

(a) *Coatings*. All coatings shall be able to withstand prolonged temperatures up to 180 degrees F without sag, blister, or peel damage during the warranty period. Topcoat formulation shall provide weathering, chemical, and ultraviolet (UV) resistance. Coatings shall meet the following ASTM requirements as amended:

1. Corrosion Weathering: ASTM D-5894, minimum 6 cycles of exposure; corrosion rating of 8 or higher according to ASTM D-1654; blistering rating of 8 or higher according to ASTM D-714.

2. Impact Resistance: ASTM D-2794, 30 day test. Epoxies- Minimum 40 in. lbs. All topcoats- Minimum 90 in. lbs.

3. Adhesion Testing: ASTM D-4541, 30 day test. Minimum 500 PSI for either: Method B-flat surface; Method E-curved surface.

4. Abrasion Resistance: ASTM D-4060, 30 day test. Maximum 90 mg loss for 1000 cycles with CS 10 or CS 17 wheel.

5. Flexibility. ASTM D-522, 30 day test- Method B. Epoxies shall pass a 180 degree bend over a ¾" mandrel. All Topcoats shall pass a 180 degree bend o0ver a 3/8" mandrel.

6. Coating color shall be Federal Standard color 20059.

CONSTRUCTION REQUIREMENTS

519A.03 Materials to be hot dip galvanized shall be constructed as follows:

(a) Coating First-Use Galvanized Steel Products – Plant and Shop.

The Contractor shall furnish a warranty performance bond equal to 100 percent of the contract price for coated galvanized products; this bond shall be maintained until release of responsibility is issued by the Engineer in writing. The Contractor's public and property damage liability insurance shall also remain in effect during the entire warranty period. Conditions for release of warranty responsibility are addressed in Subsection (g).

Steel products to be galvanized and coated shall be cleaned of weld spatter and bevel finished at exposed corners, edges and points. Areas having welds, cuts, bores, notches or grooves shall also be beveled unless otherwise noted in the Contract or directed by the Engineer. Bevel work shall produce a uniform, smooth finish prior to galvanizing. Bevel size to be used is based on steel thickness and other criteria as follows:

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HOT DIP GALVANIZING AND DUPLEX COATING

1. Less than ½ in. thick - 1/32 in. to 1/16 in.
2. Over ½ in. thick – 1/16 in. to 1/8 in.
3. Bores, notches & grooves – root face of 1/32 in. to 1/16 in.
4. Welds – clean and work finish according to AWS standards.

All fabricators and users of potentially hazardous materials or operations shall determine and comply with Colorado Department of Public Health and Environment regulations.

All coating measurements shall be taken with a Type 2 fixed probe Dry Film Thickness (DFT) gauge. The gauge shall be calibrated according to the Society for Protective Coatings (SSPC) Standard PA-2. In cases of differing readings affected parties shall agree to use the gauge displaying the greater degree of accuracy.

(b) Galvanizing

Galvanizing shall be done according to the Standard ASTM Specification stated in the Contract except that items shall not be quenched with water, oil or liquid. Ambient air quenching is acceptable. Chromate treatment of any type is not acceptable. Zinc-Phosphate Pretreatment or Acrylic Passivation Pretreatments as described in Subsection (d-1) and (d-2) are acceptable.

The Galvanizer shall measure and record thickness of galvanized coating. Measure frequency shall comply with the applicable ASTM specification. Records shall be provided to the Engineer and to the point of next fabrication.

Spot areas not requiring galvanizing shall be marked and cleanly patched with material that prevents galvanization but does not weaken the adjacent spelter. Repair of patch areas shall comply with Practice Method 1) or 2) of Subsection (c).

Prior to further work, the Galvanizer shall notify the Engineer in writing that the galvanized order is chromate free, air quenched, date(s) of galvanizing, and date(s) of any Zinc-Phosphate or Acrylic Passivation Pretreatments.

Products not certified chromate free by the Galvanizer shall be tested prior to further work. The Contractor shall provide the Engineer with certification from an independent ASTM accredited laboratory listing all individual items that test chromate free. Testing shall comply with ASTM D-2092 Appendix X2. Test results shall be provided to the Engineer before work resumes.

(c) Repair of galvanized products

Uncoated areas or damaged coating exceeding applicable specification limits shall be re-galvanized per original specification. Cuts made after galvanizing shall be ground, beveled, and smoothed before repair. Repair of all cuts, uncoated areas or minor damage shall comply with Practice Method 1 or 2 as described below:

1. Metallizing – conforming to ASTM A-780, Annex A3, except that minor repair areas shall be cleaned according to SSPC method SP-3. SSPC Method SP-2 may be used to clean difficult access areas. Thickness of the repair coat shall reasonably match adjacent galvanizing, as measured by calibrated DFT gauge.

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SECTION 519A
HOT DIP GALVANIZING AND DUPLEX COATING

2. Paint – conforming to ASTM A-780, Annex A2, except that an organic zinc-rich epoxy paint containing minimum 80% zinc concentration shall be used. The epoxy paint shall conform to all other requirements in Subsection (e), as defined for epoxy. Thinning shall comply with manufacturers instruction to prevent adjacent spelter damage. A repair coat of 3 to 5 mils shall be applied by brush or dauber only.

3. Coat imperfections such as burring, run/drip, high spots, heavy dross, or ash inclusion shall be removed and cleaned. Areas of re-work falling below zinc thickness limits shall be repaired according to Practice Method 1 or 2 of this Subsection.

4. Printed technical data sheets (PTDS) shall be provided to the Engineer for repair materials used. Spray can paint or cold galvanizing compound repair will be rejected; these substances are not compatible with the coating systems to be employed.

(d) Preparing galvanized surfaces for coating

Products shall be inspected for shipping and handling damage before surface prep work begins. Damage shall be reported to the Galvanizer and to the Engineer prior to repair. The Engineer will order repair or replacement of damaged items. Minor repair of galvanizing shall comply with Practice Method 1 or 2 of Subsection (c).

The Contractor shall prepare all coatable surfaces to provide a slightly roughened profile without removing over 1.0 mils of the galvanized coating. Minimum ASTM zinc thickness specifications shall still apply after preparation.

Fasteners to be coated shall be lightly brushed or sanded on the surfaces to be coated. Care shall be taken so that a minimal amount of zinc is removed.

Surfaces that become soiled after pretreatment shall be cleaned prior to coating by low pressure, mild detergent wash and rinse. Stained or oiled surfaces may also be mildly scrubbed with a soft bristle nylon brush. Stubborn stains may be mildly scrubbed with a 1-2 percent ammonia solution and thoroughly rinsed. Wash and rinse pressure shall not exceed 100 PSI or 185 F temperature.

Surface preparation work shall be done according to one of the following methods:
Zinc-Phosphate Pretreatment. Treatment can only be used on new galvanizing less than 48 hours of age. Thickness measure after treatment is not required when using this method.
Items shall be immersed in a bath of acidic zinc-phosphate solution for 3 to 6 minutes, rinsed with clean water and dried. The first epoxy coat shall be applied within 48 hours after immersion treatment. If treated items are shipped to a different coating facility they shall be rewashed, rinsed and dried to remove surface soiling. The first epoxy coat must still be applied within 48 hours after immersion treatment.

Acrylic Passivation Pretreatments. Treatment can only be used on fresh hot galvanizing or new galvanizing less than 48 hours of age. Thickness measure after treatment is not required for either application method. Only chrome-free solutions shall be used, applied by a method that ensures complete coverage of all coatable surfaces. The Treater shall provide the Engineer with treatment dates for each item and PTDS for solution(s) used. The Galvanizer may apply solution to fresh hot galvanizing that is less than 6 hours of age, still clean, dry, and has cooled to treatment application temperature guidelines. If newly galvanized items are shipped to another treatment facility they shall be washed, rinsed and dried to remove surface soiling. Solution shall then be applied and cured according to supplier's instructions.

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Fully cured, treated items shall be rewashed, rinsed and dried again just before coating. Articles not coated within 100 days of treatment shall be abrasive blasted per Subsection (d-3).

Abrasive Blasting. This treatment may be used on galvanized items of any age if beveling requirements as listed in the third and fourth paragraphs of Subsection (a) have been met. The Contractor shall notify the Engineer in writing at least 5 working days before blasting begins. Zinc thickness shall be measured and recorded immediately after blasting and provided to the Engineer within 48 hours of blasting. Thickness limits and measure frequency shall comply with the original applicable ASTM specification. Blast operations shall reasonably conform to ASTM Standard Practice D-6386, Subsection 5.4.1 except for:

1. Small areas falling below required zinc thickness shall be repaired according to Subsection (c) Practice Method 1 or 2. No single area shall exceed 2 in. at its largest width or 12 in. at its longest dimension.

   Total repair area shall not exceed 1% of the coatable surface per item; if limits are exceeded or zinc thickness is below specification the item shall be re-galvanized per original specification.

2. The Contractor shall measure and record the size, location and repair method used for all repairs. This information shall be included on the report of thickness measurements so the Department can later inspect these areas.

3. The first epoxy coat shall be applied within 90 minutes of abrasive blasting. Items shall be cleaned free of blast debris before coating. Compressed air used to clean items shall be free of oil residue or other harmful contamination.

(e) Coating and Paint Systems

Prepared items shall be coated with a 2 or 3 coat system described in this Subsection. Alternative coating systems shall be pre-approved in writing by the Engineer. Manufacturers PTDS for each coating type shall state test values for ASTM requirements of this Subsection. Prior to product use the coating supplier shall provide the PTDS and certify to the Engineer in writing that all furnished coating materials meet applicable requirements of this Subsection.

Faying surfaces shall not be painted unless written approval is given by the Engineer. All shop fabrication including welds and attachments shall be completed prior to coating unless otherwise noted in the Contract or directed in writing by the Engineer.

Inorganic zinc coatings shall not be used. Combined DFT of all coats applied over the galvanizing shall range from 6.5 to 10 mils with a topcoat DFT of 3 mils minimum. Dried color of the base coat and topcoat shall closely match. Finished color shall not vary more than 4 delta units from plan specification.

Volatile Organic Compound (VOC) levels shall not exceed 3.0 lbs. per gallon for each applied coat. Dry films shall contain less than 1% lead and other toxic heavy metals. Zinc concentration of epoxy coats shall not exceed 40 percent. Topcoats shall be of semi-gloss material with a rating of 50-75.
Coats shall be applied uniformly to provide an appearance free of laps, streaks, sags, drips, pinholes, and other discontinuities; all such defects shall be repaired prior to product shipment.

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The Coater shall measure the DFT of each applied coat according to SSPC, Guide PA-2, except that measurements shall be taken with a calibrated Type 2 fixed probe gauge. Thickness records shall be provided to the Engineer prior to project shipment. The following two coating systems do not require pre-approval:

1. Powder Coating. The Coater shall oven preheat the articles to abate out-gassing potential. The Coater shall be responsible for utilizing compatible materials and coating processes to obtain proper coat to coat adhesion.

   Epoxy Powder base coat(s) shall measure 2 to 6 mils DFT and be applied by electrostatic or Tirbo/Airstatic spray. Powder formulation shall be a non-hybrid epoxy of anti-gassing grade.

   The powder topcoat shall be electrostatic or Tirbo/Airstatic spray applied and measure 3 to 6 mils DFT. Powder formulation shall be non-acrylic, high-build, aliphatic-based, Enhanced Polyester or Urethane Polyester of anti-gassing grade.

2. Liquid Coating. The Coater shall apply coats by conventional or airless spray according to suppliers guidelines. Minimal striping at difficult work areas is permissible. The Coater shall be responsible for utilizing proper work methods and compatible materials to obtain proper coat adhesion. Thinning of paints shall be done according to manufacturer's instruction so that thinned products conform to the solids content and VOC limits of this Subsection.

   Epoxy base coat(s) shall measure 2 to 6 mils DFT. Paint shall be a low-blush epoxy polyamide, or a low-blush cycloaliphatic bisphenol-A polyamine. Minimum solids by weight of all epoxies used shall be 68 percent.

   The topcoat shall measure 3 to 6 mils DFT. Paint shall be an aliphatic-based Urethane Polyester or aliphatic-based Polyurea Urethane. Specially formulated aliphatic-based Polyaspartic Polyureas may also be used over compatible epoxy bases.

(f) Repair of Coated Products

The Contractor shall be responsible for repairing damage from shipment, installation, field welding, or other repairs necessary during the warranty period. Damage shall be reported to the Engineer prior to repair. Repairs shall be done to the satisfaction of the Engineer.

Significant repair procedures shall require written submittal of proposed repair from the Contractor. The Engineer shall approve the proposal in writing before repairs begin. Significant repairs shall be classified as:

Any damaged area to the base coat material over one square inch. Total repair areas exceeding 5% of the coating per item. Any single topcoat repair area over 64 square inches.

Minor and touchup repair of topcoats shall be done as follows:

A UV rated, aliphatic-based liquid topcoat paint shall be used. The paint shall be compatible with existing topcoat material and closely match existing color. Paint requirements listed in Subsection (e) shall apply to the material. The paint supplier shall provide the Engineer with PTDS for the product(s) used.

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Single area repair smaller than eight square inches shall be scuffed with 220 grit sandpaper or equivalent scuff material. Larger areas up to 64 square inches may be cleaned according to SSPC, Method SP-2. All border areas at the undamaged topcoat shall be scuffed with 220 grit material. Cleaned, scuffed areas shall be bordered and coated by airless or conventional spray. Work areas shall be adequately shielded to contain errant spray. Fresh repair areas shall be protected as necessary during the initial cure. Repair thickness shall reasonably match the adjacent coating.

The repair coat shall provide an appearance free of sags, runs, streaks, drips, pinholes or other discontinuities. Spray can paint repair will be rejected.

(g) Acceptance conditions for release of warranty responsibility

Coated products shall be free from the following defects for two full years from the initial date of written project acceptance. Defect areas that received repair during the warranty period shall also be free from the described defects:

No peeling shall exist on any portion of the coatings. No blistering shall exist on any portion of the coatings. Color fading shall not fall below a 35 gloss rating. Mottling defects shall not exceed 3% of the topcoat surface. No cracking of the topcoat material shall be visible. No rusting discoloration shall be visible on the coating. No sag or other coating adhesion loss shall be evident.

METHOD OF MEASUREMENT

519A.04 Hot dip galvanizing and duplex coating will not be measured for payment.

BASIS OF PAYMENT

519A.05 Hot dip galvanizing and duplex coating will not be paid for separately, but shall be considered subsidiary to the item to be hot dipped galvanized.

SECTION 601A
FINAL LINING

Section 601A is hereby added to the Standard Specifications for this project as follows.

DESCRIPTION

601A.01 General. The work described herein consists of installing cast-in-place, reinforced concrete Final Lining, and water management system for the Tunnel.

601A.02 Definitions.

(a) Tunnel. The Tunnel to be widened is the eastbound tunnel of the I-70 Twin tunnels.

(b) *Initial Support*. Initial Support is rock dowels, rock bolts, spiles, channels, welded wire mesh, mine straps, fiber reinforced shotcrete, steel sets or other measures installed near the face and soon after excavation for the purpose of stabilizing the opening, preserving strength of the rock arch and providing for a stable opening and worker safety for the period of time from initial excavation until installation of the final lining.

(c) *Smoothing Shotcrete.* Plain shotcrete placed to fill overbreak and cover rough surfaces shall be as defined in Section 641A, Shotcrete.

(d) *Steel Fiber Reinforced Shotcrete (SFRS).* SFRS shall be as defined in Section 641A, Shotcrete.

(e) *Final Lining.* The Final Lining is the cast-in-place concrete lining including reinforcing steel installed in the tunnels for the purpose of providing permanent and final structural support for the opening as shown on the Plans and specified herein.

(f) *Design Line.* The line shown on the Plans that defines the nominal dimensions to the exterior surface of the final cast-in-place structural lining inside, which no rock, soil, shotcrete, or elements of geocomposite drainage strips or panels shall protrude. Ends of dowels, spiles, or other bare steel components of the initial support systems may encroach up to six inches within the design line shown on the Plans.

(g) *Geocomposite Drain.* Geotextile-wrapped, dimpled plastic drainage sheet installed intermittently in strips or as overlapping panels to form a continuous sheet to collect and convey groundwater to formation drain pipes. Geocomposite drains shall conform to the requirements Revision to Section 605.

(h) *Formation Drain.* Perforated PVC drain pipes wrapped in filter fabric installed along the corners of the Tunnel invert to convey groundwater seepage collected by the geocomposite drain panels to drain pipes at the East portal. Formation Drain shall conform to the requirements Revision to Section 605.

(i) *Contact Grouting.* Pressure injection of cementitious grout through ports in crown area of tunnel lining to fill voids between Final Lining and the Initial Support or Geocomposite Drain.

(j) *Waterstops.* Embedded in concrete, across and/or along the joint, waterstops form a watertight diaphragm that prevents the passage of fluid (water) through the joint.

(k) *Groundwater Control System.* The Groundwater Control System has two components, the Formation Drains and the Geocomposite Drains. The system will collect the seepage groundwater from the surrounding rock and convey it to drain pipes at the East Portal.

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601A.03 Final Lining Materials.

(a) *Cast-In-Place Concrete (CIP Concrete).* CIP Concrete shall be Class D concrete as specified in Section 601, Structural Concrete and as shown on the Plans with the following exceptions:

1. Aggregate Size: 3/4-inch nominal sized coarse aggregate: 100 percent passing the 1-inch sieve and 90 percent to 100 percent passing the 3/4-inch sieve.

2. Maximum Water/Cement Ratio: 0.40 by weight.

3. Arch and wall liner only shall contain ASTM C1116, Type III polypropylene monofilament fibers 12 mm long at either 32 μm diameter at 1.7 lbs/cy (preferred) or 18 μm diameter at 2.5 lbs/cy. This dosage will not apply to the liner footing concrete.

4. The permeability of the laboratory trial mix shall not exceed 1500 ± 500 coloumbs at 28 days (ASTM C 1202) and shall not exhibit a crack after 15 days in the cracking tendency test (AASHTO T334).

5. Sand: ASTM C33

6. Approved fly ash may be substituted for ASTM C150 cement up to a maximum of 35% by weight of total cementitious material.

7. Mix design shall include a corrosion inhibitor such as calcium nitrite at a dosage level of 1 gallon/cubic yard

(b) *Reinforcing Steel.* For material size, spacing and requirements see Plans and standard specifications.

(c) *Grout Mix Design for Contact Grouting.* Ingredients that are compatible, non corrosive to steel and free from calcium chloride.

1. Cement: ASTM C150, Type I, II or III. Cement shall be fresh and shall not contain any lumps or other indication of hydration or "pack set".

2. Sand: ASTM C144, except maximum particle size limited to Size 16 sieve.

3. Early setting grout required: minimum compressive strength of 100 psi, 4 hours of installation (ASTM C109).

4. Water: Potable.

5. Admixtures and additives: Microsilica or other pozzolanic materials, liquefiers, accelerating, retarding and water reducing agents may be used as approved by the Engineer.

6. Resin or chemical grout meeting or exceeding the above specified time and strength requirements may be used as approved by the Engineer.

(d) *Waterstops.* Waterstops shall be a revision to Section 518

1. Hydrophilic (Swellable) Strip Waterstops shall be a non-Bentonite product and shall be composed of expansive rubber that swells upon contact with water.

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FINAL LINING

A. The product shall be a ¾ inch x 3/8 inch flexible hydrophilic rubber strip composed of non-vulcanized rubber and urethane polymer as the hydrophilic agent or ¾ inch X 3/8 inch flexible hydrophilic rubber strip composed of rubber and hydrophilic polymer. It shall have the minimum performance standards as follows:

(1) Specific gravity in accordance with ASTM D71: 1.18 minimum
(2) Hardness in accordance with ASTM D2240: A20
(3) Tensile strength in accordance with ASTM D412: 130 psi
(4) Elongation in accordance with ASTM D412: 560 percent

B. The waterstop shall have a delay coating to inhibit expansion due to moisture present in fresh concrete. Hydrophilic strip-applied waterstop shall be continuously adhered to the initial substrate (i.e. 1st pour concrete) using the manufacturer's approved adhesive, sealant, or epoxy, and his other recommendations. The product shall develop no less than 400 psi expansion pressure (unless shown or specified otherwise, use GreenStreak "Hydrotite", or approved equal).

2. Accessories

A. Adhesive as recommended by the manufacturer for securing waterstop to horizontal and vertical substrates.

B. Concrete cut nails for securing waterstop to vertical joint face.

C. Hog rings shall be provided at 12 inches on centers along the outermost edge of waterstops, providing a mechanism for positioning the waterstop prior to concrete pour.

3. Waterstops shall be certified by manufacturer for zero leakage at 125 feet head of water pressure.

601A.04 Drainage Materials.

(a) *Geocomposite Drain.* shall be as specified in Subsection 712.12 and in Revision of Section 605.

(b) *Drainage Geotextile.* Nonwoven geotextile shall conform with Subsection 712.08 and in Revision of Section 605.
(c) *Porous Concrete*. Porous Concrete shall conform to Revision of Section 605.

(d) *Formation Drain.* Perforated formation drain pipe shall be polyvinyl chloride (PVC) corrugated perforated pipe wrapped in a geotextile fabric with a smooth interior of the dimensions shown on the Plans and in conformance with Standard Specification 712.11, Plastic Pipe for Underdrains, and conform to Revision of Section 605.

CONSTRUCTION REQUIREMENTS

601A.05 Final Lining.

(a) The Final Lining shall consist of two components with the properties specified:

1. *Structural Lining* – Reinforced Cast-in-place concrete.

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FINAL LINING

2. *Drainage System* – System to convey water from the perimeter of the tunnel (consisting of Drainage Geotextile, and Geocomposite Drain) to Formation Drains as shown on the Plans.

(b) Additional requirements are as follows:

1. The drainage system shall be Geocomposite Drain Panels wrapped in geotextile and connected to formation drains at either sidewall footing. The Geocomposite Drain panels shall be installed intermittently in strips or continuously overlapped as indicated. Where a continuous drain is required, the overlap shall be as shown on the Contract Drawings or approved equal.

(c) *Cast-in-Place Final Lining.* The Cast-in-Place Final Lining shall be installed as shown on the Plans and as specified in Standard Specifications Section 601, Structural Concrete. CIP concrete Final Lining is required at the Tunnel portals as shown on the Plans and at additional locations as directed by the Engineer in writing. CIP concrete shall be reinforced with reinforcing bars as shown on the Plans. Reinforcement in Cast-in-Place Final Lining shall terminate 3 inches above the Porous Concrete. Construction joints shall be constructed as shown on the Plans.

(d) *Formwork*. The Formwork was furnished under a previous contract (Twin Tunnels Contract 1B). Formwork supporting the crown arch and sidewalls of the tunnel final lining shall not be moved sooner than 12 hours after completing placement of concrete within formwork or before a concrete compressive strength of 1000 psi has been reached. When a minimum concrete compressive strength of 1000 psi is achieved and when requested by the Contractor and approved by the Engineer, formwork supporting the crown arch and sidewalls of the tunnel final lining may be moved before the minimum 12 hours period.

(e) *Waterstops.* Installation of waterstops shall first be examined and prepared to ensure reinforcing steel does not interfere with waterstop position. The waterstops shall be protected and all dirt, debris, dust and oil shall be removed from joints. The surface shall be completely dry before the installation of the hydrophilic waterstops.

1. Construction requirements for hydrophilic waterstops shall be as follows:

A. Position waterstop on joint as indicated on the Contract Drawings. Waterstop shall be placed not closer than 2 inches from edge of concrete pour to ensure it will not spall concrete edge.

B. Press strip waterstop firmly and continuously in place over area on first concrete pour.

C. Butt ends of waterstop tightly. Press ends together to ensure no separation and no air pockets. Place in maximum practical lengths to minimize splicing. Cut ends square with sharp blade to fit splices together without overlaps.

D. Notify Engineer 24 hours prior to placement of concrete at waterstops.

E. Immediately prior to placing second pour, inspect waterstop for premature swell, discontinuity, and debris contamination. Replace swelled and damaged waterstop. Remove unacceptable waterstop from site and dispose of defective material in accordance with local regulations.

F. Remove the separation paper from the strip waterstop immediately prior to second pour.

G. Place concrete without displacing waterstop from position.

H. Thoroughly and systematically vibrate concrete around waterstop to obtain impervious, void-free concrete in vicinity of joint and to maximize intimate contact between concrete and waterstop. Do not allow vibrator to contact the strip waterstop.

601A.06 Shop Drawings. The following shall be submitted in accordance with Subsection 105.02:

Layout of Contractor's staging area including all buildings, plants, storage areas, parking areas, and stockpiles.

601A.07 Working Drawings. The following shall be submitted in accordance with Subsection 105.02:

Drawings and details of cast-in-place concrete including reinforcement schedule, and reinforcement.

Logistics of advancing and pouring including filling level speed, filling level difference, sequence of pouring and removal of forms.

Drawings and details of formwork including geometry and expected tolerances, layouts of anchors and braces, concrete placement locations and construction joint forming details.

601A.08 Reports and Records. Daily records shall be maintained and submitted to the Engineer. The following minimum data shall be included in the daily records:

(a) All survey records as specified herein.

(b) Description of Cast-in-Place Concrete installation, methods used, equipment used, forms, pour connections, and location at which concrete was installed.

(c) Description of Water Management System installation, methods used and locations at which strips or panels were installed.

601A.09 General. A tunneling pre-construction conference will be scheduled by the Engineer. Attendance is mandatory.

Clean working conditions shall be maintained at all times inside the Tunnel. All muck, slush, grout spills, and any other material not required for construction shall be removed from the Tunnel in a timely manner.

601A.10 Safety Requirements. Safety requirements will be in accordance with Subsection 107.06, Safety, Health, and Sanitation Provisions.

601A.11 Ventilation and Illumination. All ventilation and illumination for tunneling work shall be performed in accordance with applicable State, Federal and local laws, regulations, and guidelines including OSHA, as applicable. All underground areas shall have sufficient ventilation and illumination to ensure proper performance and inspection of the work.

The Contractor shall separate both power and lighting circuits; thoroughly insulate and protect them by ground fault circuit interrupters.

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The permanent illumination system shall be installed after the Final Lining has cured. Anchors as shown on the Plans shall be used to affix the illumination system to the Final Lining. The hole into which the anchor is installed shall extend no closer to the Design Line than three inches in the tunnel.

601A.12 Communications. The Contractor shall maintain contact with the Engineer at all times when Contractor personnel are on Site. If radio is used for the purposes of contact with the Engineer, the Contractor shall provide the Engineer with three radios-and-charger sets to the Contractor's frequency. The communication system chosen by the Contractor shall be compatible with the blasting method used.

601A.13 Surveying. In accordance with standard section 625 Construction Surveying, the setting out of the reference points, PGL and interior surface shall be supervised by a Professional Land Surveyor or Professional Engineer.

Perimeter Surface Surveys shall be completed and results submitted to the Engineer no more than six weeks after the full cross section of the Final Lining is installed at each location. Furthermore, the surveys shall be completed and results submitted to the Engineer no more than six weeks before project completion.

Survey methods shall meet the following requirements:

1. Cross-sections shall be at regular intervals of 25 feet or less and shall be perpendicular to the centerline of the tunnel.

2. Within each cross-section, surveyed or imaged points defining the cross-section shall be at intervals of six inches or less.

3. All points shall have an accuracy of 1 inch or better relative to the true surfaces.

4. There shall be no shadows in the surveyed/imaged cross-sections. The base point (instrument location) for surveying/imaging each cross-section shall be in the plane of the cross-section, not a point remote from the cross-section to avoid shadows from out-of-section features.

5. Cross-sections shall be for the entire surface perimeter including crown, sidewalls, and invert.

Submit the following to the Engineer:

1. Plotted cross-sections: Cross-sections shall be plotted at a true scale (without vertical/horizontal exaggeration) of 1 inch = 2 feet, unless approved otherwise by the Engineer. Plots shall show the surveyed/imaged cross-section, the Excavation Line, and the Design Line.

2. Point Listing: Tabular listing of required points presenting: point location; locations of the excavation line and initial support line; and differences between the point location and excavation and initial support lines. Point listings can, at the Contractor's option, be submitted in electronic form in Microsoft Excel compatible format. For situations, such as photographic imaging, in which discrete point locations are not applicable, the Contractor shall submit comparable data, plots, or images that present the position of the perimeter surfaces relative to the Excavation and Initial Support Lines with an accuracy of one inch or less.

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As an alternative to discrete cross-sections, the Contractor may at the Contractor's option, use rapid laser-scanning technology to create a near-continuous three-dimensional digital surface of the tunnel perimeter surface. If such a system is employed, surveyed results shall meet the same requirements as presented above for discrete cross-sections. For such a system, the requirement for instrument location to be in-plane with the cross-section will be waived, provided that the method and application are proven to not result in shadows from irregularities of the surface. Scans from multiple setups and multiple directions shall be used to achieve the required resolution and avoid shadows. For a near-continuous three-dimensional surface, the Contractor shall submit to the Engineer: 1) cross-sections as required above; and 2) either a Point Listing summary as presented above, or a digital map of the Perimeter Surface, Initial Support Line (Surface), and Design Line (Surface) in electronic format compatible with Microstation CAD software.

601A.14 Tunnel Access. The Contractor shall provide access for the Engineer to inspect and observe the work, as deemed necessary by the Engineer.

601A.15 Tunnel Drainage System. The Contractor is responsible for control of water in the Tunnel during construction and shall take all means necessary for such control. See Section 211A, Underground Excavation and Initial Support.

601A.16 Surface Preparation.

1. Non-geocomposite drain covered surfaces shall be prepared as necessary to accept the Final Lining including but not limited to power washing and brushing. Loose materials, mud, shotcrete rebound, overspray, and other foreign matter shall be removed from non-geocomposite covered surfaces on which the Final Lining is to be applied.

2. Geocomposite Drain covered surfaces shall be prepared as necessary to accept the Final Lining including, but not limited to, management of seepage water and light power washing. See Contract Plans for other requirements. The Contractor shall repair leaks and holes in the Geocomposite Drain before installation of the Final Lining.

601A.17 Tolerances. Cast in place liner shall extend no more than ½ inch inward or outward than the Interior Surface of the Cast-in-Place liner as shown on the plans.

METHOD OF MEASUREMENT

601A.18 Tunnel Final Lining will be measured by the units as shown in the basis of payment. The pay items will be measured and paid for by minimum theoretical quantities as shown on the Plans. Concrete required for overbreak and other types of waste and spill factors will be measured in accordance with terms of risk pool provisions defined in Section 109.

BASIS OF PAYMENT

601A.19 The accepted quantities as specified will be paid for at the unit price bid for the pay items below:

Payment will be made under:

8
SECTION 601A
FINAL LINING

Pay Item	**Pay Unit**
Final Lining Concrete (Portals)	Cubic Yard
Final Lining Concrete Footing	Cubic Yard
Final Lining Concrete Walls and Arch	Cubic Yard

Payment for Tunnel Final Linings will be full compensation for all formwork, installation of concrete, mudslab, waterstops, contact grouting pipes, contact grout, and all other work and materials necessary to complete the item in accordance with Subsection 109.02.

REVISION OF SECTION 601
MODIFICATIONS TO EXISTING BRIDGE

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

DESCRIPTION

Subsection 601.01 shall include the following:

This work shall include the installation of decorative concrete elements to existing functional bridge substructures or superstructures.

METHOD OF MEASUREMENT

Subsection 601.19 shall include the following:

Modifications to existing bridge superstructures or substructures will not be measured.

BASIS OF PAYMENT

Subsection 601.20 shall include the following:

Payment will be made under:

Pay Item	**Pay Unit**
Modifications to Existing Bridge	Lump Sum

Payment shall be full compensation for all incidental items and materials necessary to complete the work in accordance with the details shown in the plans.

REVISION OF SECTION 601 AND 708
STRUCTURAL CONCRETE STAIN (SPECIAL)

Section 601 and 708 of the Standard Specifications are hereby revised to include the following:

Subsection 601.01 is revised to include the following:

This work consists of: (1) Class 2 surface finish of concrete to receive Concrete Stain; (2) providing and applying an opaque structural concrete stain with high UV resistance to all concrete surfaces previously designated in the Contract to receive a structural concrete stain; and (3) provide up to 5-gallons of pre-mixed touch-up stain.

The color of the structural concrete stain shall be as noted on the plans, and shall be Approved by the Engineer from test panels provided by the Contractor.

Subsection 601.03 is revised to include the following:

Structural Concrete Stain as specified in subsection 708.08

Subsection 601.09(f) is revised to include the following:

All concrete forms shall be treated with a water based concrete form release agent prior to placing reinforcement for surfaces to which structural concrete stain is to be applied.

Subsection 601.14 (a), third paragraph, is deleted and replaced with the following:

Structural concrete stain shall be the final finish for all concrete surfaces designated on the plans and in these specifications.

Subsection 601 .14(b) 4 is deleted and replaced with the following:

Unless otherwise shown on the plans, the structural concrete stain shall be applied to all exposed concrete elements of the structure above the ground line, and shall extend 1-foot below the finished ground line. Bridge bearing devices, curb and barrier cover plates, fence, and steel bridge rail components shall be masked or otherwise protected to prevent structural concrete stain from coming into contact with them.

The color of the Structural Concrete Stain shall have the written approval of the Engineer prior to final batching and application on the project. The final color of the approved structural concrete stain shall be determined as follows:

1. 2 foot by 2 foot samples of the colors required by the Contract, shall be submitted to the Engineer for Approval. The Stain samples shall be applied to a surface similar in texture to the concrete surface on which the stain will be applied on the project. The Stain samples shall be applied by the same methods to be used in field application.

2. At least three weeks prior to beginning of the application of the structural concrete stain, 100 sf test panels shall be prepared for final color Approval. The test panels shall be produced on the actual concrete surface on which the final product will be placed, at a location recommended by the Contractor and approved by the Engineer. The stain shall be applied to the test panels by the same methods to be used in the final field application. The Engineer will be allowed three business days for the stain to dry after stain application to the test panels to issue Approval.

Concrete finishing and curing shall be completed in accordance with the specification prior to the application of the Stain. The concrete finish to which the structural concrete stain is to be applied shall be a Class 2 Finish, except as modified below:

2
REVISION OF SECTION 601 AND 708
STRUCTURAL CONCRETE STAIN (SPECIAL)

1. Following curing of the concrete in accordance with Subsection 601.13, all projections and bulges shall be removed and the surface sandblasted. Sandblasting shall profile the concrete surface, remove all form release agents, and all other deleterious materials that would inhibit the bond of the Structural Concrete Stain. The profile of the sandblasted concrete surface shall be equivalent to Concrete Surface Profile Three (CSP 3) as defined in Technical Guideline No. 03732, "Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays" by the International Concrete Repair Institute. The Contractor shall provide a CSP 3 chip for use on the project.

2. A mortar mix, proportioned by volume, consisting of one part portland cement, two to three parts sand (conforming to the requirements of ASTM C 144), and an approved bonding agent shall be used to patch all holes produced by form ties, honeycombing, voids 1/2 inch or larger in any dimension, broken corners and edges, and other defects. The mortar mix shall include an approved bonding agent. The quantity and application procedure of the bonding agent shall be in accordance with the recommendations of the manufacturer of the bonding agent. Areas to be patched shall be moistened with water before the mortar is applied, and the patched area, shall be float finished and left flush with the concrete surface without checking or cracking of patches. Patching shall be done when the ambient temperature is at least 40°F. Holes deeper than 3/4 inch shall be filled in layers that do not exceed 1/2 inch in thickness.

3. Within 24 hours prior to applying structural concrete stain, the concrete surface to be stained shall be cleaned by water blasting at a minimum pressure of 3,000 psi and at a rate of 4 to 14 gallons/minute, to remove dust, dirt, and other materials that would inhibit penetration of the stain. If the surface is contaminated before application of the stain, it shall be re-cleaned as required prior to application of the stain.

New concrete shall be at least 14 days old or as approved in writing by the stain manufacturer before the stain is applied.

Two applications of stain are required. Each application shall be applied at a rate of 100 to 200 square feet per gallon. (Approximately 3 mils dry film thickness.) The second application shall not be made within 1-4 hours of the first application if applied by spray, and 24 hours if applied by roller.

If the surface is contaminated between applications, it shall be re-cleaned as stated above prior to making the second application.

The stain shall be mixed mechanically and applied by spraying. Workmanship shall be such that the final stained surface is colored uniformly and presents a pleasing appearance. Any areas determined by the Engineer to be insufficiently stained shall be re-stained.

The stain shall be applied only when the ambient temperature is between 45°F and 100°F, and is anticipated to remain above 45°F for a minimum of twenty-four hours. The surface to be stained shall be dry and free of frost.

Subsection 601.19 is revised to include the following:

Structural Concrete Stain will not be measured, but shall be the surface area quantity shown on the plans; except that measurements will be made when field changes are ordered, or for an error of plus or minus 8 percent of the plan quantity for each structure to be stained.

Subsection 708.08 is revised to include the following:

3
REVISION OF SECTION 601 AND 708
STRUCTURAL CONCRETE STAIN (SPECIAL)

708.08 Structural Concrete Stain: The Stain shall be a one-component, non-vapor barrier, solvent based acrylic resin. No sand or other texturing agents will be permitted.

PHYSICAL PROPERTIES

Solid by Weight	48%, plus or minus 2%
Solids by Volume	34%, plus or minus 2%
Appearance:	Opaque/Stain
Gloss @ 60 degrees	10-20
Sheen @ 85 degrees	20-30
Flash Point	None
VOC	250 grams/liter maximum
Drying Time (to touch)	30-60 min.; 70 deg. F, 50-60% humidity

TEST PERFORMANCE

Water Vapor Transmission, ASTM E96	18.6 Perms
Salt spray resistance, ASTM B-117, 500 hours	Excellent
Freeze/Thaw, 50 cycles (FL DOT 400-15.2.6.7)	Pass
Water Absorption, ASTM C642	20x reduction
Weatherometer, ASTM G-153	5000 hour, no cracking, crazing or adhesive loss
Xenon Arc Accelerated Weathering, ASTM G26/G155	2500 hour, no cracking, crazing or chalking
Scaling Resistance, ASTM C672 (50 Cycles)	No defects
Chloride Ion Penetration Resistance, AASHTO T259/260	1/16” to 1/2” 82% reduction
Peel Resistance	Excellent
Chemical Resistance	Excellent

A material safety data sheet (MSDS) prepared in accordance with Federal Standard 313 and a complete set of manufacturers mixing and application instructions shall be submitted to the Engineer before the Contractor begins applying the Stain.

Subsection 601.19 shall include the following:

The quantity of Structural Concrete Stain to be paid for will not be measured, but will be the quantities shown on the plans in square yards, completed and accepted by the Engineer in compliance with the plans and specifications. Plan quantity exceptions will be: (1) when field changes are ordered, or (2) when it is determined that there are discrepancies on the plans in an amount plus or minus 8 percent of the plan quantity for the structure.

Subsection 601.20 shall include the following:

Payment shall be made at the applicable contract unit price for the Bid Item and shall include full compensation for all water-based form release agent, sample preparation, abrasive blasting, patching materials and application, structural concrete stain and application, labor, equipment, tools, and materials necessary to complete the work.

Pay Item	**Pay Unit**
Structural Concrete Stain (Special)	Square Yard

REVISION OF SECTION 602
REINFORCING STEEL (FINAL LINING)

Section 602 of the Standard Specifications is hereby revised for this project as follows:

Subsection 602.01 shall include the following:

This work shall also include reinforcing steel for the tunnel final lining as described in Section 601A Final Lining.

Subsection 602.03 shall include the following:

Reinforcing steel for the tunnel final lining shall be installed in accordance with the requirements of Section 601A Final Lining and Section 602 Reinforcing Steel.

Subsection 602.08 shall include the following:

Payment will be made under:

Pay Item	**Pay Unit**
Reinforcing Steel (Final Lining) (Footing) (Epoxy Coated)	Pounds
Reinforcing Steel (Final Lining) (Walls and Arch)	Pounds
Reinforcing Steel (Final Lining) (Walls) (Epoxy Coated)	Pounds

REVISION OF SECTION 602
WELDED WIRE FABRIC

Section 602 of the Standard Specifications is hereby revised for this project as follows:

Subsection 602.01 shall include the following:

This work shall also include welded wire fabric on this project for the purpose of providing initial ground support for tunnel excavation operations as described in Section 211A Underground Excavation and Initial Support.

Subsection 602.03 shall include the following:

Welded wire fabric shall be installed in accordance with the requirements of Section 211A Underground Excavation and Initial Support.

Subsection 602.07 shall include the following:

Welded Wire Fabric as specified herein will be measured by the square yard of wire fabric installed and accepted excluding laps. Anchors, supports and ties will not be measured for payment but shall be included in the square yard cost of the wire fabric.

Subsection 602.08 shall include the following:

Payment will be made under:

Pay Item	**Pay Unit**
Welded Wire Fabric	Square Yard

REVISION OF SECTION 603
REINFORCED CONCRETE PIPE

Section 603 of the Standard Specifications is hereby revised for this project as follows:

Subsection 603.02 shall include the following:

Reinforced concrete pipe shall be manufactured from concrete that meets the requirements for severity of sulfate exposure Class 0 specified in subsection 601.04.

REVISION OF SECTION 603
8 INCH PLASTIC PIPE

Section 603 of the Standard Specifications is hereby revised for this Project as follows:

Subsection 603.01 shall include the following:

This work also consists of the installation of a plastic pipe drainage system used for the containment of subsurface groundwater. Work shall be in accordance with these specifications and in conformity with the lines and grades shown on the plans or established.

Subsection 603.02 shall include the following:

Materials for 8 Inch Plastic Pipe as shown on the plans shall meet the requirements shown on the plans and in the following subsections:

Structure Backfill (#57 Aggregate)	703.08
Geotextile (Drainage) (Class 3)	712.08
Plastic Pipe	712.11 (PVC, non-perforated, smooth interior and exterior)

Fittings and bends shall be of the same material as the pipe and all joints shall be the weld-type.

Subsection 603.11 shall include the following:

8 Inch Plastic Pipe will be measured by the linear foot of pipe installed and accepted. Bends and fittings will not be measured separately for payment but shall be considered part of the linear footage of pipe measured.

Subsection 603.12 shall include the following:

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.

Pay Item	**Pay Unit**
8 Inch Plastic Pipe	Linear Foot

Payment for 8 Inch Plastic Pipe shall include all work and materials required to complete the item in-place, including excavation of any type, bedding, backfill, pipe joints and fittings, geotextile fabric, and HMA patching.

REVISION OF SECTION 603
8 INCH FLEXIBLE PIPE

Section 603 of the Standard Specifications is hereby revised for this Project as follows:

Subsection 603.01 shall include the following:

This work also consists of the installation of a flexible plastic pipe drainage field used for the dispersion of subsurface groundwater collected from underneath the tunnel structure. Work shall be in accordance with these specifications and in conformity with the lines and grades shown on the plans or established.

Subsection 603.02 shall include the following:

Materials for 8 Inch Flexible Pipe as shown on the plans shall meet the requirements shown on the plans and in the following subsections:

Filter Material (Class A)	703.09
Geotextile (Drainage) (Class 3)	712.08
Plastic Pipe	712.11 (polyethylene, perforated, corrugated)

Subsection 603.04 shall include the following:

(a) *Excavation for 8 Inch Flexible Pipe*. The trench shall be excavated to the dimensions and grade shown on the plans. Trench locations shown on the plans are approximate. Final layout of the trenches shall be as directed by the Engineer and shall generally adhere to the following criteria:

1. Construct the flexible pipe sections in approximately equal lengths, following the natural slope of the ground to drain away from Interstate 70 and toward Clear Creek.
2. All drainfield pipes shall lie complexly within the permanent drainage easement as shown on the plans and as located in the field.
3. Field stake locations of the pipe for approval prior to excavation.
4. Maintain a minimum of 12 inches of natural, undisturbed soil below the trench to bedrock. Probe the trench bottom as required to ensure sufficient bedding thickness.
5. Maintain the minimum cover over the pipe as shown in the plans.
6. Maintain a separation of at least 10 feet between adjacent trenches.
7. Avoid established shrubs and trees, keeping trenches out of the root systems where possible.

Subsection 603.06 shall include the following:

(a) *Placing 8 Inch Flexible Conduit*. Sufficient Geotextile (Drainage) (Class 3) shall be placed along the bottom and sides of the trench as shown on the plans to provide the required overlap over the top of the filter material. Filter Material (Class A) shall be placed in the bottom of the trench for its full width and length. Perforated flexible pipe shall be placed with the perforations down and the pipe sections shall be joined securely with the appropriate coupling fittings or bands. Joining or coupling pipe shall conform to the manufacturer's recommendations. After the pipe installation has been inspected and approved, the designated filter material shall be placed above the top of pipe as shown in the plans. Care shall be taken not to displace the pipe or the covering at open joints. The remainder of the filter material shall then be placed to the required height, the drainage geotextile folded over the top of the filter material, and the remainder of the trench backfilled.

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REVISION OF SECTION 603
8 INCH FLEXIBLE PIPE

Subsection 603.11 shall include the following:

8 Inch Plastic Pipe will be measured by the linear foot of pipe installed and accepted. Bends, fittings, geotextile, filter material and backfill will not be measured separately for payment but shall be considered part of the linear footage of pipe measured.

Subsection 603.12 shall include the following:

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.

Pay Item	**Pay Unit**
8 Inch Flexible Pipe	Linear Foot

Payment for 8 Inch Plastic Pipe shall include all work and materials required to complete the item in-place, including excavation of any type, bedding, backfill, pipe joints and fittings, geotextile fabric, and HMA patching.

REVISION OF SECTION 604
MANHOLE SPECIAL

Section 604 of the Standard Specifications is hereby revised for this Project as follows:

Subsection 604.01 shall include the following:

This work shall also include the construction of special manholes accordance with these specifications, and in conformity with the lines and grades shown on the plans or established.

Subsection 604.06 shall include the following;

Manhole Special will be measured by the complete unit including ring and cover.

Subsection 604.07 shall include the following:

The accepted quantity for Manhole Special 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**
Manhole Special	Each
Manhole Special (10 Foot)	

Structure excavation and structure backfill for Manhole Special will not be measured and paid for separately but shall be included in the work.

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REVISION OF SECTION 605
6 INCH PERFORATED PIPE UNDERDRAIN (SPECIAL)

Section 605 of the Standard Specifications is hereby revised for this Project as follows:

Subsection 605.01 shall include the following:

This work consists of constructing perforated pipe underdrains in accordance with these specifications and in conformity with the lines and grades shown on the plans or established.

Subsection 605.02 shall include the following:

Bedding and backfill for 6 Inch Perforated Pipe Underdrain (Special) shall be #57 aggregate conforming to the requirements of Subsection 703.08.

Geotextile for wrapping perforated pipe underdrain shall be Geotextile (Drainage) (Class 3) conforming to the requirements of Subsection 712.08.

Subsection 605.03 shall include the following:

(a) *Perforated Pipe Underdrain (Special).* The trench shall be excavated to the dimensions and grade shown on the plans. Perforations in the pipe shall be placed in the down position and the pipe sections shall be joined securely with the appropriate coupling fittings or bands. Joining shall conform to the applicable requirements of subsection 603.07 except as noted. Wrap the underdrain pipe such that there is a six-inch overlap of Geotextile (Drainage) (Class 3) at the top of the pipe and secure with bands or ties.

Place bedding material for the full width of the trench to the minimum bedding depth and place the pipe perforations down to the elevations as shown on the plans. Place backfill material to the springline of the pipe to secure it in place prior to inspection.

Where wyes and other fittings are required, pre-assemble them to the designated configuration and secure them in the trench prior to inspection.

After the pipe installation has been inspected and approved, the backfill material shall be placed over the pipe to the dimensions shown on the plans. Backfill material shall be placed in eight inch maximum lifts, tamping the material by hand to ensure no voids exist. Care shall be taken not to displace the pipe or cover any open joints. At cleanout locations, hold the backfill back until the cleanout pipe is installed and approved.

Subsection 605.07 shall include the following:

6 Inch Perforated Pipe Underdrain (Special) will be measured by the linear foot of underdrain pipe installed and accepted. Excavation, backfill and geotextile fabric will not be measured and paid for separately but shall be included in the cost of the work.

Subsection 605.08 shall include the following:

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.

Pay Item	**Pay Unit**
6 Inch Perforated Pipe Underdrain (Special)	Linear Foot

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REVISION OF SECTION 605
6 INCH PERFORATED PIPE UNDERDRAIN (SPECIAL)

Payment for 6 Inch Perforated Pipe Underdrain (Special) shall be full compensation for all work and materials required to complete the item including pipe, fittings and joints, drainage geotextile, securing devices, adhesives, sewn seams, excavation, and backfill material.

REVISION OF SECTION 605
GEOCOMPOSITE DRAIN (TUNNEL)

Section 605 of the Standard Specifications is hereby revised for this Project as follows:

Subsection 605.01 shall include the following:

This work also includes the installation of a groundwater control system for the final structural liner of the eastbound tunnel in accordance with these specifications and in conformity with the lines and grades shown on the plans or established.

Subsection 605.03 shall include the following:

(b) *Geocomposite Drain*. The geocomposite drain system will collect the seepage groundwater from the surrounding rock and convey it to drain pipes at the east tunnel portal. The Geocomposite Drains are the drainage sheets that are placed on the outside perimeter of the tunnel lining that will convey the seepage groundwater to the formation drains.

After the formation pipe is placed, the Geocomposite Drain shall be draped over the top of the pipe, wrapped around to the bottom of the pipe, and shall be in direct contact with the pipe as shown on the Plans such that water from the Geocomposite Drain has a free path to the pipe.

The porous concrete shall be placed after the pipe and Geocomposite Drains are installed to a minimum height of three inches above the top of pipe. Insure pipe shall not be displaced or floated during placement of the concrete. No reverse grades in the pipe shall be allowed. When placing the Porous Concrete, the Contractor shall not tear, crush or otherwise damage the Geocomposite Drains.

Subsection 605.04 shall include the following:

Geocomposite Drain shall be a geocomposite product consisting of a plastic, dimpled core layered with a geotextile fabric. Geocomposite Drain shall conform to subsection 712.12 unless specified otherwise herein.

The core shall be a solid-backed, single-dimpled product with a compressive strength at yield of at least 4,000 psf in accordance with ASTM D 1621.

Drainage Geotextile shall protect the geocomposite drain from damage, penetrations and the ingress of fines or concrete. Geotextile shall prevent rock face and other sharp objects from touching the geocomposite drain, and furthermore, the thickness of the geotextile shall be increased beyond the minimum specified herein as necessary to achieve this requirement. Geotextile shall be nonwoven having the following typical properties:

Property	Value	Test Method
Grab Tensile Strength	100 lbs. minimum	ASTM D-4632
Water Flow Rate	140 gpm/ft^2 minimum	ASTM D-4491
Weight	4 oz/yd^2 minimum	ASTM D-3776
Mullen Burst	200 psi minimum	ASTM D-3786
Apparent Opening Size	US Std Sieve # 70 or Smaller	ASTM D-4751

Additionally, the composite product shall have in-plane flow capacity of at least 10 gpm/foot at a gradient of 1 in accordance with ASTM D-4716.

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REVISION OF SECTION 605
GEOCOMPOSITE DRAIN (TUNNEL)

Geocomposite Drains shall be installed within the Tunnel in locations as shown on the Plans and along seeps and locations directed by the Engineer. Contractor shall secure Geocomposite to the shotcrete or rock surface as shown on the Plans with an approved mechanical fastener and washer.

Geocomposite Drain shall be a one-sided product with a solid (non-perforated) core and geotextile fabric on only the dimpled side of the core. The product shall be J-D Rain 400, Delta-MS or MS-20, Iso-Drain 20, or equivalent. The Geocomposite Drains shall be at least 3 feet wide and placed with the flat side of the semi-rigid drainage core toward the Final Lining and the dimpled side toward the Initial Support unless otherwise approved during the submittal process. Geocomposite Drains shall be hydraulically continuous. Where splices are required, continuity shall be made with a 9-inch minimum overlap such that the flow of water is not impeded. Furthermore, at overlaps, the lower Geocomposite Drains shall be inside the upper Geocomposite Drain to channel flow outside the lower Drain. The Contractor shall repair damage, which may interrupt the flow of water to the Geocomposite Drain.

Subsection 605.07 shall include the following:

Geocomposite drains will be measured by the square yard of surface installed and accepted based on the geocomposite applied at the design line shown on the Plans. Overbreak, overlap and other types of spill factors are considered incidental and will not be measured for payment.

Subsection 605.08 shall include the following:

The accepted quantity of Geocomposite Drain (Tunnel) 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**
Geocomposite Drain (Tunnel)	Square Yard

Payment will be full compensation for furnishing all materials, labor, tools, equipment, overlap and incidentals necessary to complete the item.

REVISION OF SECTION 605
FORMATION DRAIN

Section 605 of the Standard Specifications is hereby revised for this Project as follows:

Subsection 605.01 shall include the following:

This work also includes the installation of a formation drain system for the final structural liner of the eastbound tunnel in accordance with these specifications and in conformity with the lines and grades shown on the plans or established.

Subsection 605.03 shall include the following:

(c) *Formation Drains*. The formation drains will collect the seepage groundwater from the surrounding rock and convey it to drain pipes at the east tunnel portal. The Formation Drains are the pipes that are installed along the corners of the invert that will collect and convey the seepage groundwater from the geocomposite drains.

For Tunnel Perforated Formation Drain Pipe, a geotextile trench liner is required. After the pipe is placed, the Geocomposite Drain shall be draped over the top of the pipe, wrapped around to the bottom of the pipe, and shall be in direct contact with the pipe as shown on the Plans such that water from the Geocomposite Drain has a free path to the pipe. For the Tunnel Perforated Pipe porous concrete shall be placed to a minimum height of 1 inch above the top of pipe.

The porous concrete shall be placed after the pipe and Geocomposite Drains are installed. The pipe shall be installed such that it drains freely by gravity. The Contractor shall insure that the pipe is not displaced or floated during placement of the concrete. No reverse grades in the pipe shall be allowed. When placing the Porous Concrete, the Contractor shall not tear, crush or otherwise damage the Geocomposite Drains.

After installation, the Porous Concrete shall be tested for water penetration by dousing and observing the absorption as specified herein. The tests shall be conducted at a frequency of at least one test for every 25 feet of Formation Drain under the observation of the Engineer. Failure to meet the water absorption criterion defines Porous Concrete whose hydraulic efficiency has been severely impaired. Porous Concrete with severely impaired hydraulic efficiency shall be removed and replaced. The extents of removal shall be designated by the Engineer.

Porous Concrete shall have the following properties:

1. Aggregate: Uniformly graded coarse aggregate meeting the requirements of AASHTO M43 size No. 57. The aggregate shall contain no fine aggregate, sand, or fines.

2. Maximum aggregate size: 1.5 inches.

3. Cement: Type I or II Portland Cement

4. Porous Concrete shall have a hydraulic efficiency such that 1 gallon of water doused onto the surface of a 1 foot long section is totally absorbed within 1 minute.

5. Porous Concrete shall have a consistency such that it does not clog or flow into the perforations of the Perforated Pipe.

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REVISION OF SECTION 605
FORMATION DRAIN

Formation drain pipe shall be fully perforated such that water is able to flow into the pipe from below and above. The pipe shall have a minimum stiffness at 5 percent deflection of 46 psi. The pipe shall have an inlet area of 0.5 to 1.5 square inches per foot of pipe. If slotted openings are used, the width of slots in the pipe shall be between 0.125 and 0.25 inches. If circular openings are used, the diameter of the holes shall be between 0.125 and 0.25 inches. Couplings shall not protrude into the inside diameter of the pipe. Cleanouts, as shown on the Plans, shall be spaced at 200 feet.

Subsection 605.07 shall include the following:

Formation drain pipe will be measured by linear foot as shown of drain pipe installed and accepted based on the minimum theoretical quantities as shown on the Plans. Adjustments due to overbreak and other types of spill factors are considered incidental and will not be measured for payment.

Subsection 605.08 shall include the following:

The accepted quantity of Formation Drain 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**
Formation Drain	Linear Foot

Payment for Formation Drain shall include furnishing and installing all components of the system including, but not limited to, perforated pipe, including couplings, connections, cleanouts, geotextile, and porous concrete in the amount shown on the drawings.

Payment will be full compensation for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the item.

REVISION OF SECTION 606
GUARDRAIL TYPE 3 (SPECIAL) (FURNISH ONLY)

Section 606 of the Standard Specifications is hereby revised for this project as follows:

Subsection 606.01 shall include the following:

Contractor shall furnish extra sections of brown w-beam to CDOT Region 1 Maintenance for their replacement stockpile.

Subsection 606.02 shall include the following:

Material for w-beam rail shall comply with Subsection 710.05, and shall be galvanized and painted in accordance with the project special provision 519A, Hot Dip Galvanizing and Duplex Coating. Color shall match Federal Standard 595, Color #20059.

Subsection 606.03 shall include the following:

W-beam rail sections shall be delivered to the Region 1 maintenance yard in Hidden Valley.

Subsection 606.05 shall include the following:

W-beam rail shall be measured by the linear foot of rail purchased and delivered.

Subsection 606.06 shall include the following:

The accepted quantities will be paid for at the contract unit price for the pay item listed below.

Payment will be made under:

Pay Item	**Pay Unit**
Guardrail Type 3 (Special) (Furnish Only)	Linear Foot

Payment shall be full compensation for all labor, materials, and equipment required to purchase, galvanize, paint brown, deliver, and unload at the CDOT Region 1 maintenance facility in Hidden Valley.

REVISION OF SECTION 606
GUARDRAIL TYPE 7 (STYLE CD) (SPECIAL)

Section 606 of the Standard Specifications is hereby revised for this project as follows:

Subsection 606.01 shall include the following:

This work consists of the construction of concrete guardrail within the limits of the new eastbound tunnel and through the portal extensions in accordance with these specifications and in conformity with the details, lines and grades shown on the plans or established. The construction of the guardrail shall include the assembly and erection of all component parts and materials complete at the locations shown on the plans or as directed.

Subsection 606.02 shall include the following:

Precast barrier will not be allowed.

Hydrophilic (Swellable) Strip Waterstops shall conform to the requirements specified in Section 601A Final Lining.

Subsection 606.04(a) shall include the following:

Electrical conduit (plastic) embedded in the barrier shall be secured in a uniform, smooth alignment to prevent deformation and dislocation during the placement of concrete. Placement of the conduit will be inspected before concrete is placed.

Subsection 606.05 shall include the following:

Guardrail Type 7 (Style CD) (Special) will be measured by the linear foot along the centerline of the rail from end to end of completed and accepted rail as shown on the plans, excluding end anchorages, median terminals, and transitions.

Subsection 606.06 shall include the following:

The accepted quantities of guardrail will be paid for at the contract unit price for the type specified.

Payment will be made under:

Pay Item	**Pay Unit**
Guardrail Type 7 (Style CD) (Special)	Linear Foot

Payment for Guardrail Type 7 (Style CD) (Special) shall be full compensation for all work and materials necessary to complete the item including reinforcing steel, waterstop, and expansion joint material.

REVISION OF SECTION 607
FENCE (TEMPORARY) (SPECIAL)

Section 607 of the Standard Specifications is hereby revised for this project as follows:

Subsection 607.01 shall include the following:

Contractor shall furnish and install a fence between the detour and portal-to-portal access road to provide a visual screen for traffic viewing construction activities.

Subsection 607.02 shall include the following:

Fence (Temporary) (Special) shall be a chain link fence with a visual screen complying with the following:

1. Chain link fabric – Subsection 710.03
2. Fence posts – Subsection 710.07
3. Visual screen barrier shall be submitted to the Engineer for approval

Fence material need not be new; it may be previously used.

Subsection 607.03 shall include the following:

Fence (Temporary) (Special) shall be installed to the limits shown on the plans.

The fence shall be installed with foundations and bracing as appropriate to resist wind loads on the screen and ensure that the fence does not fall and present a hazard to traffic or workers.

The visual screen proposed by the Contractor for the Engineer's approval shall be of a type which will sufficiently block a driver's view of construction activities at the portal to prevent distraction.

Subsection 607.04 shall include the following:

Fence (Temporary) (Special) will be measured by the linear foot of chain link fence installed. End posts, line posts, line brace posts, and visual screen will not be measured and paid for separately, but shall be included in the work.

Subsection 607.05 shall include the following:

The accepted quantities will be paid for at the contract unit price for the pay item listed below.

Payment will be made under:

Pay Item	**Pay Unit**
Fence (Temporary) (Special)	Linear Foot

Payment shall be full compensation for all labor, materials, and equipment required to furnish, erect, maintain, remove, and dispose of all materials required.

REVISION OF SECTION 612
LOCATION MARKERS

Section 612 of the Standard Specifications is hereby revised for this project as follows:

Subsection 612.01 shall include the following:

DESCRIPTION

The work shall also include furnishing and installing location markers for identifying fiber optic cable and other utilities at locations shown on the plans.

Subsection 612.02 shall include the following:

MATERIALS

(c) *Location Marker (Fiber Optic) (Dome).* Location Marker (Fiber Optic) (Dome) shall be made of non-conductive high-density polymer, and shall be integrally white in color with an orange cap. All colors shall be stabilized against ultraviolet light such that they will not fade under continuous exposure to direct sunlight. The marker shall retain dimensional stability in temperatures ranging between -40º F and 175º F. In some instances when markers are installed on National Forest Service Lands the fiber optic marker shall be brown in color.

(d) *Location Marker (Utility) (Flat Slat).* Location Marker (Utility) (Flat Slat) shall be made of fiberglass reinforced composite, and shall be orange in color. The marker shall retain dimensional stability in temperatures ranging between -40º F and 175º F. In some instances when markers are installed on National Forest Service Lands the fiber optic marker shall be brown in color.

(e) *Concrete Footings.* Concrete footings for dome marker shall be 18 x 18 x 12 inches per project detail. Concrete footing shall be Concrete Class B and shall be in accordance with Section 601.

(f) *Location Marker Electronic (Ball).* Location Marker Electronic (Ball) shall be a Full Range Electronic Marker Ball operating at the frequency of 101.4 kHz for communication line locating. The electronic marker ball shall be compatible with a Dynatel cable locator. These electronic markers shall be installed within 12 inches of the lid of said pull box, manhole or open trench. Electronic Markers may be fabricated into the pull box or manhole.

Subsection 613.03 shall include the following:

CONSTRUCTION REQUIREMENTS

Location Marker (Fiber Optic) (Dome) shall be installed at appropriate Pull Box and Manhole (TMS) locations as shown on the plans to identify both the backbone fiber cable and lateral fiber cable. To additionally designate the fiber cable, intermediate markers shall be installed at 1000-foot spacing along the running line, as applicable.

The marker shall include a label with CDOT contact information and the designation of "FIBER OPTIC CABLE". The label shall have black lettering on an orange background. The label shall include the highway milepost of the Pull Box or Manhole (TMS). The mile post shall be to the nearest hundredth. This label shall be placed below the "FIBER OPTIC CABLE" warning label. In some instances when markers are installed on Forest Service Lands the dome marker label shall have black letting on a brown background. The Contractor shall provide the label submittal to the Project Engineer.

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REVISION OF SECTION 612
LOCATION MARKERS

Location Marker (Utility) (Flat Slat) shall be installed at utility pull box/manhole locations and utility point of service to identify both electric and telephone communication lines. Contractor shall designate the utility line with a marker installed mid-point between the utility point of service and the device.

The markers shall include a label with CDOT contact information and the designation of "ELECTRICAL CABLE" or "TELEPHONE CABLE". The label shall have black lettering on an orange background. In some instances when markers are installed on Forest Service Lands the flat marker label shall have black letting on a brown background. The Contractor shall provide the label submittal to the Project Engineer.

Location Marker Electronic (Ball) shall be installed inside each pull box, manhole or open trench at locations shown on the plan sheets. The Marker Ball shall be securely positioned for optimal output and prevent accidental removal.

The Contractor shall provide the Engineer with three copies of detailed As-Built drawings showing the installed locations of all markers and the associated utilities. These drawings shall include but not be limited to the following:

1. Type of location marker installed
2. Distances between location markers
3. Distances between pull boxes and manholes to ITS devices
4. The distance and location to each CDOT utility point of service connection source point which the local utility companies have provided, including electrical power, transformer source, and telephone pedestals.

Subsection 614.04 shall include the following:

METHOD OF MEASUREMENT

Location markers will be measured by the actual number of markers that are installed and accepted.

Subsection 614.05 shall include the following:

BASIS OF PAYMENT

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

Payment will be made under:

Pay Item	**Pay Unit**
Location Marker (Fiber Optic) (Dome)	Each
Location Marker (Utility) (Flat Slat)	Each

Payment will be full compensation for all work, materials and equipment required to place the markers at the locations shown on the plans, including excavation, backfill, and patching.

Concrete footings will not be measured and paid for separately but shall be included in the work.

REVISION OF SECTION 613
ELECTRICAL CONDUIT AND WIRING

Section 613 of the Standard Specifications is hereby revised for this project as follows:

Subsection 613.01 shall include the following:

The work also includes, but is not limited to, furnishing, delivering, storing, installing electrical conduits and wiring for all project elements except ITS, including identification, pull boxes, testing and placing into operation a complete lighting system in accordance with these Specifications and in conformance with the details, lines, grades, and locations shown on the Plans or established.

The work also includes furnishing and installing bonding and grounding in the tunnel and electrical equipment as indicated on the Plans, as well as grounding all electrodes and conductors.

The lighting system includes the following major components:

(a) *Tunnel Lighting Power System*, including associated terminal boxes, junction boxes, and wiring.

(b) *Tunnel Lighting Luminaires*, including all mounting and installation.

The Plans indicate the general arrangement of circuits, locations of devices, equipment, conduits, and other work. It is intended that the Plans and Special Provisions describe the work in its entirety; however, every item necessary for the installation may not be specifically shown or described.

The arrangement, position, and connection of wires, conduits, and apparatus shown in the Plans are diagrammatic but shall be followed as closely as possible. The Contractor shall coordinate the locations of equipment, fixtures, devices, outlets, and conduit to avoid interferences and to best fit with the details of job conditions.

(c) *Roadway Light Standards*, including luminaires, poles, arms, brackets, bases, foundations, control centers and powers sources.

Subsection 613.02(c) shall include the following:

1. *Liquidtight Flexible Metal Conduit* (LFMC). LFMC shall be 2-inch trade size. LFMC shall comply with UL-1 Listed and be standard weight, flexible, galvanized steel conduit with a heavy wall neoprene or polyurethane jacket. Fittings shall be galvanized steel designed for use with liquidtight flexible metal conduit and comply with UL Standard 514.

2. *Flexible Metal Conduit* (FMC). Shall not be used.

3. *Galvanized Rigid Conduit* (GRC). Galvanized rigid metal conduit shall be mild steel, hot-dip galvanized conduit complying with ANSI C80.1 and FS WW-C-581 and shall be UL listed.

4. *Fittings and Supports*. Fittings and supports shall comply with ANSI/NEMA FB-1.

5. *Junction Boxes*. Junction boxes used within the tunnel shall be galvanized cast-metal conduit bodies of the type, shape, and size, to suit each respective location and installation, constructed with threaded conduit ends, and include a removable and weatherproof cover with corrosion-resistant screws.

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REVISION OF SECTION 613
ELECTRICAL CONDUIT AND WIRING

Unless otherwise noted in these Specifications or shown on the Plans, all conduits shall be GRC. Elbows, bends, and similar offsets shall be made of full weight materials complying with the above and shall be coated and threaded the same as conduit. Threads for conduit, couplings, and fittings shall be full depth and clean cut. Conduit shall be 3/4-inch trade size or larger or as indicated on the Plans.

6. *Rigid Nonmetallic Conduit* (PVC). Rigid nonmetallic conduit (non-ITS) shall only be allowed exterior to the tunnel or as a future conduit (unused) embedded within Type 7 Guardrail and shall be Schedule 80 PVC conduit manufactured from ASTM D 1784 PVC in compliance with NEMA TC-2. PVC conduit shall be UL listed. Joints shall be solvent cement type. PVC elbows, bends, fittings, and adaptors shall be provided as required for a complete installation. Fittings shall comply with NEMA TC-3. Provide solvent cement as recommended by the conduit manufacturer. PVC shall not be used in the tunnel except as specified above.

7. *Wiring*. 600-volt wire and cable shall be copper, not less than 98 percent conductivity. Insulation shall be XHHW-2. Wire shall be stranded. All wire sizes shown are in American Wire Gauge sizes.

   All power wire shall be color coded as follows:

Conductor	**120 Volt**	**277/480 Volt**
Ungrounded	Black	Brown (ΦA)-Orange (ΦB)-Yellow (ΦC)
Grounded	White	Gray
Grounding	Green	Green

   Factory-fabricated metal connectors of the size, rating material type, and class required for each service shall be provided.

Lubricants for assisting in the pulling of jacketed cables shall be those specifically recommended by the cable manufacturer.

The lighting materials shall comply with the applicable standards of ASTM, NEMA, ICEA, and where applicable shall be UL listed.

Subsection 613.02 shall include the following:

(j) *Electrical Identification*. Wiring within the tunnel shall be identified with nameplates and labels, and shall be fabricated of the specified materials and constructed as follows:

Engraved Plastic Laminate Nameplates shall be a three-layer laminated plastic with minimum nameplate dimensions of 1-3/4 inches high by 5 inches wide. Lettering height for panel or equipment identifier shall be 3/8-inch. Remaining lines at 1/8 inch high with 1/8-inch spacing between lines.

Commercial Power identification shall be of white letters on a black background.

600 volt wire and cable markers shall be a permanent type sleeve.

(k) *Bonding and Grounding*. Bonding and grounding components shall be fabricated of the specified materials and constructed as follows:

1. Grounding Conductors:

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ELECTRICAL CONDUIT AND WIRING

A. In conduit: Stranded, insulated, copper as indicated on the Plans.
B. Buried: Stranded, bare, copper as indicated on the Plans.

2. All grounding materials and components shall be UL listed.

Subsection 613.03 shall include the following:

Obtain the prior approval of the Engineer before disconnecting or de-energizing any existing electrical feeder.

Handle all equipment carefully to prevent internal component damage, breakage, denting, or scoring of the finish. Do not install damaged equipment.

Store all equipment in a clean, dry space and protect from dirt, fumes, water, construction debris, and physical damage.

Provide auxiliary heaters, or store in a heated space, for any equipment that would be damaged by moisture condensation, such as electronic components, and contacts.

Contractor shall examine the areas and conditions under which electrical equipment is to be installed and notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work.

Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the Contractor and the Engineer.

(l) *Electrical Identification*. Nameplates, labels, and markers of the types specified above shall be installed as follows:

Surface Preparation: Degrease and clean surfaces to receive nameplates.

Application: Nameplates shall be secured to equipment front using adhesive. Nameplates and labels shall be installed as follows:

1. Electrical Equipment and Devices:

   A. Provide engraved plastic laminate nameplates on junction and pull boxes mounted inside tunnel. Text shall include panel name, designation, and electrical characteristic.

   B. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit of feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's Shop Drawings for control wiring.

2. Conduit and Raceways:

   A. Identify underground conduits using warning tape. Install one tape per trench at 12 inches above conduit.

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ELECTRICAL CONDUIT AND WIRING

B. The conduit of all feeders and branch circuits shall be properly designated at all panelboards, switches, and other equipment by a brass tag one inch in diameter, Seton, or approved equal. The lettering shall be black and 0.25 inch high. Doubled No. 18 Monel wire shall be used to secure tag.

(m) *Bonding and Grounding*. The bonding and grounding of the types specified above shall be installed as follows:

1. Install products in accordance with manufacturer's instructions.

2. Install rod electrodes at locations indicated.

3. Provide bonding to meet Regulatory Requirements and as specified herein.

4. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

Subsection 613.07 shall include the following:

All conduit runs shall be sloped a minimum of 0.25% (3 inches per 100 feet) for drainage.

Where a conduit size is not shown, size conduit for conductor type installed or for Type RHH/RHW conductors, whichever is larger. Conduit size shall be 3/4-inch minimum for surface mounted unless noted or required otherwise.

Route exposed conduit parallel and perpendicular to walls and adjacent piping.

Maintain minimum 6-inch clearance between conduit and piping.

Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using conduit straps or bolted split stamped hangers.

Group conduit in parallel runs where practical and use conduit supports constructed of stainless steel channel with stainless steel conduit clamps designed to provide the proper separation between the conduit and the tunnel surface.

Fasten conduit with approved stainless steel clamps before conductors are pulled. Do not use spring steel clips for conduit clamps. Remove all wire used for temporary conduit support during construction.
Support conduit at a maximum of 7 feet on center.

Install no more than the equivalent of three 90-degree bends between boxes. Adequately sized boxes shall be installed to meet this requirement whether specifically shown or not in the Plans.

Use conduit bodies to make sharp changes in direction, as around beams or corners.

Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 1-1/2 inch size.

Conduit offsets shall be properly made and installed where required. Where two or more conduit offsets or bends are installed in parallel, they shall be symmetrically formed and arranged.

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REVISION OF SECTION 613
ELECTRICAL CONDUIT AND WIRING

Wipe plastic conduit clean and dry before joining. Apply full even coat of primer and cement to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum. Additional installation procedures recommended by conduit manufacturer shall be followed.

Waterproof PVC stub-ups with duct-seal at light standard bases and pull boxes.

Conduit shall be supported on each side of conduit bends or fitting and not more than 2 feet away from any junction box, pull box, panelboard, switch, or control cabinet.

Conduit shall not be fastened to other conduits or pipes for support.

Conduit shall not cross equipment access hatch, but shall be routed to avoid such openings in wall or ceiling construction.

Conduits and conduit boxes shall be of such sizes and numbers and shall be so installed that the required number of conductors may be drawn in without injury or excessive strain. The Contractor will be permitted to increase the size of conduits and number of boxes, if it so desires, to facilitate a speedier and less complicated installation, however, such changes shall be at its expense.

Where fasteners are required in concrete floors, walls, or ceilings of the tunnel liner or outdoors, undercut type anchors shall be used unless noted otherwise.

1. The minimum allowable static anchor working load for existing concrete strength f'c = 3000 psi, shall be certified in writing as follows:

   Tension = 5500 lbs., Shear = 7200 lbs.

2. These values are based on a minimum 6-inch embedment into existing concrete.

3. The Type 316 stainless steel bolts, nuts, washers, and assemblies shall be supplied by one of the following manufacturer or an approved equal:

   A. HILTI Corporation
   B. Williams
   C. Marine Fasteners

4. All anchors supplied shall be from one manufacturer.

5. The bolts shall be installed by first drilling holes into existing concrete using manufacturer's required equipment and effectively cleaning loose material from the drilled holes. The Contractor shall exercise care in locating and drilling the holes so as to avoid damage to reinforcing steel bars and concrete.

6. The Contractor shall follow the installation procedures recommended by the manufacturer, including, but not limited to, the size and depth of hole for the required bolt size, the type of drilling and installation tools required, surface preparation, and anchor setting instructions.

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ELECTRICAL CONDUIT AND WIRING

7. The Contractor shall proof test a minimum 5 percent of installed anchors to above required tensile capacity. The testing shall be performed using a portable hydraulic unit specifically designed for such tests and which provides a scaled indication of the force of tension to which the anchor is being subjected. A gauge or chart recorder would provide an acceptable indication for this test. The Engineer shall be notified 24 hours in advance of the tests.

Neither wooden plugs inserted in concrete or masonry as bases for conduit fastenings nor are shall conduit or pipe straps welded to steel structures acceptable.

Conduit terminations in NEMA 4/4x and NEMA 12 enclosures, except those made in cast boxes or boxes that have threaded hubs, shall be made using galvanized or electro-plated malleable iron hubs, 'Bullet' hub by Thomas & Betts or approved equal.

The conduit identifying number shall be as shown on the Plans. Identification shall conform to Section 613, Electrical Identification.

Conduits routed within the tunnel or on the face of the portal shall be Rigid Steel Conduits (RGS).

Connections to equipment subject to vibration, calibration, periodic removal, or where specifically indicated or noted on the Plans shall be made with between 18 and 24 inches of liquid-tight flexible metal conduit.

In Subsection 613.08, delete the third paragraph and replace with the following:

Luminaires shall operate at 277 VAC single phase, 60 Hz.

Subsection 613.08 shall include the following:

Wire and cable shall not be installed until the raceway system has been completed. The equipment and method for the installation of wire and cable shall ensure that no cuts or abrasions in the insulation of protective covering or kinks in the conductors occur.

Wire and cable shall be pulled into the conduit with sufficient length remaining at the ends to conveniently make connections to all equipment or devices.

Where practicable, the minimum radius to which an insulated conductor shall be bent, whether permanently or temporarily during installation and shall be ten times the diameter over the outer covering. Manufacturer's recommendations requiring larger bending radii shall govern.

Where a lubricant is needed as an aid in pulling wire or cable, a non-conducting lubricant of cable-pulling compound approved by the wire and cable manufacturer and that is not injurious to the sheath or insulation shall be used. Oil or grease shall not be used for lubrication. Excessive pulling stresses will not be permitted. Pulling directions shall be used, which cause the least cable tension.

Wire connectors shall be provided for connecting conductors to terminal blocks. They shall be solderless, pressure type. Terminals shall be put on with a full compression pressure tool approved by the manufacturer of the terminals. Conductor ends shall be carefully stripped of insulation to avoid nicking the metal conductor.

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REVISION OF SECTION 613
ELECTRICAL CONDUIT AND WIRING

Power and control cable shall be continuous, with no splice permitted except in enclosed steel boxes provided for the purpose, or in manholes. Shipping length of power cable shall be equal to a circuit length or summation of various circuit lengths to minimize cable waste. Wire for lighting circuits may be spliced in outlet boxes and junction boxes by the use of approved waterproof pressure fittings. Splices will not be permitted in conduits. Wire in pull boxes shall be tied and neatly racked on the boxes' side in an approved manner. Supports shall be installed as required.

Wire connectors used for joining conductors shall be approved solderless, pressure type. They shall be furnished and installed as required for all splices, joints and connections, to render the connections mechanically and electrically secure, and shall be covered with an insulating material equal to that of the conductor insulation.

All power, control, and lighting cable shall be identified by nonmetallic tags machine stamped with identification symbols and securely fastened to the cable at points where they are clearly visible. Tags shall be attached to each cable at intermediate pulling points in junction boxes, pull boxes, points of entering or leaving cable tray or conduit, and where required at other access points. Each conductor shall be tagged at splices, devices, terminal blocks, and panels. Identification shall be in accordance with Section 613, Electrical Identification.

In Subsection 613.10, delete the second paragraph and replace with the following:

The Contractor shall operate the tunnel night lighting system continuously and the Level 1 and Level 2 lighting system from dawn to dusk for 10 consecutive days. The Contractor shall operate the nighttime roadway lighting system from sunset to sunrise for 10 consecutive days. If LED lamps, drivers, or photoelectric cells fail, they shall be replaced. This test will be considered complete once all components have been operated for 10 days.

Subsection 613.10 shall include the following:

Provide all instrumentation and labor required to conduct all tests recommended by the manufacturer, required by codes or laws, required by the Standard Specifications, and required herein.

Voltage: When the installation is complete and the system is in operation, check the voltage on the secondary side of each new transformer supplying power to project loads.

Perform an insulation resistance (Megger) test on all new 600-volt cables and conductors with respect to ground and between each conductor at 1000 VDC. Meggering shall be done after the cable is pulled, but before terminations are made. Minimum Megger test value shall be as follows on circuits with total single conductor length of:

1. 2000 feet and over – at least 6 Meg-ohms

2. Less than 2000 feet – at least 8 Meg-ohms

For each panelboard, record the amperes reading under fully loaded conditions and submit to the Engineer.

Separate readings shall be recorded for each of the following conditions:

1. Nighttime loads (Night Time lighting energized, Supplemental lighting off).

2. Dawn Level, (Night time lighting energized, low level (level 1) Supplemental lighting energized, High Level (level 2) Supplemental lighting off).

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ELECTRICAL CONDUIT AND WIRING

3. Daytime loads (All circuits energized).

4. Roadway lighting (All circuits energized during nighttime hours).

Perform all tests in the presence of Department personnel or their authorized representative. All test results shall be documented and submitted to the Engineer for approval.

Subsection 613.11 shall include the following:

Electrical identification will not be measured and paid for separately but shall be included in the cost of the item which they identify.

Rod electrodes, grounding connectors, grounding conductors and associated components described herein, and the installation thereof will not be measured and paid for separately but shall be included in the lump sum cost for Wiring. Included in the term "associated components" are all equipment required to perform the complete installation of bonding and grounding as described herein.

Subsection 613.12 shall include the following:

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**
1 Inch Electrical Conduit	Linear Foot
2 Inch Electrical Conduit	Linear Foot
3 Inch Electrical Conduit	Linear Foot
4 Inch Electrical Conduit	Linear Foot
2 Inch Electrical Conduit (Plastic)	Linear Foot
3 Inch Electrical Conduit (Plastic)	Linear Foot
2 Inch Electrical Conduit (Liquidtight Flexible Metal)	Linear Foot
Wiring	Lump Sum

Terminations and associated components and incidentals and the installation thereof shall be included in the Work. Included in the term "incidentals" are all pulling compounds and equipment required to perform the complete installation and testing for the tunnel wiring system. Weatherheads will be considered incidental to the cost of the conduit.

REVISION OF SECTION 613
ELECTRICAL CONDUIT (ITS)

Section 613 of the Standard Specifications is hereby revised for this project as follows:

DESCRIPTION

Subsection 613.01 shall include the following:

This work consists of furnishing and installing liquidtight flexible metal conduit for above-ground ITS applications when transitioning from underground conduit to a pole-mounted cabinet or device.

This work also includes furnishing and installing either HDPE or PVC electrical conduit for ITS project elements. All materials furnished, assembled, fabricate and installed under this item shall be new, corrosion resistant and in strict accordance with the plan sheets and these Special Provisions.

MATERIALS

Subsection 613.02 shall include the following:

(n) *Liquidtight Flexible MetalCconduit (LFMC) for ITS*. All underground-to-aboveground ITS and aboveground ITS conduit installations shall utilize liquidtight flexible metal conduit (LFMC) as indicated on the Plans. LFMC shall meet UL safety standard UL 6 Electrical Rigid Metal Conduit - Steel and be manufactured to ANSI C80.1 Electrical Rigid Steel Conduit (ERSC).

Conduit directional changes from a vertical orientation to a horizontal orientation shall be accomplished through the use of a Type "LB" conduit bodies as called out in the Plans. The Type "LB" conduit bodies shall be fitted to accommodate the thread on 2" diameter RMC. Each Type "LB" conduit body shall come equipped with a cover, preassembled gasket and hardware to secure the cover to the body. The cover shall be removable to facilitate fiber optic cable pulling and future cable maintenance. Malleable iron conduit bodies and covers shall utilize a zinc electroplate finish.

All conduit transitions shall be constructed in a smooth and gradual manner as directed by the Engineer. Conduit sweeps into pull boxes and splice vaults shall be installed to facilitate pulling fiber optic cable directly through the pull box or splice vault.

Prior to installation, the specifications for all conduit types, couplings, fittings, elbows, L-bends, mounting hardware, conduit plugs , sealing plugs, pull tape, warning tape and curb markers shall be submitted to the Engineer for written approval.

(o) *Plastic Conduit for ITS*. All conduit shall be Schedule 80 in the diameters, quantities and colors as shown on the project detail sheet and shall be compliant with all ASTM and Bellcore TW-NWT-000356 requirements.

All HDPE conduit shall be factory lubricated, low friction, high-density conduit constructed of virgin high-density polyethylene resin. Conduit shall be capable of being coiled on reels in continuous lengths, transported, stored outdoors, and subsequently uncoiled for installation, without affecting its properties or performance.

PVC conduit shall be certified by the manufacturer as meeting ANSI/UL 6 and 651. The manufacturer shall be ISO 9000 compliant.

Electrical Conduit (Bored) shall be HDPE and installed using a trenchless technology of directional boring.

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REVISION OF SECTION 613
ELECTRICAL CONDUIT (ITS)

Electrical Conduit (Plastic) shall be PVC or HDPE and installed by direct burial methods such as plowing, open trenching, or other excavation methods.

Each individual conduit shall be equipped with a pull tape as described below. Each bore or trench shall have a copper tracer wire of at least 12 gauge in one of the conduits.

Each individual conduit shall be equipped with pull tape. The pull tape shall have a minimum tensile strength of 1800 lbs. and be of a design and manufacture that prevents cutting or burning into the conduit during cable installation.

The installation of conduit shall be performed in such a manner as to avoid unnecessary damage to streets, sidewalks, utilities, landscaping, and sprinkler systems. Excavations and conduit installation shall be performed in a continuous operation. All trenches shall be backfilled by the end of a shift. The material from trenching operations shall be placed in a location that will not cause damage or obstruction to vehicular or pedestrian traffic or interfere with surface drainage.

The following conduit colors shall be used so that the contents can be easily identified:

1. 2-inch conduit for CDOT fiber – Orange
2. 2-inch conduit for power – Red
3. 2-inch conduit for other – Black

CONSTRUCTION REQUIREMENTS

Subsection 613.03 shall include the following:

Liquidtight Flexible MetalCconduit (LFMC) for ITS

All conduit installation shall conform to the requirements of the following NEC sections as applicable:

1. NEC Article 356 LFMC

All RMC shall be installed to permit expansion and contraction per the manufacturer's requirements without causing damage to the structure, junction box, fiber optic cable or other elements. The Contractor shall submit to the Engineer for approval the design of all installation materials and methods that are proposed prior to installing the conduit, hangers, anchors and other elements.

Contractor shall drill a hole in the bottom of the pole-mounted VMS cabinet, the LFMC shall connect to this opening and the connection shall be sealed.

Plastic Conduit for ITS

The Contractor shall take all necessary precautions to avoid heaving any existing asphalt/concrete mat or over-excavating a trench, whether caused by equipment directly or by dislodging rocks and boulders. Any such heaving or over-excavation shall be repaired or replaced at the Contractor's expense. The Contractor shall bear the cost of backfilling all over-excavated areas with the appropriate backfill material as approved by the project engineer.

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REVISION OF SECTION 613
ELECTRICAL CONDUIT (ITS)

The Contractor shall restore all surface materials to their preconstruction condition or better, including but not limited to pavement, sidewalks, sprinkler systems, landscaping, shrubs, sod, or native vegetation that is disturbed by the conduit installation operation. All repairs shall be included in the cost of the conduit.

If the Contractor is unable to bore the conduit at the lengths shown on the plans from access point to access point, all splice couplings and associated work to splice conduit shall be included in the cost of this item. The coupling technology shall allow the conduit to be connected without the need for special tools, and shall form a watertight, airtight seal. Breaking force between segments shall exceed 250 pounds of force. No metal fittings shall be allowed. No elevation difference between the conduit run and the splice location will be allowed. Conduit splices shall be kept to a minimum and all locations shall be approved by the project engineer. Additional pull boxes shall not be substituted for splices.

Conduit plugs shall be supplied and installed in all conduit ends as soon as the conduit is installed. Conduit shall be plugged at all termination points such as pull boxes, manholes, controller cabinets, and node buildings. All plugs shall be correctly sized to fit the conduit being plugged. Empty conduits shall be sealed with removable mechanical type duct plugs that provide a watertight barrier and are equipped with a rope tie on the inside end for connection of the pull tape. No foam sealant will be allowed. All plugs and sealant shall be approved prior to construction.

All conduits shall use sweeps to elevate the buried conduits to the final grade within a pull box or manhole, as shown in the plans. The sweeps shall be terminated within the pull boxes and manholes to allow for easy installation and removal of the conduit plugs. The sweeps shall be set above the ground surface within the pull box at a height that does not interfere with the coiling of the fiber optic cable.

All conduit runs are intended for the future installation of fiber optic cable and shall have a limited number of bends. The sum of the individual conduit bends on a single conduit run between two pull boxes shall not exceed 270º. No individual bend shall be greater than 45º. All conduit bends shall have a minimum acceptable radius of 30 inches.

If new conduits are installed in existing pull boxes, manholes or cabinet bases the Contractor shall carefully excavate around the pull box or manhole and install the new conduit as shown in the plans. The Contractor shall not damage the existing pull box, manhole or their contents. If the existing pull box, lid, or the concrete collars are cracked or damaged during conduit installation, the Contractor shall restore the damaged section to preconstruction condition at no additional cost.

Subsection 613.10 shall include the following:

Electrical Conduit will be measured by the actual number of linear feet that are installed and accepted. Conduit shall also include anchors, bands, skids, sweeps, pull tape, copper tracer wire, adapters, fittings, conduit plugs, installation equipment, splice couplings, mounting brackets and hardware, structure anchors, adhesives, labor, and all other items necessary to complete the work.

METHOD OF MEASUREMENT

Subsection 613.11 shall include the following:

Electrical Conduit contract unit price shall be full compensation for work described above, specified in the plans, and complete and in place.

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ELECTRICAL CONDUIT (ITS)

BASIS OF PAYMENT

Subsection 613.12 shall include the following:

Payment will be made under:

Pay Item	**Pay Unit**
2 Inch Electrical Conduit (Liquidtight Flexible Metal)	Linear Feet
2 Inch Electrical Conduit (Bored)	Linear Foot
2 Inch Electrical Conduit (Plastic)	Linear Foot

REVISION OF SECTION 613
LIGHTING

Section 613 of the Standard Specifications is hereby revised for this project as follows:

Subsection 613.01 shall include the following:

This work also consists of furnishing, installing, wiring, and testing the tunnel and approach lighting system complete with luminaires, lamps, poles, arms, mounting brackets, junction boxes including all miscellaneous conduit, hardware, and all other equipment and materials required to install the luminaires completely and operable as specified herein and as shown on the Plans.

(a) *Applicable Publications*. The publications listed below form a part of these Specifications to the extent referenced. The publications are referenced in the text by basic designation only. Materials and workmanship shall be in accordance with the following standards and codes to the extent specified herein. Unless otherwise indicated, the issuance or date of applicable standards and codes at the time the request for proposal is issued shall govern.

1. American Architectural Manufacturers Association (AAMA) Publications:

   A. 2605 Superior Performing Organic Coatings on Aluminum Extrusions and Panels

2. American National Standards Institute (ANSI) Publications:

   A. C2 National Electrical Safety Code
   B. C37 Seismic Testing of Relays
   C. C81 Electric Lamp Bases and Holder
   D. C82 Fluorescent and High Intensity Discharge Lamp Ballasts
   E. C136-10 Standard for Roadway Lighting Equipment, Locking-Type Photocontrol Devices
   F. C136-14 Standard for Roadway Lighting, Enclosed Side-Mounted Luminaires for Horizontal Burning High Intensity Discharge Lamps
   G. C136-15 Standard for Roadway Lighting, High Intensity Discharge and Low Pressure Sodium Lamps in Luminaires Field Identification
   H. C136-22 Standard for Roadway Lighting, Internal Labeling of Luminaires
   I. C136-31 Standard for Roadway Lighting Equipment Luminaire Vibration

3. ASTM International, Inc. (ASTM) Publications:

   A. D522 Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
   B. D714 Standard Test Method for Evaluating Degree of Blistering of Paints
   C. D1654 Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
   D. D3359 Standard Test Methods for Measuring Adhesion by Tape Test

4. International Electrotechnical Commission (IEC):

   A. EN 60598 Degrees of Protection provided by Enclosures (IP Code)

5. Institute for Electrical and Electronic Engineers (IEEE) Publications:

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A. National Electrical Safety Code

6. Illuminating Engineering Society of North America (IESNA) Publication:

A. HB-10 IESNA Lighting Handbook
B. RP-8 Practice for Roadways
C. RP-16 Nomenclature and Definition
D. RP-22 Practice for Tunnel Lighting
E. LM-31 Photometric Testing of Roadway Luminaires Using Incandescent Filament and High Intensity Discharge Lamps
F. LM-63 Standard file format for Electronic Transfer of Photometric Data
G. LM-71 Photometric Measurements of Tunnel Lighting Installations
H. LM-79 Photometric Measurement of Solid State Lighting Products
I. LM-80 Measuring Lumen Maintenance of LED Sources
J. TM-15 Lighting Classification
K. TM-15 BUG Ratings Addendum

7. National Fire Protection Association (NFPA) Publication:

A. 70 National Electrical Code
B. 502 Standards for Road Tunnels, Bridges, and Other Limited Access Highways

8. National Electrical Manufacturers Association (NEMA):

A. 250 Enclosures for Electrical Equipment

9. Underwriters Laboratories Inc. (UL) Publications:

A. 467 Grounding and Bonding Equipment
B. 1029 High Intensity Discharge Lamp Ballasts
C. 1598 Standard for Luminaires

(b) *Submittals*. Submittals shall consist of a package received in hard copy (unless otherwise noted) that consisting of the necessary information illustrating compliance with the Warranty Requirements, Test Requirements, Shop Drawings, Component Data, and Samples. All submitted information shall employ the terminology, classifications, and methods prescribed in *Applicable Publications*. Failure to provide the following information with the submittal will give cause to reject the submission in its entirety and be returned incomplete without supporting comments. All submittals shall be returned in hard copy form with a status of "Approved" or "Approved as Noted" prior to any production of any product defined in this Section.

1. Warranty Compliance: The Manufacturer shall provide in written form as part of the submittal process the willingness to comply with the Warranty specified in this document.

2. Test Data: Manufacturer will provide all test data defined under *Testing* with the submission. Information required; photometric reports, paint adhesion and finish tests, *water spray testing* (tunnel fixtures only), and vibration tests. For the initial submittal, preliminary (pre-production) in-house testing will be allowed; however, the Engineer reserves the right to request additional tests on post-production product to ensure compliance with these Specifications.

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3. UL Listing: Manufacturer will provide supporting UL Listing information with the submission.

4. Shop Drawings: Shop drawings shall be submitted for the each luminaire type, including complete fabrication and assembly drawings, mounting brackets, bills of materials and assembly drawings for all luminaires being submitted.

5. Component Data: Manufacturer's data shall be submitted for each luminaire type (if applicable); housing, lens frame, latches, LED Modules, printed circuit board, driver(s), fuses and fuse holders, pin and socket (quick-disconnect) connectors, SO Cord and SO Cord Connectors (M&F).

6. Catalogue cuts for all products and components.

7. Mounting Equipment: Manufacture's data shall be submitted for the mounting channels, hardware, anchors, and brackets proposed to mount the tunnel lighting fixtures as shown on the Plans.

8. Samples: With the Shop Drawings, submit a sample luminaire of each style, mounting and Lamp and or LED PCB configuration specified. Reports indicating that all required tests specified have been successfully completed shall accompany each pre-production sample at the time it is submitted. All samples will become the property of CDOT and be used to confirm quality conformance to the prescribed requirements herein. Provide access for factory inspection, for two representatives of the Department, during initial production runs of tunnel roadway luminaires at no cost to Department. Finishes, pre-treatments, and colors for the samples shall be identified. Do not begin processing of production materials until Engineer's written acceptance of samples has been obtained.

9. Calculations: Luminaire Manufacturer to provide a computerized calculations detailing the entire area(s) to be illuminated by the submitted luminaires detailing a statistical summary of maintained Illumination levels using a light loss factor (LLF) of 0.55 per the spacing(s), mounting height(s), and details defined in the Contract Documents. The calculations shall show that the submitted luminaires will meet the criteria defined in these Specifications. The calculations shall conform to guidelines for performing tunnel calculations as defined in IESNA RP-22-11. The submitted information shall be provided to the Engineer, in hard copy and electronic form, for all calculations. All calculations shall be provided using the AGI32 program and submitted in the format from which the calculations are derived. The files shall be submitted, at no cost to the Project, on a CD-ROM or on Flash Media for record purposes directly to the Engineer with each submission. The Engineer shall be the sole judge as to acceptability.

(c) *Testing*. The Engineer reserves the right to order such tests as it deems necessary to ensure compliance with these Specifications and to reject those luminaires failing such tests or those luminaires with improper or inadequate light distribution or construction quality. The Engineer shall be the sole judge as to acceptability. The Engineer shall have the right to request testing of preproduction samples or to randomly select a luminaire or luminaires of each type from the project's production lot at either the Manufacturer's plant or job site; this choice shall be of sole discretion of the Engineer. The Contractor shall then deliver the luminaire(s) to a recognized independent testing laboratory that is acceptable to the Engineer.

All tests (photometric, paint adhesion, water and dust intrusion, and vibration) shall be either performed by an independent testing facility acceptable to the Engineer or in front of the Engineer. It is the Contractor/Manufacturer's responsibility to inform the Engineer 3 weeks prior to testing as to the testing process they intend on using. If the Contractor/Manufacturer chooses to perform the test(s) in house in the presence of the

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Engineer, all travel expenses incurred by the Engineer shall be considered testing costs and shall be paid for directly by the Contractor/Manufacturer and will be deducted from the most recent Project invoice.

The certified results of these tests shall then be forwarded directly to the Engineer. If one or more luminaires in each group fail to meet the criteria of the Engineer, the Contractor shall deliver two additional luminaires, chosen by the Engineer, for testing. Additional groups of two luminaires shall be delivered until one group fully passes all tests. No rejected luminaires may be used on this Project. All testing shall be at the sole expense of the Contractor/Manufacturer.

1. Photometric Test(s): A hard copy photometric report, completed in accordance with the appropriate IESNA testing procedure, shall be accompanied with a CD/DVD or flash media that includes the data in IESNA format for each fixture type submitted. All tests submitted must have been completed within the past 3 years.

   The photometric report must include:

   A. Iso-Illuminance Diagram (20-foot mounting height – no tilt). Diagram to include horizontal illuminance, 1/2 maximum candela trace and maximum candela point.
   B. Candela distribution tabulation.
   C. Coefficient of utilization and flux distribution analysis.
   D. Maximum plane and maximum cone of candela.

2. Paint Adhesion and Finish Test(s): The Manufacturer shall submit a sample piece of each cast or fabricated part(s) for testing. The Manufacturer shall use the same preparation treatment, the same paint, and the same method of application the submitted luminaire shall receive. All test samples shall be submitted to the Engineer for review and acceptance after testing has been completed.

   Tests shall include the following:

   A. Castings: Test Method B of ASTM 3359, Rating shall be 5B. This includes the housing, doorframe, and latch(s). Test shall be performed in 4 locations on the sample.

   B. Fabricated Parts: All exposed fabricated parts shall be subjected to the following tests (Tests shall be performed in 4 locations on the sample):

      (1) AAMA 2605 - 7.4 Film Adhesion.
      (2) AAMA 2605 - 7.5 Impact Resistance.
      (3) The flexibility of the finish shall withstand a 180-degree bend over a 1/4-inch mandrel diameter without loss of adhesion or cracking.

   C. Castings and Fabricated Parts: All exposed parts, castings or fabricated, shall be subjected to the AAMA 2605 – 7.8 Corrosion Resistance Test. The part shall not exhibit any blistering or pealing after 200 hours of testing.

   D. All aluminum parts of the fixtures including any mounting hardware shall be subject to the test requirements for ASTM B 117 and ASTM D 1654 by an independent A2LA accredited laboratory.

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3. Dust and Water Intrusion Test(s). The test data and results shall be completed in writing and shall be submitted to the Engineer for review and concurrence. If the proposed luminaire has been subject to a witnessed test as defined within the past 2 years, provided past results to determine whether additional testing is required.
   Each luminaire shall be submitted to the testing requirements defined in IES 60598 illustrating the ability to meet or exceed an IP66 rating.

4. Vibration Test. While attached to its mounting plate, the complete luminaire (same luminaire), with LED lamps and drivers installed, and shall successfully pass a vibration test at 2 g loading for 100,000 cycles in two of the three major axes and a 4 g test for 5000 cycles in one axis chosen by the Engineer. At the end of the test, the luminaire shall then be energized to illustrate that no failure to the electrical components has been experienced.

   Note: as an alternative test, the Contractor/Manufacturer shall submit the results of the luminaire submitted to the ANSI 136.31. However, the same luminaire and mounting plate shall be sued in all planes of test.

(d) *Warranty*. The Manufacturer shall provide written confirmation of willingness to comply with the following product warranty:

1. Manufacturer(s) agrees to repair or replace luminaires and/or components there-of as well as LEDs and Drivers that fail in materials or workmanship; corrode; fade, stain, chalk due to effects of weather, vibration or solar radiation.

   a. This warranty period shall be a minimum of ten (10) years from date of Installation. The manufacturer is to provide a statement to the engineer that installation of their equipment meets their installation guidelines as outlined in item number 2 of this section.

   b. This Warranty shall included field labor and service charges related to the repair or replacement of the Product for five (5) years from the date the product is installed..

   c. In the event of a systematic failure during the first ten (10) years that affects more than 10% of the luminaires or their component parts. All material, required to make the correction, will be repaired or replaced at the Seller's discretion. All labor shall be at a negotiated rate as agreed between the Seller and End User or Contractor.

2. For Warranty Purposes, the manufacturer, or their representative has the right to perform periodic reviews of the installation to insure that the supplied products have been installed in accordance to their installation guidelines. Deviations from the installation guidelines shall be reported to the engineer for correction by the Installing Contractor.

(e) *Handling and Delivery*. Ship luminaires and accessories securely packaged and labeled for safe handling in shipment and to avoid damage or distortion. Store luminaires and accessories in secure and dry facility and in original packaging in a manner to prevent soiling, physical damage, wetting, or corrosion prior to installation.

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Provide for storage inspection by Engineer after luminaires, electrical equipment, and accessories have been delivered. This inspection is at no additional cost to the Department. All cartons shall be clearly marked with the proper identification of Manufacturer, catalogue number, luminaire designation, and proper storage/handling instructions.

(f) *Manufacturer's Experience Record*. The Contractor shall submit proof to the Engineer that the Manufacturer of the proposed tunnel roadway luminaires (Type's D1, N1) has been manufacturing similar fixtures to those specified herein, for use in a vehicular tunnel environment, for a minimum of 5 years and has a proven satisfactory performance record. Certification will be required of the 5-year manufacturing history and of a satisfactory performance record. Tunnel luminaire submittals will not be reviewed until the Manufacturers experience record has been deemed acceptable. The Engineer shall be the sole judge as to acceptability. All fixtures submitted shall be similar to the specified "Cree THE EDGE LED Transportation" Luminaire. Manufacturers known to have a satisfactory 5-year history are Cree Lighting, General Electric Lighting Systems, and Schreder. Submissions from Manufacturers other than those listed will be reviewed but must provide an acceptable experience record (NO EXCEPTIONS).

Subsection 613.02 shall include the following:

General Requirements. All materials, equipment, and devices shall, as a minimum, meet the requirements of UL where UL standards are established for those items and the requirements of NFPA 70. All equipment and materials provided shall be new. All assembled luminaires shall bear the Underwriters' UL1598 Wet Location (direct spray) Label appropriate to location applied on the Contract Drawings. Locations of luminaires are shown diagrammatically on the Contract Drawings. Contractor shall verify exact locations in the field and notify the Engineer about field conditions at variance with the Plans before commencing installation.

Inclusive of the submittals listed above, the Manufacturer shall provide verification of the UL Listing as Underwriters Laboratories lists it (e.g.: Listing sheet provided to the Manufacturer upon acceptance.)

Unless otherwise noted, all gaskets shall be extruded of a silicone designed to provide the necessary protection against water intrusion. All shapes used shall completely cover the flange to which the gasket is affixed. Gasket shall meet the UL Pull Test and not be able to be pulled from its affixed position.

All luminaire surfaces shall be painted inside and outside. Painted finishes of fixtures and accessories shall be applied such that the entire assembly is rendered completely corrosion resistant for the service intended. Once the finish is applied, no additional holes will be acceptable.

Where aluminum parts come in contact with other parts of dissimilar materials, whether painted or not, both surfaces shall receive a coating of acceptable corrosion protection coating, or a neoprene gasket shall be provided for use between the surfaces.

Whether internal or external, all components, mounting brackets, driver/ballast trays, door hinges, and latches, shall be Type 316 stainless steel. The Manufacturer can request to use and alternative non-corrosive materials by means of supporting technical documentation illustrating the benefits of using the alternate material. The Engineer shall be the sole judge as the acceptability.

All fixtures shall be free of light leaks.

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All LED fixtures shall be designed to provide the appropriate heat dissipation for LEDs and driver to operate at component Manufacturer's recommended conditions.

Luminaires shall be furnished complete, of the type specified herein, and shall conform to fixture dimensions shown on the Plans.

Wiring channels and PCB mountings shall be rigid and accurately made.

Reflector material (if required) shall be pre-finished aluminum, minimum thickness 0.032 inch, architectural type 1 with class M1, ANODIC coating providing 83 percent reflectivity.

All Luminaires to have a minimum IP66 Rating, the luminaire is the entire luminaire assembly including, but not limited to, all mounting hardware, mounting brackets, power and control cords, fittings, and adapters.

Finishes. Unless otherwise stated all aluminum pieces that make up a luminaire assembly shall have an ASTM Standard D 1654 Rating of 4 or better as to not have a corrosion creepage greater than 6 millimeters.

All aluminum components shall be cleaned and treated utilizing the Alodine 5200 product procedures. The base coat shall be a PPG 590-534 Cathodic Epoxy E-coat applied 0.08 to 1.20 mil (2.03 to 30.48 microns) in a single coat application, followed with a TGIC Powder coat applied to 2.0 to 4.0 mil (50.8 to 101.6 microns) of the approved RAL color in a single coat application.

Electrical Components. Electrical components shall consist of the highest grade of materials normally found in the marketplace. Manufacturer is responsible for all compatibility testing between components.

Lampholders and lamp sockets shall be vibration resistant and hold lamps securely.

Wiring channels and socket mountings shall be rigid and accurately made.

Ballast(s). Ballast operating characteristics shall comply with the requirements of the lamp Manufacturer with regard to lamp electrical characteristics. When available, all ballasts shall be a lag-type regulator type. Provide ballasts suitable for the line voltage with 0.9 power factor, and maximum current crest factor of 1.8. The ballast shall provide reliable lamp starting at the minimum temperature indicated, and operate in ambient temperatures up to 40 degrees C. Ballasts shall be capable of starting and operating the lamps at a minimum temperature of minus 40 degrees C. The ballast shall be securely mounted inside the fixture, in such a manner as to obtain the necessary heat dissipation. Ballasts shall conform to the applicable requirements of UL and ANSI standards. Ballasts shall be supplied with spade connectors compatible with specified terminal blocks on lamp side. Spades shall be copper with soldered and crimped connection. Ballasts shall be supplied with nylon quick-connect type connector on source side.

Driver(s). The minimum power factor for the driver shall be 0.90. The driver case shall be a minimum of IP66 with a maximum case temperature of 80 degrees C. The driver shall be capable of 0-10V dimming with a minimum output power of 42 watts. Wiring inside the driver shall comply with 600V/105 degrees C rating or higher. LED drivers shall comply with UL1012, have a Class A sound rating, have a minimum ambient operating temperature of minus 40 degrees C, a life expectancy of 100,000 hours at a case temperature of less than or equal to 65 degrees C, the drivers shall comply with the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR Part 15 Non-Consumer (Class A). The driver current for operating the LED light engines shall be 525mA.

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Light Emitting Diodes (LEDs) PCB. Consisting of one or more LED modules or 'light bars' each comprised of multiple LEDs. The number of LED modules used shall be based on the required lumen output to achieve the project illumination design goals defined. The optics package with the required number of light bars shall also be rated with the housing for vibration. The optics package (light bars) shall be rated IP66. Manufacturer of LEDs shall have been in the business for more than 15 years. Qualified manufacturers of LEDs include: NICHIA, CREE or equal.

LEDs used by the luminaire manufacturer shall be identified and direct-sourced from the manufacturer of the LED and shall be certified by the manufacturer of the luminaire as being the LED type and rating used in the manufacture and design of the photometric and thermal characteristics of the particular luminaire. LEDs shall be color matched for all light bars on any given luminaire to the Correlated Color Temperature (CCT) and CRI identified for each product.

Consisting of one or more LED modules or 'light bars,' each comprised of multiple LEDs connected such that individual LED failures may occur without affecting any other LEDs in the column and row where the failed LED occurred. Quality control checks, specifications, and binning procedures used by the manufacturer of the luminaire shall be submitted along with the luminaire specification sheets and Shop Drawings.

LED maximum rated junction temperature: The overall design of the thermal package shall provide a temperature margin when operating at the maximum rated driver current in a 50 degrees C ambient temperature not to exceed the maximum allowable LED junction temperature.

Fixture Wires. Shall be stranded tinned-copper construction, not smaller than No. 16 AWG. Insulation for conductors is to be silicone rubber 200 degrees C rated. Conductor size, temperature rating, voltage rating and manufacture clearly marked on the insulation of each conductor. Use wires between lampholders/LED Boards and associated operating and starting equipment of the same ampacity rating as leads from the ballast. Wiring within the fixtures shall conform to the requirements of NEC and UL. Unless otherwise specified, the housing of each ballasted lighting fixture shall be provided with a separate, factory-installed, grounding device. The grounding device shall be used for connecting a separate, green, grounding conductor to the fixture housing. Insulated bushings shall be installed at points of entrance and exit of wiring.

All HID style fixtures are to include a molded one-piece construction terminal block, consisting of a four-circuit, 30 AMP, 600 volt capacity (or higher). Connections to be made with copper spades held in place with #10-32 washer head binding screws. A non-conducting barrier strip shall be between each adjacent row of terminal positions. Terminal block shall be attached to luminaire housing using a minimum of No. 8 screws or in accordance with Manufacturer recommendations. Terminal blocks shall conform to NEMA and UL standards and be able to accommodate the necessary conductor sizes to meet the UL and NEC sizing requirements for the application. The Contractor and Manufacturer of the product shall be responsible for ensuring that the appropriate conductor sizes have been accommodated in accordance with the Plans.

Quick connect/Quick disconnects shall be supplied between the ballast tray and the terminal block and the optical assembly and the ballast tray for easy removal of either item. Connectors shall be Nylon 6/6 94V-O with Brass and Phosphor bronze sockets. Pins shall be solid and made of Brass and Phosphor bronze. Connectors shall have capacity for three connections of not smaller than No. 16 AWG. Operating Characteristics shall allow 600 VA @ 15 amps maximum with an operating temperature of minus 55 degrees to 105 degrees C. Performance Test for vibration shall require no discontinuities greater than 10 microseconds and 5.0 milliohms maximum termination resistance, dry circuit. Contact shall be retained at a minimum axial force of 15 pounds. Plugs and caps shall be visually inspected for defects that would increase mating force beyond 3 pounds and decrease unmaking below 7 pounds with locking latches disengaged. Connectors shall conform to UL and NEMA standards.

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Fixture Hardware. All hardware required to assemble and mount the luminaire shall consist of the highest grade of Type 316 Stainless Steel materials normally found in the marketplace. Manufacturer is responsible for all compatibility testing between components. Latch and release mechanism, hinges, pins and other retaining parts of fixtures: screws, bolts or other assembly and mounting parts. All retaining (supporting) hardware shall be self-retaining and be rated for a minimum of a 400-pound load capacity. Provide bolts, nuts, washers, screws, nails, rivets, and other fastenings necessary for proper erection or assembly of work. All nuts shall have captive externally-footed lock washers.

The Manufacturer can request to use and alternative non-corrosive materials by means of supporting technical documentation illustrating the benefits of using the alternate material. The Engineer shall be the sole judge as the acceptability.
Welds. If required, locate all welds in assemblies and be anodized to conceal visible discoloration in the heat-affected zone. Where welded metal will be exposed after anodizing, select filler alloys to closely match composition of base metal. Comply with parent metal Manufacturer's recommendations for such filler alloys.

PRODUCTS

LED Tunnel Luminaire. The light emitting diode tunnel roadway luminaires, designated as "Type D1" and "Type N1" shall be provided and manufactured in accordance with the following specification. The luminaire(s) shall meet the following illumination levels within the tunnel and consist of the following elements:

(a) Tunnel Lighting Illumination Requirements; tunnel illumination has been developed by following the guidelines and recommendation of IES RP-22-11 following the 'Step Method' with a Safety Rating Number (SRN) of 4.7 and a design driving speed of 55mph. The products selected for submission approval must meet RP-22-11 recommendations for wall illumination, uniformity ratios, flicker, and the following roadway luminance requirements:

1. Threshold Zone 1 (331 feet) = 160 cd/m^2
2. Threshold Zone 2 (110 feet) = 113 cd/m^2
3. Transition Zone 1 (237 feet) = 65 cd/m^2
4. Nighttime (680 feet) = 2.50 cd/m^2

(b) The LED light engines or refractor/reflector assemblies shall be fully protected against outside contaminants. The LED assemblies shall be positioned in the fixture as shown on the Plans and shall provide the fixture type "D1" consisting of 525mA driver – 22,300 minimum initial delivered lumens – 265 watts maximum – Type II short with a BUG rating of 3-0-3. The fixture type "N1" consisting of 525mA driver – 10,200 minimum initial delivered lumens – 133 watts maximum – Type V medium with a BUG rating of 4-0-2. (Note: Any Manufacturer submitting for this Contract will be required to submit independently-tested photometric reports of the exact specified fixture distribution.)

(c) The luminaire housing shall consist of a combination of extruded and die cast construction of high-pressure low copper aluminum (less than 0.1 percent or less). The housing shall be completely sealed using a silicone gasket and secured together by means of stainless steel hardware.

(d) Fixture shall have integral driver(s) with a maximum output of 150 watts and a maximum input power of 160 watts. Input voltage shall be between 120-277V, Output voltage shall be between 60 and 210V.

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(e) The luminaire shall be factory pre-wired with a 3 conductor #12, Type SO cord with a 3-contact, 600 volt, 20 amp straight mail plug of one piece molded body thermoplastic construction, with metal coupling hardware. The companion female plug will be of the same attributes as the male counterpart. The cord shall extend 24" from the luminaire. Each cord set shall be furnished with a threaded aluminum adapter ring for joining the male and female plugs together. The connected plugs shall meet the requirements of NEMA 4-4X, 6 and 6P plus IP66 min. withstanding high pressure hose-down to 1,000 psi..

(f) The Correlated Color Temperature (CCT) for fixture type "D1" shall be 5700K maximum with a CRI of 70 minimum. The CCT for fixture type "N1" shall be 4000K maximum with a CRI of 70 minimum.

(g) Luminaires shall have integral time delay fusing.

(h) The finish shall be gray and applied as specified.

(i) The luminaire shall bear the "UL 1598 Listed SUITABLE FOR WET LOCATIONS AND DIRECT SPRAY" label. Construction shall conform to UL1598 – Suitable for Marine Duty Salt Water Applications.

(j) To prove water-tightness and dust-tightness, the luminaire shall be tested to International Standard IEC 598-1 and fully meet the tests for the IP66.

(k) The luminaire shall have a NEMA lamp identification decal.

(l) Stainless Steel (Type 316) Mounting support brackets shall be provided and be able to securely mount to the metal framing system made up of channel, fittings, and hardware as defined the Metal Framing Manufacturers Association Standard Publication MFMA-1. All channels, fittings, and hardware shall be of Type 316 Stainless Steel. Metal Framing Channels shall be formed from 12-gauge cold rolled steel. All channels shall have a nominal overall width of 1-5/8 inches and a height of 1 5/8 inches with a 9/16-inch by 1-1/8-inch slot face opening. Lengths of the channels shall be as shown on the Plans. All testing and tolerances shall be in accordance with latest MFMA-1 Standard. The mounting support bracket shall engage the framing system at various intervals along longitudinal mounting support channel. The SS mounting support bracket shall have a neoprene gasket for dissimilar metal protection between the bracket and the main fixture housing, as defined in the Contract Documents.

(m) Neoprene pads or gaskets shall be used to separate any dissimilar materials. This includes any and all locations where the SS mounting bracket may come into contact with the aluminum fixture housing.

LED Roadway Luminaire, the light emitting diode roadway luminaires, designated as "Type A", shall be provided and manufactured in accordance with the following specification.

Luminaire shall consist of 525mA driver – 15,500 minimum delivered lumens – 195 watts maximum – Type II short; Finite catalog numbers shall be developed by the manufacturer and submitted with the Shop Drawing review process to ensure all options defined are properly incorporated into the product. Alternate manufacturers indicated above are provided for sourcing purposes only. Products failing to meet specification requirements will not be accepted. The LED Roadway Luminaire will be pole mounted as defined on the Plans on CDOT 40-foot Metal Pole Lighting Standards with 8-foot arms and a Transformer Base.

(a) Luminaire shall be UL 1598 listed for installation in wet locations and direct spray environments.

(b) Comply with IESNA testing and reporting procedures for reporting luminaire photometric performance.

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(c) Installation environment: The luminaire shall be designed to provide 100,000 hours of life, applicable to the location and environment where fixture is installed (i.e. on a bridge structure, high humidity, and vibration).

(d) Metal Parts: Free of burrs and sharp corners and edges.

(e) Sheet Metal Components: All materials shall be corrosion-resistant aluminum, unless otherwise indicated. Each component shall be formed or supported to prevent warping and sagging.

(f) Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. All surfaces shall be protected with an electrostatically-applied, polyester powder coating inside and out; corrosion-resistant passing 3000-hour salt spray test; the luminaire as a complete assembly shall be rated IP66. The EPA shall be less than 0.9 sq ft. Provide filter/breather for enclosed luminaries.

(g) Construction: The luminaire shall be modular to the extent that the optics package and power supply are separate and removable from the housing and that failure of any part thereof would not require total replacement of the luminaire. The optics package and the power supply shall be sealed against the entry of moisture and dirt where the branch circuit enters the housing.

(h) Finish: The luminaire, pole, and arms (brackets) shall be finished in accordance to CDOT standards with a Federal Standard color as follows: “Forest Service Brown, Federal Standard 595C No. 20059.

(i) Mounting: The housing shall be designed for slip-fit mounting. The mounting system for the luminaires shall include two hot-dip galvanized steel clamp brackets, which are secured by means of two stainless steel mounting bolts on each bracket. This adaptation point shall be designed for standard 2-inch (50-mm) Schedule 40 tubing.

(j) Thermal Management: Heat sink design and spacing shall provide required heat dissipation at the highest operating current but shall be arranged and oriented such that bird droppings and feathers from roosting birds cannot foul the airways and compromise the cooling efficiency. A self-cleaning heat sink design without requiring the use of hose spray is required by this application. The design of the luminaire shall provide the necessary heat dissipation to maintain the driver’s case temperature to maximize the life expectancy of the driver to 100,000 hours.

(k) Hardware Material: Unless otherwise noted, all hardware shall be Stainless Steel with nylon inserts for all nuts.

(l) Wiring Connections:

1. Branch circuit wiring to the luminaire shall be via the mast arm tenon through the slip fit. Wiring shall be secured inside the luminaire with an integral wire clamp to prevent movement and abrasion.

2. The incoming AC line conductors (#12AWG or #10AWG) shall be terminated in a polarized plug/receptacle combination so that the luminaire may be locally de-energized and the plug removed without presenting a shock hazard or the potential for shorting the conductors together or to ground. The luminaire shall be designed to be removable once the plug is removed from the receptacle (any such maintenance shall normally be performed while the branch circuit connecting to the plug remains energized - the plug shall be weather-protected in case the luminaire cannot be replaced immediately).

3. Grounding lug connected to the housing shall be provided.

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(m) Luminaires shall be rated for operation over the range minus 40 degree C to plus 60 degrees C.

(n) Performance: The combined operating life rating of optics package and power supply shall be 100,000 hours minimum where end-of-life shall be taken as the point where lumen output has decreased to 70 percent of the initial value.

(o) Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

(p) Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 89 percent
2. Specular Surfaces: 90 percent
3. Diffusing Specular Surfaces: 85 percent

(q) Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses in luminaire doors.

(r) All fixture details shall be shown on the Shop Drawings.

(s) All fixtures shall be provided with a NEMA twistlock photocell receptacle and the NEMA photocell.

(t) Luminaire shall be provided with the following:

1. Fixture to have anti-vermin protection
2. Ballast door and lens frame are each to be secured to housing via a 1/16 -inch galvanized safety cable. This cable shall be long enough as to not interfere with the opening and closing of any doors or covers.
3. Luminaire safety cable shall be galvanized steel 1/8 inch with two crimped ends with loops, Loctite and split lock washers on all bolts.
4. Wiring terminal block.
5. Teflon, abrasion resistant, safety cable cover.

(u) Luminaire Quality Control Samples. The Manufacturer shall provide a random sample of post-production run of each luminaire type if deemed necessary by the Engineer. The sample shall be sent to an independent lab acceptable to the Engineer. The sample shall be tested for water tightness, noise omittance, lumen output, and overall adherence to quality standards set forth in these Specifications. Random selection and testing shall be overseen by the independent testing laboratory and the Engineer.

(v) Roadway Lighting Illumination Requirements; Roadway illumination has been developed by following the guidelines and recommendation of IESNA RP-8-00 following the Luminance Method for a Freeway Class A. The products selected for submission approval shall meet RP-811 recommendations for Average Luminance, Uniformity Ratios, and Veiling Luminance Ratios.

Metal Halide (Chain-up Area(Station) Luminaire. The Metal Halide chain-up luminaire shall be provided and manufactured in accordance with the following specification.

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(a) Luminaire: The luminaire shall in every way match the existing luminaire in the Chain-up area including but not limited to; wattage, shape, size, distribution, lumen output, color temperature, CRI, lamp type, finish, color, ballast type, manufacturer, or any other elements that will affect the lighting quality, life, performance, or aesthetic/architectural styling.

(b) Pole: The pole and arm shall in every way match the existing pole and arm in the Chain-up area including but not limited to; size, shape, finish, color, material, mounting methods, or any other elements that will affect the pole and arm quality, performance, strength, or aesthetic/architectural styling.

(c) Finish: The pole, arms (brackets), covers, and luminaire shall be finished in accordance to CDOT standards with a Federal Standard color as follows: Federal Standard 595A No. 30117.

CONSTRUCTION REQUIREMENTS

Performance Requirements. Perform all Work in accordance with the requirements of NFPA 70 and authorities having jurisdiction. Verify that other construction work is complete to the extent that Luminaires may be installed. Install Luminaires of the type required in the locations shown and make all final electrical connections. Provide accessories as required to properly install the material defined in this Section even though these accessories may not be specifically indicated on the Plans. Provide appropriate support(s) for each lighting fixture. Fixtures and support elements shall not be mounted on or in contact with ducts or pipes.

Installation. Install rows of fixtures accurately on straight lines unless otherwise indicated on the Plans. Install all necessary hangers, channels, bars, supports, and rods required to align Luminaires.

Fixture Alignment: Provide labor and materials for final aiming of all fixtures to the Engineer's satisfaction. Aiming shall take place immediately before the Work is accepted by the Engineer.

Anchors/Fastening System for Lighting and Conduits. Stainless steel undercut type anchors/fasteners shall be used to attach/mount new Lighting Fixture mounting system to concrete tunnel walls, ceilings, or floor. Anchor assemblies shall be 316 stainless steel.

Cleaning. Follow the cleaning procedures recommended by the fixture Manufacturer. Clean the bottoms, trim, reflecting surfaces, and lenses of luminaires during installation, so as to render them free of foreign material, substances, or film on the fixture.

Luminaire Operation. Ascertain and make sure that the LED luminaires installed are exactly as specified for each fixture type luminaire with regards to the number of LED and distribution required for the given location. Provide 10 percent additional LED PCB Assemblies of each type and wattage in addition to those replaced due to failure. Replace without cost to the Department inoperative LED panels, which fail prior to Final Acceptance of the Work.

Lamping (HID). Ascertain and make sure that lamps installed are exactly as specified for each fixture type. Install in each lighting fixture the required lamps as soon as fixture is properly installed and wired. Provide 10 percent additional lamps of each type and wattage in addition to those replaced due to failure. Replace without cost to the Department burned out or inoperative lamps, which fail prior to Final Acceptance of the Work.

Temporary Luminaires. Remove temporary luminaires, lamps and associated wiring, conduit, and boxes after the permanent system is fully operational.

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Grounding. Ground non-current carrying parts of Luminaires and associated equipment as specified in Revision of Section 613, Bonding and Grounding. Where the copper grounding conductor is connected to a metal other than copper, provide specifically treated or lined connectors suitable for this purpose to mitigate corrosion between the facing surfaces of dissimilar metals.

Warranty Replacement. Replace faulty drivers at no additional costs to the Department. The fixtures shall not be installed until after wall and ceiling erection and cleaning in the vicinity have been completed. Deviation from location and mounting height shall be a maximum of 1/2-inch, non-cumulative, in any unit or continuous run of fixtures. All damage to tunnel ceiling and walls shall be repaired prior to Final Acceptance. All repairs shall be performed at the Contractors Expense and as directed by the Engineer.

Operation Tests and Inspections. The following tests and inspections shall occur, and be completed satisfactorily, before Contractor turns lighting system over to the Department.

(a) Operating Tests: Upon completion of the installation, conduct an operating test to demonstrate that the lighting systems and associated equipment operates in accordance with the requirements of this Section.

(b) Insulation Resistance Tests: Perform test as specified below:

1. Inspect cables for physical damage and proper connection in accordance with accepted Shop Drawings.

2. Test cable connections for proper torque in accordance with Manufacturer's recommended values.

3. After wiring installation is completed and connected ready for operation, but prior to placing in service and before any branch circuit breakers are energized, perform the following:

   A. Continuity tests to ensure proper cable connections.

   B. Insulation resistance tests between conductors and between each conductor and ground shall be conducted as previously described.

4. Recorded results shall be tabulated in a formal test report. The test report shall include, but not be limited to the following:

   A. Identification of each component tested.

   B. Location of each component tested.

   C. Time of each Test.

Subsection 613.11 shall include the following:

Tunnel lighting and roadway luminaires shall be measured per unit, complete, in place and include all supporting devices and all other accessories and equipment required to perform the complete installation and testing for the tunnel lighting and roadway luminaires.

Subsection 613.12 shall include the following:

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The accepted systems will be paid for at the Contract lump sum price for each of the pay items listed below that appear in the bid schedule.

Pay Item	**Pay Unit**
Luminaire (LED)	Each
Light Standard Steel (40 Foot)	Each
Light Standard Steel (40 Foot) (2 Arm)	Each
Light Standard Metal (30 Foot)	Each
Light Standard Foundation	Each
Lighting Control Center	Each
Luminaire Metal Halide (150 Watt)	Each
Luminaire (LED) (Tunnel) (133 Watt)	Each
Luminaire (LED) (Tunnel) (265 Watt)	Each
Luminaire Mounting Support System	Lump Sum
Luminaire (LED) (Tunnel) (133 Watt) (Furnish Only)	Each
Luminaire (LED) (Tunnel) (265 Watt) (Furnish Only)	Each

REVISION OF SECTION 613
PULL BOX

Section 613 of the Standard Specifications is hereby revised for this project as follows:

Subsection 613.01 shall include the following:

This work also consists of furnishing and installing cabinets and enclosures used as pull boxes in the tunnel and equipment enclosures as indicated on the Plans. Hand-holes and exterior boxes that are located at grade or below grade are also included in this Section. The term junction box may be used when splices are made and its term shall be considered interchangeable with pull box.

Subsection 613.02 shall include the following:

Box Size shall be as shown on the Plans; or as required by applicable national, State, and local codes and regulations. Pull boxes shall be fabricated of the specified materials and constructed as follows:

All pull boxes exposed to earth and below grade shall be:

1. Size: 24 inches x 24 inches x 14 inches.

2. Materials: Precast concrete with size, configuration, cover, grates, and reinforcing as required for the particular installation. Pull box frame and cover having an H-20 traffic rating.

All pull boxes located within the tunnel for lighting power shall be:

1. Size: 16 inches x 14 inches x 6 inches

2. Materials: NEMA 4X rated, 0.090-inch thick type 5052 H22 Aluminum Alloy with external mounting supports. After fabrication, the box shall be anodized then finished with an electro-coat acrylic undercoat and zinc-rich polyester powder gray paint finish.

CONSTRUCTION REQUIREMENTS

The cabinets, enclosures, and handholes used as pull boxes of the types specified above shall be installed as follows:

1. Install products in accordance with manufacturer's instructions.

2. Install cabinets and enclosures plumb; fasten securely to metal support channels that are anchored to the wall with support points at each corner, minimum.

3. Pull boxes (handholes) installed below grade and exposed to earth shall be installed with the top located approximately 1 foot below finished grade and covered by gravel or light aggregate. The box shall be readily accessible for excavation, with no paving installed above it. The location of the box shall be effectively identified as shown on the Plans.

Subsection 613.11 shall include the following:

Pull boxes, associated accessories and hardware described herein and the installation thereof shall be measured per each complete pull box unit installed, and accepted.

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REVISION OF SECTION 613
PULL BOX

Subsection 613.12 shall include the following:

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**
Pull Box (16” X 14” X 6”)	Each
Pull Box (24” X 24” X 14”)	Each
Pull Box (36” X 24” X 8”)	Each

REVISION OF SECTION 613
PULL BOX (ITS)

Section 613 of the Standard Specifications is hereby revised for this project as follows:

DESCRIPTION

Subsection 613.01 shall include the following:

Contractor shall furnish and install fiberglass reinforced, polymer concrete pull boxes for ITS project elements as shown in the plans.

MATERIALS

Subsection 613.02 shall include the following:

Pull boxes (24x36x24) installed in dirt or landscaped areas shall have a concrete apron with three sides, 12 inches wide by 6 inches deep and a top side of 18 inches wide by six inches deep for marker installation. Pull boxes shall not be installed above the grade of the apron. Concrete apron shall have a 1% slope away from the top of pull box. All concrete aprons shall be Class B and shall be in accordance with Section 601.

Pull boxes shall have a detachable cover with a skid-resistant surface and have the words "CDOT COMM" or "CDOT POWER" cast into the surface, as appropriate. Painting of words shall not be accepted. The cover shall be attached to the pull box body by means of 3/8 x 3.5 inch lag head stainless steel hex head bolts and shall have two lift slots to aid in the removal of the lid.

Wire mesh shall be installed in a manor to completely surround the box. The wire mesh shall meet the material standard ANSI/ASTM A555-79 and made of T-304 stainless steel, 0.025 inch wire diameter minimum and shall have a spacing of 12 mesh per inch.

Pull boxes shall be verified by a 3rd Party Nationally Recognized Independent Testing Laboratory as meeting all test provisions of ANSI/SCTE 77 2007 Specification for Underground Enclosure Integrity, Tier 22 rating. Pull boxes shall be UL listed. Certification documents shall be submitted with material submittals.

The Pull Box (18x30x18) and the Pull Box (24x36x24) shall have a one piece lid.

CONSTRUCTION REQUIREMENTS

Subsection 613.03 shall include the following:

A minimum of 12 inches of ¾ inch granite-gravel shall be installed as a base for the pull box to aide in drainage. The ¾ inch granite-gravel shall be free of dirt and debris and spread evenly to facilitate a level base for the pull box. The Contractor shall ensure that sufficient compacting is made prior to the installation of ¾ inch granite-gravel to help alleviate future settling.

Wire mesh shall be installed in a manor to completely surround the box. The wire mesh shall be installed prior to the installation of the pull box above the bed of 3/4" granite-gravel and extending one foot past the outer edges of the concrete apron. The wire mesh shall be gently cut to allow only the entrance of the conduit at the bottom of the box. Any openings cut in the wire mesh larger than the diameter of the conduit shall be remedied by the installation of additional wire mesh to obtain a completely sealed pull box enclosure.

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REVISION OF SECTION 613
PULL BOX (ITS)

METHOD OF MEASUREMENT

Subsection 613.11 shall include the following:

Pull Boxes will be measured by the actual number that are installed and accepted, and will include base, lid, excavation, backfill, concrete apron, wire mesh and 3/4" granite-gravel. Pull Boxes shall also include the removal and patching of pavement, sidewalks, curb and gutters and their replacement in kind to match existing grade.

BASIS OF PAYMENT

Subsection 613.12 shall include the following:

Pay Item	**Pay Unit**
Pull Box (18x30x18) (Deep)	Each
Pull Box (24x36x24)	Each

Concrete for Pull Box (24x36x24) will not be measured and paid for separately, but shall be included in the cost of the pull box.

REVISION OF SECTION 613
TUNNEL LIGHTING CONTROL SYSTEM

Section 613 of the Standard Specifications is hereby revised for this project as follows:

Subsection 613.01 shall include the following:

This work also consists of furnishing, installing and testing one tunnel lighting control system. Included in this system is a light sensor (photocell), lighting controller, panel, and controls necessary to control the tunnel lights.

Subsection 613.02 shall include the following:

(l) *Tunnel Lighting Control System*. Materials for the Tunnel Lighting Control System shall meet the following requirements:

1. Submittals. Submittals shall consist of Manufacturer's Data, Shop Drawings, Samples and Test Data. All submitted data, shop drawings, and reports shall employ the terminology, classifications, and methods prescribed by the IESNA Lighting Handbook, as applicable, for the lighting systems specified.

A. Manufacturer's data shall be submitted for the following: photocell, lighting controller and lighting contactors, finishes and all internal major components.

B. Shop Drawings shall be submitted for the following:

(1) Illuminance Meter (photocell)
(2) Lighting Controller
(3) Mounting Brackets
(4) Lighting Contactors
(5) Enclosure, Cabinet and Component Assembly Details
(6) Wiring Diagrams
(7) Bill of Materials
(8) Installation Diagrams

C. Handling and Delivery. Ship photocell, contactors, and accessories securely packaged and labeled for safe handling in shipment to avoid damage or distortion. Store photocell, lighting controller, contactors, and accessories in a secure and dry facility and in original packaging in a manner to prevent soiling, physical damage, wetting or corrosion prior to installation. All cartons must be clearly marked with the proper identification of Manufacturer, Catalog Number and proper storage/handling instructions.

D. Equipment shall be installed per Manufacturer's instructions.

E. The tunnel lighting controller shall include the following:

(1) Photocell/Control (Tork #LC-200/EPC-1 with receptacle and set range of 2-100fc or equal).

a) Comply with ANSI C136.10-1988 and EEI NEMA Standards.

b) The mounting bracket/receptacle shall be on a galvanized steel conduit, and shall allow for mounting of the photocell 36" above the parapet of the tunnel portal.

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REVISION OF SECTION 613
TUNNEL LIGHTING CONTROL SYSTEM

c) Aiming of the photocell shall be horizontal and away from oncoming traffic. The photocell shall be located such that the meter has an unobstructed view of the portal at times of maximum snow height.

(2) Contactors sufficient to control all circuits as shown on the Contract Drawings.

a) Lighting contactors shall conform to applicable standards.

b) Lighting contactor shall be rated at 600 volts, 60 Hertz and sized as shown on the Contract Drawings.

c) The number of poles shall be as shown on the Contract Drawings.

d) The contactor coil shall operate at 120-volt ac.

e) The contactor shall be electrically operated, mechanically held and shall have silver alloy double break contacts and coil clearing contacts, and shall require no arcing contacts.

f) Provide contactor with hand-off-automatic selector switch mounted in cabinet door.

g) Selector switches shall illuminate when energized; and shall have LED back-lighted faces. Arrange 3/4 inch switches as indicated on the Contract Drawings. Square D, class 9001, Type K_J or equal.

(3) Control Power Transformer (CPT), 277-120 Volt, fused capacity as shown on the Contract Drawings or of adequate volt-ampere (VA) capacity to meet the 120-Volt power requirement of the cabinet assembly.

a) Transformer shall also power a 15 amp convenience receptacle and light.

(4) Equipment Enclosure

a) The enclosure shall be free standing on legs mounted on a pad, sufficiently sized to accommodate the panelboards and all equipment, as shown on the Contract Drawings.

b) The enclosure shall be anchored to the pad as shown on the Contract Drawings.

1) Hinged Cover Enclosures: NEMA 4 as indicated on the Drawings.

2) Manufacturers: Hoffman, Rittal, Crouse Hinds or approved equal.

3) Finish: Manufacturer's standard enamel finish.

4) Covers: Continuous hinge, held closed by stainless steel clamps (NEMA 4) operable by screwdriver.

5) Panel For Mounting Terminal Blocks or Electrical Components: 14-gage steel, white enamel finish.

6) Cabinets: Galvanized steel.

7) Manufacturers: Hoffman, Rittal or approved equal.

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REVISION OF SECTION 613
TUNNEL LIGHTING CONTROL SYSTEM

8) Box Size: As shown on Contract Drawings; or as required by applicable national, state, and local codes and regulations.

9) Fronts: Steel, surface type with concealed trim clamps, concealed hinge, and flush lock. Finish with gray baked enamel.

10) Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power wiring.

11) Provide accessory feet for free-standing equipment.

12) Terminal blocks shall be constructed as follows:

(i) Terminal Blocks: NEMA ICS 4; UL-listed. Marathon, Square D or Buchanan.
(ii) Power Terminals: Unit construction type, with closed-back type, with tubular pressure screw connectors, rated 600 volts, Marathon, Square D or Buchanan.
(iii) Signal and Control Terminals: Marathon 1612, Square D or Buchanan.
(iv) Cast Outlet Boxes: NEMA FB 1, Type FD, aluminum and cast feralloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.

13) Fabricate cabinets and enclosures as follows:

(i) Shop assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with NEMA ICS 6.
(ii) Provide knockouts on enclosures where noted or required.
(iii) Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.
(iv) Shop paint enclosures and cabinets with Federal Standard color "Forest Service Brown, Federal Standard 595C No. 20059

F. Spares: The contractor shall provide spare parts to include the following:

(1) Minimum one spare lighting contactor installed in each equipment enclosure, or as shown on the Plans.

Subsection 613.11 shall include the following:

Tunnel Lighting Control System will not be measured but will be paid for on a lump sum basis.

Subsection 613.12 shall include the following:

Payment will be made under:

Pay Item	**Pay Unit**
Tunnel Lighting Control System	Lump Sum

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REVISION OF SECTION 613
TUNNEL LIGHTING CONTROL SYSTEM

Payment for Tunnel Lighting Control System will be the contract lump sum bid and will be full compensation for all work and materials necessary to complete the item including equipment enclosure and pad, photocell, cabinet, lighting contactors, all control cables/wires, convenience light, convenience receptacle, conduit nipples, wireway, control power transformer, incidentals, installation and testing. Included in the term "incidental" are all nuts, bolts, anchors, and equipment required to perform the complete installation and testing as described herein.

REVISION OF SECTION 613
SECONDARY SERVICE PEDESTAL

Section 613 of the Standard Specifications is hereby revised for this project as follows:

DESCRIPTION

Contractor shall furnish and install the Secondary Service Pedestal in accordance with the plans and these special provisions.

MATERIALS

Subsection 613.02 shall include the following:

Secondary Service Pedestal shall consist of the following:

1. 125A, 120/240V, NEMA 3R meter housing conforming to the utility provider requirements
2. 100A, 250V heavy duty, 2-pole, NEMA 3R, service entrance rated disconnect switch with ground and neutral bars
3. 100A, MLO, 120/240-10-3W, 8 space NEMA 3R load center with branch circuit breakers
4. Heavy duty, galvanized c-channel type rack setting in concrete
5. 5/8 8 foot copper-clad driven ground rod with approved clamp

CONSTRUCTION REQUIREMENTS

All hardware shall be installed in accordance with manufacturer's recommendations and per the latest CDOT M&S Standards.

METHOD OF MEASUREMENT

The Secondary Service Pedestal will be measured by the actual number of units installed and accepted.

BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for the Pay Item listed below.

Payment will be made under:

Pay Item	**Pay Unit**
Secondary Service Pedestal	Each

Payment will be full compensation for all labor, materials, and equipment required to complete the work.

REVISION OF SECTION 614
COMMUNICATIONS CABINET

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

DESCRIPTION

Subsection 614.01 shall include the following:

Communications cabinets shall be furnished and installed at the proposed CCTV camera locations as indicated on the plans, to house and protect electrical power components, DIN rails, field equipment, communications telemetry equipment and fiber optic termination panels.

MATERIALS

Subsection 614.08 (c) shall be deleted and replaced with the following:

Communications cabinets shall be UL 508A Industrial Control Panels listed and conform to a NEMA Type 4X rating. Communications cabinets shall be constructed of 0.125 inch Type 5052 H-32 aluminum conforming to the requirements of ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate. The dimensions shall be as shown in Table 1 below.

Table 1 - Communications Cabinet Types

COMMUNICATIONS CABINET	DIMENSIONS	MAXIMUM WEIGHT (W/O BACK PANEL)
Type 2	30” (h) x 24” (w) x 12” (d)	40 lbs.

All fabricated materials and added components must be free from burrs and sharp edges. Exterior seams of the cabinet shall be continuously welded with edges ground smooth to a 0.03 inch radius. All welding shall be done with gas tungsten arc welds that comply with AWS B2.1-22-015 Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Aluminum and C5.6 Recommended Practices for Gas Metal Arc Welding. All welds shall be neatly formed and free of blisters, blowholes, cracks and other irregularities. All bolts, clamps, fasteners, hinges, latches, nuts and screws shall be stainless steel, unless an alternative corrosion proof material is approved in writing by the Department.

The cabinet door opening shall be designed to prevent dust and moisture intrusion in conformance to NEMA 4X requirements. All flange joints shall be welded or continuously formed. The door shall have an adequately sized, oil-resistant gasket that provides a uniform seal with the door frame surface in conformance with NEMA 4X requirements and shall be permanently bonded to the door. The door shall utilize a continuous stainless steel hinge that allow for door removal from the hinge side. Hinges shall be mounted such that the cabinet door opens out to the left, unless otherwise specified on the Plans, Project Details or as specified by the Department. Hinges shall be mounted with appropriately sized stainless steel hardware. The door shall be equipped with a hasp and staple for padlocking. The cabinet shall have a lock and be keyed identical to other cabinets on the corridor. A document holder constructed of high-impact thermoplastic shall be provided for each communications cabinet and permanently mounted to the lower portion of the inside door. The Contractor shall insert a copy of the communications cabinet Bill of Materials (BOM), individual communications cabinet component specification sheets and an as-built electrical/low-voltage wiring diagram of the communications cabinet in the document holder.

Each communications cabinet, designated for mounting on a pole, shall include a pole mounting kit suitable for pole diameters ranging from 7-12 inches. Each pole mounting kit shall include channel bars (for attachment to factory mounting holes on the back of the communications cabinet), pole shims (to prevent cabinet movement against pole), stainless steel straps and all other associated mounting and sealing hardware. The channel bars, pole shims and

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REVISION OF SECTION 614
COMMUNICATIONS CABINET

associated mounting hardware shall be manufactured from either galvanized steel or stainless steel. Mounting holes on the back of the communications cabinet shall be installed at the factory (communications cabinet Manufacturer) to assure NEMA 4X integrity along with all factory-recommended mounting and sealing hardware. Field installation or modification of mounting holes shall be prohibited.

CONSTRUCTION REQUIREMENTS

Each communications cabinet shall have tapped pads to provide for the mounting of a back panel as specified herein.

Two conduit access holes shall be made on the bottom of the communications cabinet for electrical wiring, specific field device low-voltage control cabling, waveguides and fiber optic cabling, as applicable for each communications cabinet application. The conduit access holes shall be sized and positioned at locations shown in the Project Details to ensure the proper, safe routing of cabling entering the cabinet. The holes shall be free of burrs and sharp edges prior to the installation of LFMC, fittings and nipples. Conduit access holes and appropriate sealing strategies to maintain a NEMA 4X integrity shall be performed at the factory and no field installation or modification of the conduit access holes shall be permitted.

Back Panels
Back panels shall be constructed of 0.10 inch Type 5052-H32 aluminum alloy, unless otherwise specified by the Department. One back panel and associated mounting hardware shall be included with each communications cabinet and be rated for use in NEMA 4X cabinets. The back panel shall be not less than 27 inches (h) × 21 inches (h) and protected on one side with a plastic film. The back panel shall be mounted within the communications cabinet with a minimum of four screws.

Outlet Box
Each communications cabinet shall contain a four inch square junction box attached to the back panel as shown in the Project Details. Each junction box shall be constructed of drawn or welded steel and have a minimum depth of 1.25 inches. Each junction box shall include knockouts and clamps for conduit and cables, as appropriate. Steel box covers shall be provided with each junction box as appropriate for the specific communications cabinet application, e.g., duplex receptacles and/or duplex GFCI receptacles.

Duplex NEMA 5-15R receptacles shall be provided within the outlet box as specified in the Project Details. NEMA 5-15R receptacles shall be rated for 125 VAC, 0.5 HP and 15 A. It shall be of commercial grade quality and be manufactured from high strength nylon. NEMA 5-15 receptacles shall have two poles, three wires and include a self-grounding strap to insure ground contact.

Duplex NEMA 5-15R GFCI receptacles shall be provided within the outlet box as specified in the Project Details. NEMA 5-15R GFCI receptacles shall be rated for 125 VAC, 0.5 HP and 15 A. It shall be of commercial grade quality and manufactured from high strength nylon. NEMA 5-15R GFCI receptacles shall have two poles, three wires, a manual reset button and a self-test button.

Both duplex NEMA 5-15R and duplex NEMA 5-15R GFCI receptacles shall be UL listed.

Power Strip
Furnish and install one back panel mounted power strip with six front facing NEMA Type 5-15R outlets. Mounting location shall be as shown in the Project Details. The power strip shall be rated for 15 A at 120 VAC. It shall have an energy rating of 630 Joules, clamping voltage of 500 V and EMI/RFI noise filter of 150 KHz to 100 MHz at up to 43 dB. The power strip shall have a recessed power switch and a power cord of not less than 2.5 feet.

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REVISION OF SECTION 614
COMMUNICATIONS CABINET

Power Conditioner
The power conditioner shall be designed for outdoor use, support an operating temperature range of -40°F to +165°F, be operational in humidity levels of 0% to 95% (non-condensing) and operate at an altitude ranging from sea level to two miles above sea level. It shall utilize an input voltage of 120 VAC, 40 to 70 Hz and an output voltage of 120 VAC (± 3%), user selectable 50 to 60 Hz (± 0.25%). The power conditioner shall support an output current of 4.8 A (400 W/570 VA). It shall have a total harmonic distortion not exceeding 3.0%. The power conditioner shall utilize input and output electrical connectors conforming to the IEC 60320-1 Appliance Couplers for Household and Similar General Purposes specification. Its dimensions shall not exceed 1.7 inches (h) × 11 inches (w) × 8.5 inches depth and its weight shall not exceed five lbs. One power conditioner shall be provided with each communications cabinet.

DIN Rails
Each communications cabinet shall utilize standard 1.38 inch DIN rails. The DIN rails shall be of steel construction with a coating for corrosion resistance. The DIN rails shall utilize 0.25 inch × 0.71 inch slots for fastening to the back panel located in each communications cabinet. The spacing of the DIN rail slots shall be 0.98 inch center-to-center. DIN rails and associated mounting hardware for attachment to the back panel shall be provided with each communications cabinet in the lengths and quantities specified in the Project Details.

12 VDC Power Supply
The 12 VDC power supply shall support an input voltage range of 85-264 VAC and frequency range of 47-63 Hz. It shall have a typical efficiency of at least 76% and typical AC current of 1.6 A at 115 VAC. The 12 VDC power supply shall provide an output voltage of 12 VDC and have a current rating of 6.3 A. It shall support an output current range of 0 to 6.3 A and have a rated power of 75 W. The 12 VDC power supply shall have overload protection of 105-150% for its rated output power and overvoltage protection for voltages of 15-16.5 VDC. It shall be designed for an operating temperature of +14°F to +140°F and humidity levels of 20% to 90% (non-condensing). The 12 VDC power supply shall conform to the following standards: IEC 60068-2-6 Environmental Testing (Vibration) and UL 508 Industrial Control Equipment. It shall be DIN rail mountable, have dimensions not exceeding 5 inches (h) × 2.25 inches (w) × 4 inches (d) and a weight of not more than 1.5 lb. One 12 VDC power supply shall be provided with each communications cabinet.

Finish
All final condition communication cabinets shall have a finish color equal to Federal Standards 595 #20059. The finishing process shall conform to all applicable CDOT standards.

Warranty
The communications cabinet manufacturer shall affix a permanent label on the inside of the door that identifies the cabinet type, date of manufacture, warranty expiration date and manufacturer's name. The warranty expiration date shall be expressed in the (mm/dd/yyyy) format. The warranty shall cover all communication cabinet materials and workmanship, including pole mounting kits, for two (2) years after delivery of each communication cabinet.

Service Disconnect
The service disconnect shall have factory installed main lugs. It shall have an ampere rating of 70A, a voltage rating of 120/240 VAC (3-wire, single phase) and a short circuit current rating of 10 kA. The service disconnect shall accommodate up to four single pole circuits or two tandem circuit breakers. It shall accept aluminum wire sizes of #12 AWG to #3 AWG and copper wire sizes of #14 AWG to #4 AWG. The service disconnect shall utilize a tin plated aluminum bus and include a grounding bar. It shall have been specifically designed for industrial requirements to protect electrical systems, equipment and people and must be UL listed.

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REVISION OF SECTION 614
COMMUNICATIONS CABINET

The service disconnect shall be NEMA 3R rated with the following maximum dimensions: 5 inches (W) × 9.5 inches (H) × 4 inches (D). It shall be constructed of galvannealed steel with knockouts on the sides, bottom and back and a rainproof closing cap for any hub opening on the top of the enclosure. The service disconnect shall have a gray baked enamel finish electrodeposited over cleaned, phosphatized, galvannealed steel. The complete service disconnect shall include the interior trim and door. The door shall open upward and be equipped with a hasp and staple for padlocking.

The Contractor shall be responsible for sizing the circuit breakers in the service disconnect in accordance with Article 240 of the NEC and circuit breakers must conform to UL 489 Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures. The Contractor shall consider all loads within the communications cabinet to be continuous except for the duplex GFCI receptacles which shall be non-continuous.

One service disconnect and corresponding circuit breakers shall be provided with each communications cabinet.

All communications cabinets shall be Federal Standard color 20059 in accordance with Revision of Section 519 – Hot Dip Galvanizing and Duplex Coating. This will not be paid for separately, but will be included in the cost of the pay item.

Subsection 614.13 shall include the following:

METHOD OF MEASUREMENT

Communications Cabinet will be measured by the actual number of Communications Cabinets installed and accepted.

Subsection 614.14 shall include the following:

BASIS OF PAYMENT

Payment will be under:

Pay Item	**Pay Unit**
Communications Cabinet	Each

Payment will be full compensation for all labor, materials and equipment required to complete the work.

REVISION OF SECTION 614
MICROWAVE VEHICLE RADAR DETECTOR

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

Subsection 614.01 shall include the following:

DESCRIPTION

This work shall consist of furnishing and installing microwave vehicle radar detectors for existing ground-mounted 334 sites in accordance with these Special Provisions at the locations shown on the Plans. Contractor shall order the Wavetronix SmartSensor HD, model number WX-SS-H126, configuration software, mounting hardware, and compatible Click! DIN rail mountable components and shall include a Wavetronix WX-CLK-301 module.

MATERIALS (mounted inside communications cabinet)

The Microwave Vehicle Radar Detector (MVRD) shall include the radar detector unit, 20' standard combination power/data cable with connector, required length of un-terminated Belden 9330 or approved equal 4 pair separately shielded 22 AWG cable to reach from pole mounted communications cabinet to traffic control cabinet, data line surge suppressor, pole mount hardware, communications cabinet, and configuration software.

A WX-CLK 301 module shall be furnished and installed, along with any cabling.

The radar detection unit shall be a non-intrusive device using frequency modulated continuous wave radar technology for the gathering of vehicle information including traffic volume, lane occupancy, individual and average speed, vehicle classification, and presence. It shall have auto configuration capabilities to simultaneously identify up to ten highway lanes with the ability to detect over center median barriers and accurately detect partially occluded vehicles. Weather shall not impact the radar detection of the unit. Wind or temperature change shall not cause the device's original field installation configuration to alter over time. The radar detection unit shall include the manufacturer's recommended power/communication cable. The radar detection unit shall meet the following minimum requirements:

1. Installation Type: Side Fire or Forward Fire installation
2. Detection Zones: Up to 10 Lanes Simultaneously
3. Detection Range: 3 to 250 feet
4. Detection Zone Resolution: 1 foot
5. Time Resolution: 2.5 msec
6. Elevation 3 dB Beamwidth: 65º
7. Azimuth 3 dB Beamwidth: 7º
8. Operating Frequency: 24.0 to 24.25 GHz (K-Band)
9. Communications: RS-232 and RS-485
10. Power: 8.0 Watts at 9 to 36 Volts DC
11. Operating Temperature: -40 to +165ºF (Ambient)
12. Humidity: Up to 95% Relative
13. Shock: 10g 10ms Half Sine Wave

The communications cabinet shall be non metallic Nema 4x enclosure or equivalent, measuring 8 x 6 x 4inches (H x W x D), and have a securable hinged door with weather proof seal to prevent the ingress of wind and water. The communications cabinet shall include an internal backplane with DIN rail and mounting bracket assembly for attachment to supporting pole.

The DIN rail mountable components to be installed inside the communications cabinet shall include a WX-SC-200 Click 200 data line surge suppressor with hot swappable protected busses. The Data Line surge suppressor shall

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REVISION OF SECTION 614
MICROWAVE VEHICLE RADAR DETECTOR

provide protection for RS-232, RS-485, and DC power to the radar detection unit. Wiring for the surge suppressor shall be by means of pluggable screw terminals and include unprotected as well as protected RS-232 and RS-485 communications connectors and shall have a minimum operating temperature range of -29 to 165˚F up to 95 percent relative humidity.

MATERIALS (mounted inside 334 traffic control cabinet)

There shall be a 19" bent rack mount Din rail, a Din rail mountable WX-SC-206 Click 206 .05 Amp re-settable circuit breaker and switch, a DIN rail mountable WX-SC-201 Click 201 AC to DC power converter. The power supply shall accept input voltage from 100 to 240 VAC at 45 to 65 Hz and provide 24 VDC output at 1Amp. The power supply shall have a minimum operating temperature range of -29 to 165˚F up to 95 percent relative humidity. The power supply shall provide for 100 percent power reserve for a minimum of 20 ms to protect against static voltage dips, transient failures of supply voltage, or continuous phase failures. There shall be a WX-SC-205 Click 205 AC lightening power line surge protector DIN rail mountable with hot swappable protected busses, and a WX-SC-200 Click 200 data line surge suppressor. The surge suppressor shall provide protection for RS-232, RS-485, and DC power. Wiring for the surge suppressor shall be by means of pluggable screw terminals and include protected and unprotected RS-232 and RS-485 communications connectors. The surge suppressor shall have a minimum operating temperature range of -29 to 165˚F up to 95 percent relative humidity. The necessary number of input file-mountable WX-SC-114 Click! 114 four-channel and/or WX-SC-112 Click! 112 two-channel contact closure (loop emulator) modules with required RJ-11 patch cords shall be provided to emulate 1 primary and 1 secondary loop for each mainline lane.

CONSTRUCTION REQUIREMENTS

Two conduit access holes, not to exceed 1.5 inches shall be made on the bottom of the communications cabinet. One of these holes is to be used for the power/communications cable in from the sensor and the other for the power/communications cable out to the traffic control cabinet. The access holes shall be positioned at a location to ensure the proper, safe routing of wiring entering the cabinet. 3/4 inch Type 201 stainless steel strap used in conjunction with Type 201 stainless steel buckles shall be used to mount the communications cabinet to the structure so that the top of the cabinet is approx 5 feet above surrounding grade. The communications cabinet shall be oriented such that anyone working in the cabinet has direct line of sight with oncoming traffic. The Contractor shall be responsible for any necessary modifications or additions needed to mount the communications cabinet to the structure.

0.75 inch Type 201 stainless steel strap used in conjunction with Type 201 stainless steel buckles shall be used to mount the radar detection unit at a height and angle determined by roadway off-set and detection distance in accordance with manufacturer's recommendations and shall be properly grounded per the manufacturer's specifications.

The manufacturer's recommended power/communication cable shall run on the interior of the mounting structure from the radar detection unit to the communications cabinet. A hole not to exceed 1.5 inches shall be made 12 inches below the radar detection unit to allow passage of the power/communications cable into the structure. The Contractor shall ensure strain relief and drip loops in the power/communication cable before the cable enters the structure in accordance with manufacture's recommendations. Two holes not to exceed 1.5 inches shall be made below the communications cabinet to allow the power/communications cables to pass from the interior of the structure to the interior of the communications cabinet. Flexible conduit shall be used to run cables from the structure to the communications cabinet.

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REVISION OF SECTION 614
MICROWAVE VEHICLE RADAR DETECTOR

The Contractor shall run and connect power from the structure to the 0.5A circuit breaker and power line surge protector in the 334 traffic control cabinet. The Contractor shall wire supply power, power supply, surge suppressors, breaker, and radar detection unit in accordance with the manufacture's recommendations. The radar detection unit shall be wired to support RS-232 serial communications.

All holes shall be free of burs and sharp edges prior to the installation of all cable, conduit, and conduit nipples. All cable entrances in structures, conduits, and cabinets shall be sealed and waterproofed. All wiring and electrical connections shall be performed in conformance with the latest version of the NEC.

The Contractor shall configure the radar detection unit to detect all lanes, in accordance with the manufacture's recommendations.

The units shall be environmentally hardened for outdoor use with a temperature range of -10 to +80 degrees centigrade and available in one, two or four RS-232 port units. Also included at this location, a 120 volt AC to 24 volt DC power supply shall be included. This unit shall have a slim line DIN mountable case and be mounted to DIN rail in the 334 traffic control cabinet. The Contractor shall provide units which are compatible with current Department devices installed at various locations.

Subsection 614.13 shall include the following:

METHOD OF MEASUREMENT

The Microwave Vehicle Radar Detector will be measured by the actual number of units installed and accepted, and will include warranty, testing, documentation, radar detection unit, power supply, power source termination, surge suppressor, pole-mounting hardware communications cabinet, installation hardware, all necessary wiring, communication cables, labor and all other items necessary to complete the work. Testing will be measured by verification of vehicle detection, speed and volume of all lanes in the northbound direction with 90% accuracy.

Subsection 614.14 shall include the following:

BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for the pay item listed below.

Payment will be made under:

Pay Item	**Pay Unit**
Microwave Vehicle Radar Detector	Each

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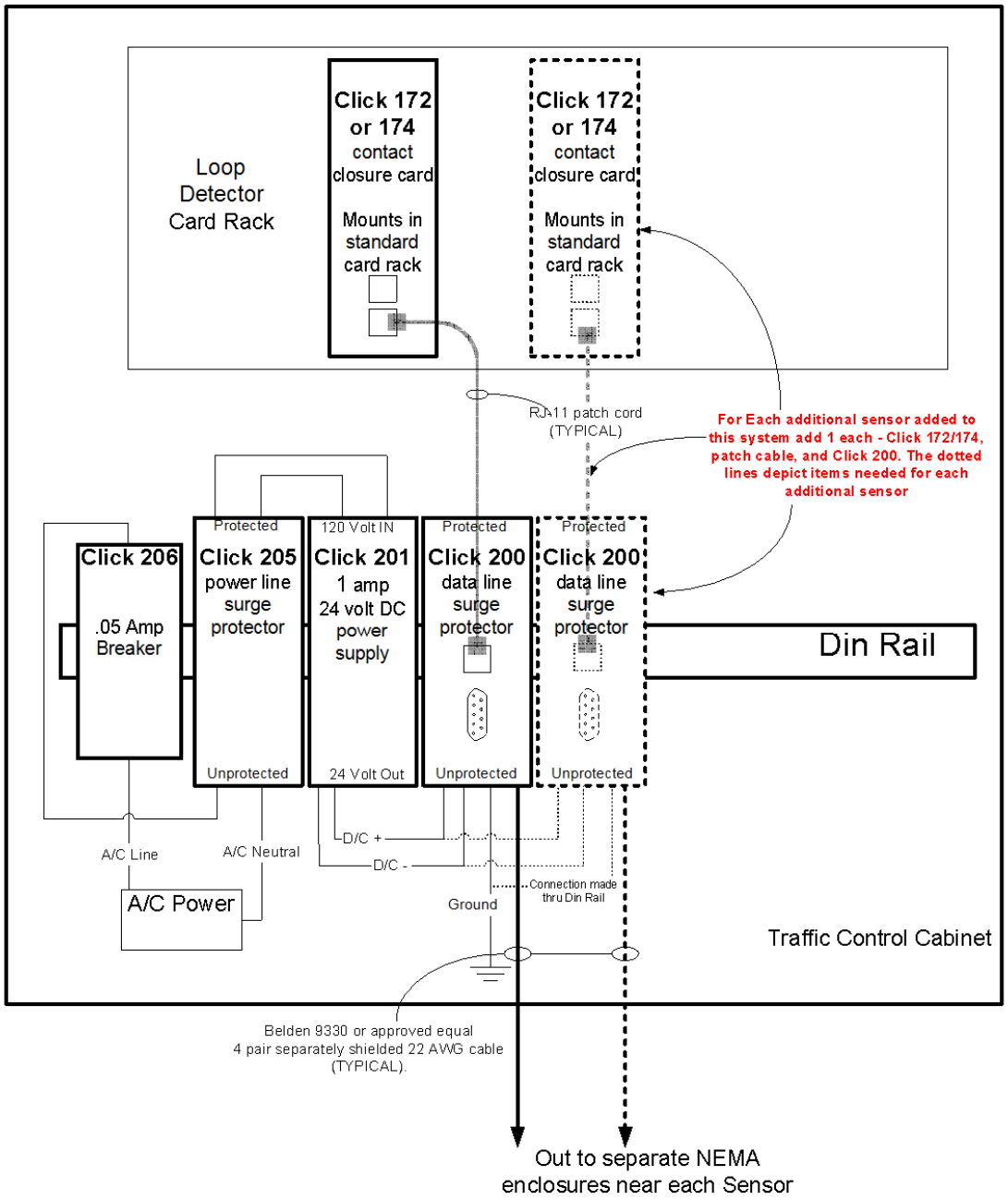
REVISION OF SECTION 614
MICROWAVE VEHICLE RADAR DETECTOR

Drawing showing the equipment needed in the Control Cabinet when Installing Wavetronix SmartSensors with contact closure.



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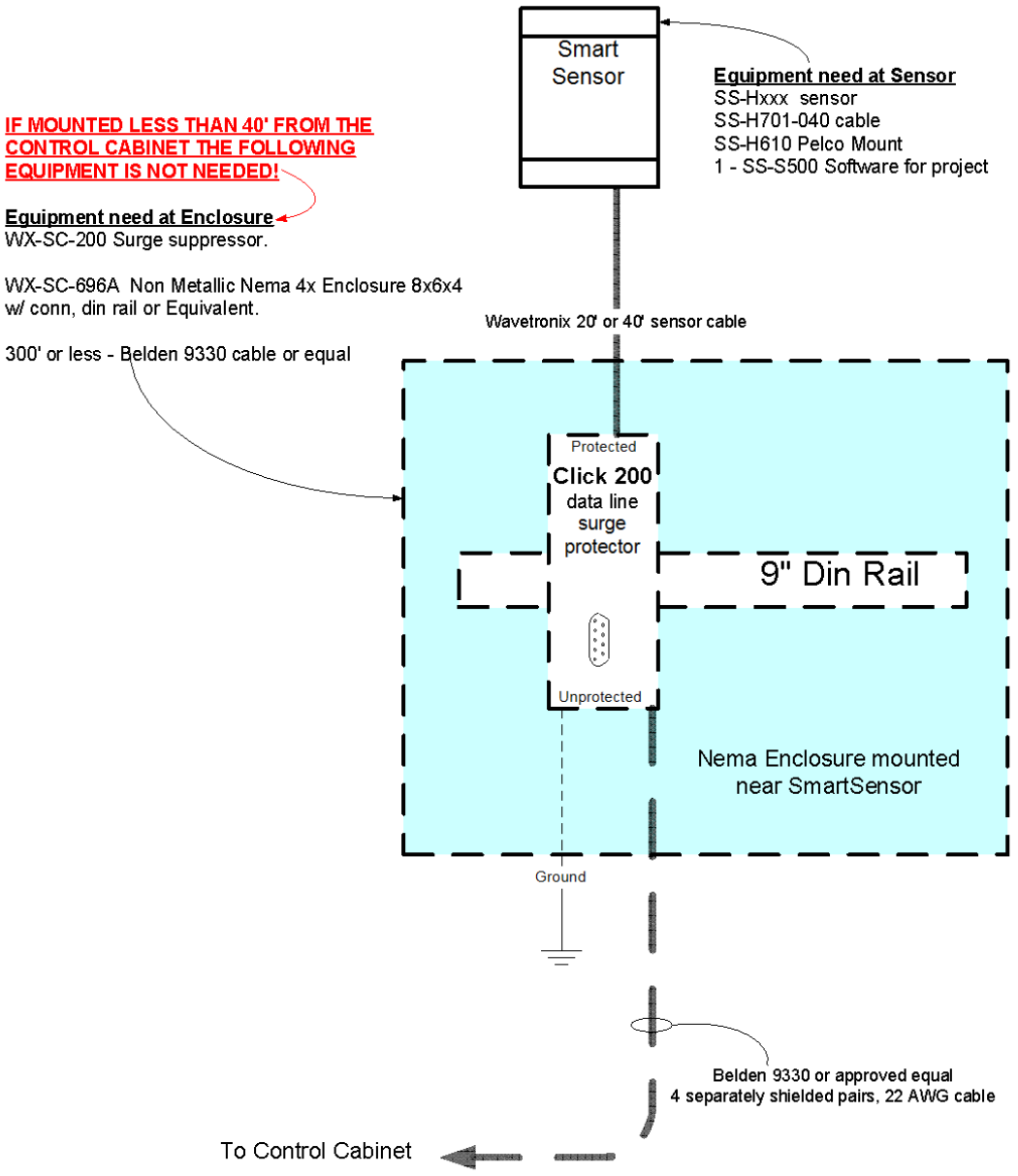
REVISION OF SECTION 614
MICROWAVE VEHICLE RADAR DETECTOR

Equipment drawing for each SmartSensor located less than 300' from control cabinet (as the wire travels).



REVISION OF SECTION 614
SERIAL TO IP CONVERTER

Section 614 of the Standard Specifications is hereby revised to include the following:

DESCRIPTION

This work consists of furnishing and installing a 2-port, hardened serial-to-IP terminal server as shown on the plans. The serial-to-IP converter shall be used to convert serial data to IP Ethernet for use with an IP Ethernet network.

MATERIALS

The serial-to-IP converter shall have four (4) serial port connections which convert serial data to an Internet Protocol (IP) network over a single TCP/IP connection of 10/100 Mbps. The converter shall be stand alone. The converter shall have the capability of operating with a temp range of -35 degrees C to 74 degrees C. A power supply shall be provided for each unit to make the unit wholly functional.

Cables shall be provided for connection to the end equipment and in turn to the Ethernet switch. Serial connection shall be appropriately mated to the end equipment on one end and a RJ-45 male connector on the other. Connections to the Ethernet switch shall be by Ethernet CAT-5e cabling with RJ-45 connectors on both ends. Cable length shall be sized accordingly to allow connectivity between the unit and device, plus nominal slack.

The converter shall support RS-232, RS 422, and RS-485 serial communications at baud rates of up to 230 Kbps throughputs on all ports with up to 64 Kbps of port buffering. All ports shall have TCP and UDP socket support.

Converter shall be supplied with software for configuring the unit and communication ports using Windows operating systems.

CONSTRUCTION REQUIREMENTS

The Contractor shall furnish and install the unit, power supply, and all cabling necessary for the Serial to IP Converter. This shall include all cable termination and copper wiring using current industry standards for cable management and workmanship techniques.

All cables shall be labeled on both ends indicating the individual connections. Labels shall be vinyl, self laminating type with black lettering on a white background.

The serial-to-IP converter shall be installed in accordance with the details in the plans and in accordance with manufacturer’s recommendations.

METHOD OF MEASUREMENT

Serial to IP Converter will be measured by the actual number of wholly-functioning converters installed and accepted. Set-up software shall also be provided.

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REVISION OF SECTION 614
SERIAL TO IP CONVERTER

BASIS OF PAYMENT

Payment will be under:

Pay Item	**Pay Unit**
Serial to IP Converter	Each

Payment will be full compensation for all labor, materials and equipment required to complete the work.

REVISION OF SECTION 614
FIBER OPTIC TERMINATION PANEL - 6 FIBER

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

DESCRIPTION

This work consists of furnishing and installing 6-port fiber optic termination panels in field communications cabinets for single mode fiber. The 6-port termination panels shall be secured to the side of the communications cabinets.

MATERIALS

Configurations shall be as shown in the project plans and special details. The configurations of patch panels shall be as follows:

The unit shall meet the design requirements of ANSI/TIA/EIA-568 and the plastics flammability requirements of UL 94 V-0.

Field termination panels shall be provided in all communications cabinets install which require communications via fiber optic cable as shown in the plans. The panels shall be 6-port as shown on the plans and provided with ST type bulkheads. The panel shall be sized to accommodate the entry of the lateral fiber optic cable, the fiber fan-out, and bulkheads.

CONSTRUCTION REQUIREMENTS

All hardware shall be installed in accordance with manufacturer's recommendations. The Contractor shall provide the Project Engineer with documentation and all manuals. All connector housings shall have a labeling scheme that complies with ANSI/TIA/EIA-606.

METHOD OF MEASUREMENT

Fiber optic termination panels and splice trays will be measured by the actual number of fiber optic termination panels and splice trays installed and accepted. Fiber optic pre-connectorized patch cables shall be included in the cost of termination panels installed.

BASIS OF PAYMENT

Payment will be under:

Pay Item	Pay Unit
Fiber Optic Termination Panel - 6 Fiber	Each

Payment will be full compensation for all labor, materials and equipment required to complete the work.

REVISION OF SECTION 614
FIBER OPTIC CABLE (SINGLE MODE)

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing single mode fiber optic cable.

Fiber optic cable shall be used for either main backbone cable or lateral cables that connect to equipment field cabinets. The main backbone cable shall be terminated in a Communications Node or Regeneration Building. Lateral fiber cables shall be terminated using fan-out kits in a termination patch panel in the field equipment cabinet.

All fiber optic cables shall be suitable for outdoor conduit installation.

MATERIALS

All fiber optic cable shall have compatible chrematistics with proposed and existing cables.

All optical cables furnished on this project shall meet the following fiber optic industry standards:

1. International Telecommunications Union Recommendation G.652 Table D
2. Electronic Industries Alliance (EIA)
3. Telecommunications Industry Association (TIA)
4. International Organization for Standardization (ISO)
5. International Telecommunications Union (ITU)
6. Insulated Cable Engineers Association (ICEA)

All cables shall be new and unused non-armored outdoor cable consisting of dispersion-unshifted, low water peak single-mode fiber strands free of surface imperfections and inclusions. Each single mode fiber shall consist of a doped silica core surrounded by a concentric silica cladding. The fiber shall be of matched clad design.

(a) **Fiber Strands**

1. Typical core diameter of 8.3µm
2. Cladding Diameter of 125. 0 ± 1µm
3. Core-to-Cladding Offset: ≤ 0.5 µm
4. Cladding Non-Circularity: ≤ 1 %
5. Coating Diameter (Colored): 245 ± 10 µm.
6. Maximum Attenuation (Loose Tube): 0.35 dB//km at 1310 nm wavelength and 0.22 dB/km at 1550 nm wavelength
7. Mode-Field Diameter: 9.20 ± 0.30 µm at 1310 nm wavelength and 10.40 ± 0.50 µm at 1550 nm wavelength
8. Attenuation at the Water Peak: 0.32 to 0.34 dB/km at 1383 ± 3 nm wavelength
9. Cutoff Wavelength: ≤ 1260 nm.
10. Zero Dispersion Wavelength: 1300nm to 1322 nm
11. Zero Dispersion Slope: 0.090 ps / (nm^2 • km)
12. Polarization Mode Dispersion: 0.06 ps/ $\sqrt{}_{km}$
13. Maximum Polarization Mode Dispersion at 0.01% distribution (PMDq): 0.20 ps/$\sqrt{}_{km}$
14. Maximum Fiber Dispersion: 3.5 ps/(nm • km) for 1285 nm through 1330 nm and shall be < 18 ps/(nm • km) at 1550 nm.
15. Fiber Curl: ≤ 4.0 m

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REVISION OF SECTION 614
FIBER OPTIC CABLE (SINGLE MODE)

All optical fibers shall be proof tested by the manufacturer to a minimum load of 0.7 GN/m^2 (100 ksi).

The fibers shall not adhere to the inside of the buffer tube.

The coating shall be a dual layered, UV cured acrylate applied by the fiber manufacturer. The coating shall be capable of being mechanically stripped with a force of 0.3 – 2.0 lbf (1.3 – 8.0 N).

Each single mode fiber strand shall be color coded with distinct and recognizable colors in accordance with the most recent version of EIA/TIA-598, Optical Fiber Cable Color, as shown in the plans.

(b) **Buffer Tubes**

Each buffer tube shall contain 6 or 12 fibers as appropriate for the respective size cable.

Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 3.0 mm

Each buffer tube shall be color coded with distinct and recognizable colors in accordance with the most recent version of EIA/TIA-598, Optical Fiber Cable Color, as shown in the plans.

In buffer tubes containing multiple fibers, the coloring shall be stable during temperature cycling as stated under "Fiber Specification Parameters" and shall not be subjected to fading or smearing onto each other or into the buffer tube gel filling material. Colorings shall not cause fibers to stick together.

Buffer tubes shall be of a dual-layer construction with the inner layer made of polycarbonate and the outer layer made of polyester.

Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents.

Buffer tubes shall be stranded around a central member of the cable using a reverse oscillation stranding process.

The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrink requirements of EIA/TIA standards.

(c) **Fiber Cable**

Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.

The central anti-buckling member of the cable shall consist of a glass reinforced plastic rod. The purpose of the central member shall be to prevent buckling.

For single layer cables, a water blocking tape shall be applied longitudinally around the outside of the strand tubes/fillers. The tape shall be held in place by a single polyester binder yarn. The water blocking tape shall be non-nutritive to fungus, electrically non-conductive homogenous. It shall also be free from dirt and foreign matter. Gel filled water-blocking compound shall not be allowed in the cable core interstices in either the backbone cable or the lateral cables.

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REVISION OF SECTION 614
FIBER OPTIC CABLE (SINGLE MODE)

Binders shall be applied with sufficient tension to secure the buffer tubes to the central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking (or rendered so by the flooding compound), and dielectric with low shrinkage.

The cable shall contain at least one ripcord under the sheath for easy sheath removal.

Tensile strength shall be provided by high tensile strength dielectric yarns and shall be helically stranded evenly around the cable core.

Outer cable jacket shall have a consistent thickness throughout the entire cable length and shall be sheathed with medium density polyethylene, (MDPE). The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water blocking tape. The MDPE shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

The cable jacket shall be free of holes, splits and blisters.

Cable jackets shall be marked with sequential foot markings, year of manufacture and a telecommunication handset symbol, as required by Section 350G of the National Electrical Safety Code (NESC). The actual length of the cable shall be within 0 to 1% of the length markings. The marking shall be in contrasting color to the cable jacket. The height of the marking shall be easily readable.

(d) **Environmental Parameters**

1. Shipping, storage and operating temperature range of the cable as defined by Bellcore GR-12 shall be;
    a. -40°C to +75°C (-40°F to +167°F)
2. Operating temperature range of the cable as defined by Bellcore GR-12 shall be; -40°C to +70°C (-40°F to 158°F)
3. Installation temperature range of the cable as defined by Bellcore GR-12 shall be; -30°C to +60°C (-22°F to +140°F)

(e) **Quality Assurance**

1. All optical fibers shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel.
2. The cable manufacturer shall be ISO 9001 registered.

(f) **Packaging**

1. The complete cable shall be packaged for shipment on non-returnable wooden reels.
2. Top and bottom ends of the cable shall be available for testing.
3. Both ends of the cable shall be sealed to prevent the ingress of moisture.
4. Each reel shall have a weatherproof reel tag attached identifying the reel and cable.
5. Each cable shall be accompanied by a cable data sheet that contains significant information on the cable.

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REVISION OF SECTION 614
FIBER OPTIC CABLE (SINGLE MODE)

CONSTRUCTION REQUIREMENTS

The Contractor shall provide the Engineer with two copies of the cable manufacturer's installation instructions for all fiber optic cable. All installations shall be in accordance with the manufacturer's recommendations except as otherwise directed by the Engineer. All additional costs including fiber optic cable associated to damages caused by the Contractor's neglect of recommended procedures shall be the Contractor's responsibility.

The Contractor shall submit a Method Statement to the Engineer indicating cable routing, splice points and cable end splicing locations. Installation of the cable will not be permitted until the schematic diagram has been approved by the Engineer.

Fiber optic cable including both backbone cables and lateral cables shall be installed in continuous runs. Under no conditions shall fiber optic cable be cut or spliced at intermediate points without express written direction from the Engineer.

Blowing cable is an acceptable alternative to pulling cable. If the Contractor chooses to use this method, submittals for cable installation shall be submitted along with complete information on fiber installation equipment.

The maximum pulling tension shall be 2700 N (600 lbs) during installation (short term) and 890 N (200 lbs) long term installed.

All cables shall have a minimum bending radius based on the diameter of the cable and shall meet the following;

1. Pulled under tension, (Short Term) – 20 (Twenty times the cable diameter)
2. Pulled not under tension, (Long Term) – 10 (Ten times the cable diameter)

The fiber optic cable shall be installed in the conduit with a split-mesh cable grip to provide a firm hold on the exterior covering of the cable.

The manufacturer's recommended limits for cable pull lengths shall not be exceeded. The Contractor shall use a pulley system with a numerical readout indicating the cable tension. The pulley system shall be capable of alerting the installer when the cable pulling tension approaches the manufacturer's maximum allowable tension. The Contractor may supplement this procedure with a breakaway tension limiter set below the lowest recommended tensile limit of the cables being pulled. Intermediate pulleys shall be used at all pull boxes or manholes along the installation run to prevent cable damage.

If cable installation limits are met and the entire length cannot be installed completely from the shipping reel, installation shall be continued from the mid-point of the run. The Contractor shall first pull one-half of the cable from the reel at the mid-point through the conduit to one end of the run. The other half of the cable shall be removed from the reel and carefully placed on the ground in a figure eight pattern with a minimum loop diameter of 10 feet. While installing the remaining cable, care shall be taken to avoid any dragging against the ground resulting in damage or excess bending of the cable. The Contractor shall not kink, twist or bend the cable during installation coiling or uncoiling.

The cable shall be continuously lubricated as it enters the conduit. The Contractor shall only use pulling lubricants recommended by the cable manufacturer. Liquid detergent shall not be used.

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REVISION OF SECTION 614
FIBER OPTIC CABLE (SINGLE MODE)

If the Contractor must install new cable in conduits which contain existing fiber or electrical wiring, the Contractor shall be responsible for any damage to the existing cables or wires. After this installation the Contractor shall perform a functional test of all the equipment connected by the existing fiber cables or electrical wiring to ensure proper working conditions.

If an existing fiber optic cable is damaged during construction, it shall be removed from both points of termination and replaced, at no cost to the project. In no case shall the fill of any new conduit exceed the requirements of the National Electrical Code. The Contractor shall provide documentation to the Engineer supporting the conduit fill. All costs associated with equipment testing and repairs shall be included in the cost of the Fiber Optic Cable.

Lateral cables shall be installed in continuous runs from the backbone splice location to the field equipment cabinet. Odd length cables and reel ends are acceptable for lateral cables provided they are pre-tested and free of defects and are of sufficient lengths to archive continuous runs.

Lateral cables shall have slack and include a maximum of three locations of appropriate strain relief within all field equipment cabinets.

All fiber optic cables shall include identification labels attached to the cable in each pull box, manhole or field equipment cabinet. The label shall be provided with information as shown on the Project Detail Sheet.

The Contractor shall coil 50 feet of lateral cable in the manholes and pull boxes.

The Contractor shall ensure that all cable coils and splice canisters are attached to the cable management hardware in all pull boxes and manholes.

The Contractor shall terminate the lateral cable at the field equipment cabinet using a buffer tube fan-out kit. Fanned-out fiber strands shall be terminated in a termination block with ST connectors.

The Contractor shall submit a final documentation package. The final documentation package shall include the cable manufacturer's installation procedures, technical support documentation and material documentation. These documents shall match the original submittals provided to the Engineer.

METHOD OF MEASUREMENT

Fiber Optic Cable shall be measured by the Linear Foot for both backbone and lateral cable and shall include all labor and materials required to install, splice and terminate the cable to make a complete and operational system and shall include the following items:

1. All required splice closures and splice closure reseal kits shall be furnished and provided to CDOT ITS for installation by Comcast.
2. All required termination panels in field equipment cabinets.
3. All required fan-out kits, hardware and labor to accomplish fan-out.
4. All required termination connectors, adapters, jumpers, pigtails, hardware and labor required to accomplish lateral cable terminations.
5. Identification labels for both backbone and lateral fiber cables in each pull box, manhole and field equipment cabinet.
6. As Built Documentation

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REVISION OF SECTION 614
FIBER OPTIC CABLE (SINGLE MODE)

BASIS OF PAYMENT

Payment for Fiber Optic Cable will be made upon completion of cable installation and the review and acceptance of all fiber test results showing the conformance to this specification and the 614 Test Fiber Optic Cable Specification included in this plan package.

Payment will be made under:

Pay Item	**Pay Unit**
Fiber Optic Cable (Single-Mode) (12 Strands)	Linear Foot

REVISION OF SECTION 614
BUFFER TUBE FAN-OUT KIT

Section 614 of the Standard Specifications is hereby revised to include the following:

DESCRIPTION

For this project, the Buffer Tube Fan-out Kit shall be furnished and installed on 12-strand single mode fiber optic lateral cable ends in field communications cabinets.

MATERIALS

The Contractor shall use fiber optic fan-outs on the 12 fiber single mode lateral cable in the communications cabinet. Fanned out cables shall be installed on the ends of lateral fiber cable strands. Buffer tubes for lateral fiber strands shall be 9mm minimum and shall be neatly coiled and secured within the field termination panels with tubes matching the lateral fiber strand color. Bulkhead connectors shall be terminated on the ends of the lateral cable strands and installed on the back side of the termination panels.

METHOD OF MEASUREMENT

Buffer Tube Fan-Out Kit will be measured by the actual number of 12 fiber fan-out kits installed, terminated, and accepted.

BASIS OF PAYMENT

Payment will be made under:

Pay Item	**Pay Unit**
Buffer Tube Fan-out Kit	Each

Payment will be full compensation for all labor, materials and equipment required to complete the work.

REVISION OF SECTION 614
AUTOMATIC TRAFFIC RECORDING STATION

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of the installation of loop detector wires, or loops, piezoelectric axle sensors (piezo), and providing a telephone drop/connection for the Automatic Traffic Recorder (ATR). Work shall be in accordance with this specification and as shown on the plans.

This work also consists of resetting a Division of Transportation Development Automatic Traffic Recorder (DTD ATR) that was relocated and stored during Construction Package 1A, which includes a communications cabinet, traffic counter, porch-style fiberglass base, and related materials and equipment. All infrastructure shall be in place for the ATR station before the temporary ATR station is taken out of service. All work shall be coordinated with Mike DelCupp, 303-748-0946.

MATERIALS

Loop detector wire shall consist of specified loop wire encased in ¼ inch OD, 3/16 inch ID vinyl or polyethylene tubing. (14-1/C Loop detector cable 19 STR. PVC/Nylon/PVC Tube 600v IMSA 51-5)

Loops shall be sealed with a two-part self-curing, self-bonding weatherproof epoxy approved for sealing loops. Loops shall be 6 feet by 6 feet.

The piezo shall be class II and 6 feet in length. The piezo shall have sufficient lead in cable, so the lead in cable can be pulled in to the cabinet without splicing.

Grout or epoxy for the installation of the loops and piezos shall conform to manufacturer's recommendations.

Conduit and Pull boxes shall be in accordance with Section 613.

CONSTRUCTION REQUIREMENTS

(a) *General.* A minimum of five days prior to installation, the contractor shall submit a schedule of installation activities including alternative scheduling to the CDOT Project Manager and the Traffic Data Collection (TDC) Manager (Mike DelCupp 303-757-9816 robert.delcupp@dot.state.co.us). The installation instructions from the manufacturer shall also be submitted for approval. Installation of loops and piezos shall not begin until approval has been received from CDOT.

The Contractor shall install the loops and piezos as close to the locations shown on the plans as possible. Exact locations, dimensions, and configurations may vary based on site conditions, and shall be as approved by CDOT.

All work will be inspected by the Traffic Data Collection Unit (TDC) during installation. Acceptance will be based on the testing and operation of the piezos and loops under actual traffic conditions, in which one week of actual data will be collected. The volume and vehicle class shall be within ±10 percent for the site compared to historical data for the same time period. There shall be no more than 1 percent sensor misses in any one lane for the same time period.

The Contractor shall reset the ATR cabinet that was removed and stored in Package 1A in the new location on a new fiberglass, porch-style base. Communications equipment and electrical equipment shall be reset.

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REVISION OF SECTION 614
AUTOMATIC TRAFFIC RECORDING STATION

Communications cabinet, DTD ATR and power source shall be installed in accordance with these specifications, the details shown in the Plans, and in accordance with manufacturer's recommendations.

(b) *Installation of loops.* Loops shall be centered in the travel lane with two sides parallel to lane striping. The saw cut for the loops shall be made 3/8 inch wide and 3-½ inches deep. The saw slot shall be as straight as possible and shall not vary more than ½ inch when checked with a straightedge. No more than one set of loop lead wires shall be placed in one saw slot. Saw cuts shall be hydro-blasted with a mixture of water and air and then blown free of water and debris with compressed air, using a large capacity air compressor of at least 150 CFM. The cuts shall be dry prior to placement of loop wire.

(c) The contractor shall locate all buried utilities, which may interfere with the planned location of the ATR site. The Contractor shall contact the Utility Notification Center of Colorado (UNCC) at 811 or 1-800-922-1987 for location of member utilities at least three working days prior to any excavation, not including the day of actual notice.

The Contractor shall also locate non-member utilities, such as storm sewer and ditch. Any utility conflicts encountered with the proposed installation shall be brought to the attention of the Engineer

After the saw slot is cleaned of debris and dried, the wire shall be placed for the loop by pushing it into the slot with a blunt non-metallic object. A screwdriver or other sharp tool will not be permitted. Care shall be used to avoid abrading or damaging the insulation.

All loop corners shall be rounded using a 1-½ inch hole drilled to a minimum depth of 3-½ inches. Loop leads shall be drilled when leaving the roadway surface at a 45 degree angle 8 inches from pavement edge out through the side or bottom of roadway, the drilled hole shall be no larger than ¾ of an inch. All holes shall be spaced a minimum of three inches from one another. No more than one set of loop lead wires shall be placed in one drill hole.

One continuous length of loop wire shall be used for each loop from pull box or cabinet around the loop with 4 turns and back to the pull box or cabinet with no splices. The wires shall be seated in the bottom of the saw slot. A ½-inch backer-rod shall be installed to insure wires do not float to the surface during grouting. Backer-rod shall be installed in 4 to 6 inch pieces with 1 to 2 foot gaps in-between, to insure the sealant will come in contact with the loop wire. One continuous piece of backer-rod will not be allowed.

Prior to sealing the loop, loop lead and feeder slots, a loop continuity test will be performed. The test will be performed by the TDC representative. Loop continuity shall be no higher than 1 ohm. Loop continuity higher than 1 ohm shall be cause for replacement of the loop. Replacement shall be at the Contractor's expense.

After the loops are properly seated and tested, the slots shall be filled with a two-part self-curing, self-bonding epoxy or grout, as recommended by the manufacturer. Excess epoxy shall be removed to avoid unnecessary high spots, and level with the roadway surface.

Loop leads shall be pulled into cabinet without splices to match original installation when applicable.

All detector loops shall measure six feet by six feet.

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REVISION OF SECTION 614
AUTOMATIC TRAFFIC RECORDING STATION

Installation at an ATR count or classification site shall consist of one loop or one loop set (two loops) within a single lane. The loop sets shall be separated by 10 feet, plus or minus 1 inch, resulting in a distance of sixteen feet from the leading edge of the first loop in the direction of travel to the leading edge of the second loop.

Loop and loop leads shall be installed directly into the pavement, to pavement edge, pull box or cabinet. If loops are installed during asphalt paving, the loops shall be installed before the final lift is placed.

Loop lead wires from pavement edge to pull box shall be enclosed in ¾ inch PVC conduit or ¾ inch rubber hose to protect wire from abrasion. Loop lead-in pairs from pavement edge, to pull box, shall be symmetrically twisted 5 turns per 1 foot. Pull boxes or cabinet shall contain a minimum of 3 feet of loop lead wire for splicing. All loop and loop leads shall be clearly labeled in all pull boxes and or cabinet. The Contractor shall be responsible for all trenching and digging from pavement edge to pull box.

All splices shall be made with approved waterproof pressure connector. All splices shall be capable of satisfactory operation under continuous submersion in water.

(d) *Piezo Installation*

The piezo shall be permanently installed by grouting into the roadway, flush to 1/16 of an inch above the roadway surface by grouting into a concrete roadway or the final lift of asphalt.

Piezo sensors shall be installed in compliance with the manufacturer's recommendations.

The piezo shall be tested for capacitance and dissipation factor, prior to and after installation using a LCR meter. Capacitance and dissipation shall be within ±20 percent of the data sheet supplied with the piezo.

Prior to acceptance of the site, the TDC will test the piezo for voltage and signal quality with live traffic. Voltage shall be no lower than 80 millivolts on the front axle of a class II vehicle (car).

At an ATR axle classification site, one 6 foot piezo sensor per lane shall be installed at the exact midpoint between the two loops and to the right or left side of the line, centered in the wheel path.

The saw cut shall be as straight as possible and shall not vary more than ½ inch when checked with a straightedge. The size of the saw cut shall be to the manufacturer's specifications and not vary more then 1/8 of an inch in width. The slot for the piezo lead wire shall be 3 inches deep and 3/8 of an inch wide. Only one piezo lead wire shall be placed in the saw slot.

Piezo lead shall be drilled when leaving the roadway surface at a 45 degree angle 8 inches from the pavement edge out through the side or bottom of the roadway, the drilled hole shall be no larger than ¾ of an inch. All holes shall be spaced a minimum of 3 inches from one another. No more than one piezo lead wires shall be placed in one drill hole.

Saw cuts shall be hydro-blasted with a mixture of water and air and then blown free of water and debris with compressed air, using a large capacity air compressor of at least 150 cubic feet per minute. The cuts shall be dry and cleaned with acetone prior to placement of the piezo.

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REVISION OF SECTION 614
AUTOMATIC TRAFFIC RECORDING STATION

The piezo shall not be installed if roadway surface temperature is not above the manufacturer's recommended minimum temperature, or cannot be maintained above this temperature for a minimum of two hours after installation. The piezo shall not be installed if roadway surface temperature is above the manufacturer's highest recommended temperature for grout installation.

The piezo lead wire shall be placed in the saw slot with a blunt non-metallic object. ½ inch backer-rod shall be installed to insure the wire does not float to the surface during grouting. Backer-rod shall be installed in 4 to 6 inch pieces with 1 to 2 foot gaps in-between, to insure the sealant will come in contact with the piezo lead wire. One continuous piece of backer-rod will not be allowed.

The sealant for the piezo lead wire shall be the same as used for loops.

Piezo lead wire shall be pulled into the cabinet without splices, unless the length exceeds 300 feet.

Only one lead wire shall be placed in a saw slot.

Piezo lead wires from pavement edge to pull box shall be enclosed in ¾ inch PVC conduit or ¾ inch rubber hose, to protect wire from abrasion. Pull boxes or cabinet shall contain a minimum of three feet of piezo lead wire for splicing. Lead wire shall be clearly labeled as approved by the Engineer and the TDC.

All splices in piezo wiring shall be soldered and enclosed in a resin filled splice kit.

(e) *Pull Boxes.* All pull boxes on the shoulder of the roadway surface shall be raised to finished grade or level with the surrounding ground. If the shoulder has been raised to the point that the conduit is below the bottom of the pull box, then the conduit shall be raised. All wiring splices for existing wiring shall be a minimum of 12 inches in length above the conduit.

All existing pull boxes that are found to be damaged shall be replaced.

(f) *Water Valves.* A minimum of two feet of slack shall be provided on the loop and piezo wires that are contained in water valves.

No splices shall be allowed in water valves.

(g) *Pull Rope.* A 1/8 inch nylon pull rope shall be installed in all new conduits and all existing conduits where a wire or cable is added or an existing wire or cable is replaced.

(h) *Conduit*. The contractor shall seal all conduits with a sealing compound where a wire or cable is added or an existing wire or cable is replaced. The sealing compound shall be UL tested and approved for use. Sealing compound shall be a permanently soft, fibrous, non-staining sealer that can be easily applied and removed by hand at all working temperatures. Sealing compound shall be designed to seal out weather, moisture, dust rodents and atmospheric conditions both indoors and outdoors. No foam sealant will be allowed.

(i) *Telephone Drop/Connection*. The contractor shall provide a telephone drop/connection to the ATR cabinet for connection to DTD and reestablish communications using the reset field telemetry.

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REVISION OF SECTION 614
AUTOMATIC TRAFFIC RECORDING STATION

METHOD OF MEASUREMENT

Automatic Traffic Recording Station will be measured by the actual whole system as installed and accepted.

BASIS OF PAYMENT

Payment will be under:

Pay Item	**Pay Unit**
Automatic Traffic Recording Station	Each

Payment will be full compensation for all labor, materials and equipment required to complete the work.

REVISION OF SECTION 614
CLOSED CIRCUIT TELEVISION

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing an Internet Protocol (IP) Closed Circuit Television (CCTV) camera at the locations shown on the Plans.

MATERIALS

The CCTV camera shall include: camera with weatherproof dome housing, pole mount adapter, Power over Ethernet (PoE) midspan module, manufacturer supplied management software, Cat-6 Ethernet cables, and all attachment hardware to complete installation.

Camera Specifications:

The pan-tilt-zoom camera shall be of dome type construction and shall be enclosed in a sealed, heated environmental video dome housing to operate in 93% humidity at a minimum operating temperature of -40° to 122°F carrying both IP66 and NEMA 4x ratings. The camera shall utilize Ethernet protocol for native communications and be capable of sending multiple individually configurable video streams in H.264 and MJPEG format up to 30fps and capable of gathering a minimum of 50 preset color video still frame images with a minimum 176x120 resolution and maximum 704x480. The camera shall have an internal web interface for configuration with security functionality allowing multiple user access levels with password protection. The camera shall support Ipv4/v6, HTTP, HTTPS, SSL/TSL, QOS Layer 3 DiffServ, FTP, SMTP, SNMP v1/2/3, UpnP, DNS, DynDNS, NTP, RTSP, TCP, UDP, IGMP, RTCP, ARP, SOCKS.

Technical specifications for the camera shall be as follows:

1. The lens shall be f=3.4 to 119mm, F1.4 to 4.2, autofocus; focus range of 35 mm (wide) to 800 mm (telephoto) to infinity. The angle of view shall be 2.8°- 48° horizontal with minimum zoom capability of 35x optical and 12x digital
2. Minimum illumination color 0.5 lux at 30 IRE and B/W 0.005 lux at 30 IRE
3. The camera shall provide dual mode, day (color) and night (monochrome) video down to 0.008 lux
4. Shutter speed shall be variable from 1/30000 to 0.5 seconds at 60Hz.
5. The pan function shall provide 360° of continuous rotation at 0.05 – 450°/s and a 220° tilt range allowing for 20° view above the horizon at 0.05 – 450°/s

Pole-mount adapter arm and bracket:

The adapter shall have a minimum 33 lb load rating and have provisions that allow mounting directly to the weatherproof dome housing without modification to the housing. The adapter bracket shall have slots for a minimum of 2 straps or banding material for mounting to the poles from 3 inches to 6 inches in diameter. The bracket shall have cable strain relief in at least two locations on the reverse side, (between the bracket and the pole).

PoE midspan module:

Power for the camera shall be by means of a high power over Ethernet midspan module with a pass through port for all Ethernet communications. The module shall meet IEEE 802.3at and 802.3af standards and operate at temperatures from -40°F to +122°F. The PoE module shall allow 100-240 VAC input and 55 VDC output at 60W and operate at temperatures from -40°F to +122°F.

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REVISION OF SECTION 614
CLOSED CIRCUIT TELEVISION

Manufacturer's supplied management software:

Management software shall give the user access to discover and configure the camera using standard network protocols. Software shall allow for network setup and firmware updates.
Cat6 Ethernet cable:

Cable shall be a UTP cable, Category 6 rated and constructed of 24 AWG stranded copper wires. The outer jacket shall be UV resistant PVC insulation. The Ethernet cable shall be terminated with male 8P8C connectors as a 'straight through' cable using the Telecommunications Industry Association / Electronic Industries Alliance (TIA/EIA) T- 568B pin/pair assignments.

CONSTRUCTION REQUIREMENTS

The CCTV camera shall be installed in accordance with these specifications, the details shown in the Plans, and in accordance with manufacturer's recommendations. The Contractor shall make all arrangements for a qualified manufacturer's representative to be on-site to ensure proper installation of the CCTV camera.

The weatherproof dome housing shall be attached to the pole mount adapter using the materials supplied from the manufacturer.

For the attachment of the adapter bracket to the pole, a ¾ inch type 201 stainless steel strap used in conjunction with type 201 stainless steel buckles at a mounting height shown on the Plans. The attachment shall be banded to the pole at an orientation to achieve the optimal view of both the main roadway and crossroad or as directed by the Engineer.

A maximum 1 inch hole shall be drilled in the mounting pole to allow passage of the Ethernet cable. The hole shall be free of burs and sharp edges prior to the installation of the Ethernet cable. The Ethernet cable shall be attached to the reverse side of the mounting bracket to ensure proper strain relief or damage caused to the camera or housing. The Ethernet cable shall run down the interior of the pole and exit through non-metallic flexible conduit to the communication cabinet. The non-metallic flexible conduit shall be weather sealed on each end to eliminate exterior liquid entry. The Contractor shall also provide a weather seal for the adapter bracket at the 1 inch hole at the top of the pole per the manufacturer's recommendations.

The PoE midspan module shall be securely mounted in the communication cabinet and plugged into the communications power outlet. The Ethernet cable attached to the camera shall be connected to the PoE midspan output jack. A separate Cat 6 Ethernet cable shall be provided for connection to the field communication device.

METHOD OF MEASUREMENT

Closed Circuit Television will be measured by the actual number of Closed Circuit Televisions installed and accepted for a complete installation. Also included shall be all configuration, cabling, dome housing, adaptor arm, adaptor bracket, and PoE midspan module. All costs associated with arranging for the manufacturer's representative to be on-site will not be measured and paid for separately, but shall be included with the cost of the CCTV.

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REVISION OF SECTION 614
CLOSED CIRCUIT TELEVISION

BASIS OF PAYMENT

Payment will be made under:

Pay Item	**Pay Unit**
Closed Circuit Television	Each

Payment will be full compensation for all labor, materials and equipment required to complete the work.

REVISION OF SECTION 614
TEST FIBER OPTIC CABLE

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

DESCRIPTION

Testing shall be performed to assure the cable's performance and durability in the field environment. It shall conform to the following industry standards organizations:

1. Electronic Industries Alliance (EIA)
2. Insulated Cable Engineers Association (ICEA)
3. International Electrotechnical Commission (IEC)
4. International Organization of Standardization (ISO)
5. International Telecommunication Union – Telecommunication Standardization Sector (ITU-T)
6. Telcordia Technologies, Inc. (Telcordia)
7. Telecommunications Industry Association (TIA)

The industry standards shown in the table below shall be referenced throughout this section by its Section Standard Number (SSN).

SSN	Standard	Edition	Fiber Optic Test Procedure (FOTP)	Standard Title
8-1	TIA-526-7	02	7	Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
8-2	TIA-455-78	B	78	Optical Fibers: Attenuation Measurement Methods and Test Procedures
8-3	ICEA S-84-608	07	N/A	Telecommunications Cable Filled, Polyolefin Insulated, Copper Conductor Technical Requirements
8-4	ICEA S-85-625	07	N/A	Telecommunications Cable Aircore, Polyolefin Insulated, Copper Conductor Technical Requirements
8-5	ITU-T G.652	05	N/A	Characteristics of a Single-Mode Optical Fiber and Cable
8-6	TIA-455-3	B	3	Procedure to Measure Temperature Cycling Effects on Optical Fiber Units, Optical Cable and Other Passive Components
8-7	EIA-359		N/A	Colors for Color Identification and Coding
8-8	TIA-598	C	N/A	Optical Fiber Cable Color Coding
8-9	TIA-455-82	B	82-B	Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable
8-10	TIA/EIA-455-81	B	81	Compound Flow (Drip) Test for Filled Fiber Optic Cable
8-11	TIA/EIA-455-41	A	41	Compressive Loading Resistance of Fiber Optic Cables
8-12	TIA-455-104	A	104	Fiber Optic Cable Cyclic Flexing Test
8-13	TIA/EIA-455-25	C	25	Impact Testing of Optical Fiber Cables

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REVISION OF SECTION 614
TEST FIBER OPTIC CABLE

SSN	Standard	Edition	Fiber Optic Test Procedure (FOTP)	Standard Title
8-14	TIA-455-33	B	33	Optical Fiber Cable Tensile Loading and Bending Test
8-15	TIA-455-85	A	85	Fiber Optic Cable Twist Test
8-16 NOT USED	TIA/EIA-455-181	93	181	Lightning Damage Susceptibility Test for Fiber Optic Cables with Metallic Components
8-17	TIA/EIA-455-226	02	226	Calibration of Optical Time-Domain Reflectometers
8-18	TIA-455-231	03	231	Calibration of Fiber Optic Power Meters
8-19	ISO/IEC 17025	05	N/A	General Requirements for the Competence of Testing and Calibration Laboratories
8-20	TIA-455-37	A	37	Low or High Temperature Bend Test for Fiber Optic Cable
8-21	TIA/EIA-455-98	A	98	Fiber Optic Cable External Freezing Test
8-22	Telcordia GR-20 CORE	3	N/A	Generic Requirements for Optical Fiber and Optical Fiber Cable
8-23	ISO 9000	N/A	N/A	International Standards for Quality Management

8.10: FIELD TESTING

8.10a: Prior to completion of the work, the CONTRACTOR shall run the following tests on all traffic signals in the presence of the ENGINEER or the signal maintenance contractor.

8.10b: Each circuit shall be tested for continuity and for grounds.

8.10c: A functional test shall be made in which it is demonstrated that each and every part of the system functions as specified or intended herein. The functional test for each traffic signal system shall consist of not less than thirty (30) days of continuous, satisfactory operation commencing with full operation of all electrical facilities.

8.10d: When fiber optic cable is installed, the fiber optic cable test shall consist of the testing of single mode fiber optic cable. The testing procedures involve an Optical Time Domain Reflectometer (OTDR) test and an Optical Power Meter Test.

The guidelines for fiber optic cable testing include:

1. Launch box and test jumpers must be of the same fiber core size and connector type as the cable system:

   i) Singlemode fiber 8.3/125 μm

2. The light source and OTDR must operate within ±20 nm of the 1310/1550 nm singlemode nominal wavelength for testing in accordance with SSN 8-1.

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REVISION OF SECTION 614
TEST FIBER OPTIC CABLE

3. The power meter and the light source must be set to the same wavelength during testing.

4. The OTDR and power meter must be calibrated at each of the nominal test wavelengths and traceable to the National Institute for Standards and Technology (NIST) calibration standards. The calibration of the OTDR and power meter shall conform to the requirements set forth in SSN 8-17 and 8-18, respectively.

5. All system connectors, adapters and jumpers must be cleaned as per manufacturer's instructions before measurements are taken.

MATERIALS

A) Fiber Optic Cable Testing Equipment. Equipment shall be calibrated biennially by the manufacturer or by a SSN 8-19 accredited calibration laboratory. A copy of the most recent certificate of calibration and any out-of-tolerance conditions shall be provided to the ENGINEER prior to the initiation of any testing activities. The following is equipment and information is required to perform fiber optic cable tests:

1. an OTDR (submit certification and put in checklist)
2. a launch box (min length – 300 m)
3. a light source at the appropriate wavelength
4. Optical Power Measurement Equipment capable of measuring optical power in dBm.(submit certification in checklist
5. CPR Test Jumper-1 and Test Jumper-2 shall be 1-4 meters long with connectors compatible with the light source and power meter and have the same fiber construction as the link segment being tested per SSN 8-1.
6. Jacket Length measurements for lateral and backbone cable at each end including splice enclosures and patch panels.
7. Bare fiber slack not accounted for in jacket length.

B) Optical Fiber Cable Testing with OTDR. The CONTRACTOR shall perform an OTDR test of all fibers in all tubes on the reel, prior to installation of the fiber. The test results shall be supplied to the ENGINEER prior to installation of the cable.

Fiber testing shall be performed on all terminated fibers from patch panel to patch panel and unterminated fibers from end to end. Additionally, mid entry splices into mainline cables require testing of all strands in the mainline cable, before and after installation. Testing shall consist of a bi-directional end-to-end OTDR trace performed per SSN 8-2. The system margin loss measurements shall be provided at dual wavelengths 1310 and 1550 for singlemode fibers.

Tables to be filled out by contractor for OTRD results.

1. Pulse width
2. Layout

OTDR readings will be used to ensure proper installation and to troubleshoot faults. OTDR signature traces will be used for documentation and maintenance. An OTDR provides an indirect estimate of the loss of the cable plant; generally, more accurate or reliable values will be obtained by using an Optical Power Meter.

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REVISION OF SECTION 614
TEST FIBER OPTIC CABLE

Loss numbers for the installed link shall be calculated by taking the sum of the bi-directional measurements and dividing that sum by two.

The CONTRACTOR shall use an OTDR that is capable of storing traces electronically and shall save each final trace.

To ensure the traces identify the end points of the fiber under test and the fiber designation, the CONTRACTOR shall use a test reel if required, to eliminate the "dead zone" at the start of the trace so that the start of the fiber under test can be identified on the trace. Indicate the length of the test reel for all test results.

If the fiber designation is not indicated on the trace itself, the CONTRACTOR shall provide a cross-reference table between the stored trace file name and the fiber designation.

In compliance with SSN 8-2 , the CONTRACTOR shall record the following information during the test procedure:

1. Name and contact information for individual responsible for conducting the test.
2. Type of test equipment used (manufacturer, model, serial number, calibration date and valid certification of calibration).
3. Date test is being performed.
4. Jacket readings in and out of each splice vault and each pullbox
5. Corrected index of refraction – use refraction recommended by Cable manufacturer.
6. Optical source wavelength and spectral width.
7. Fiber identification.
8. Start and end point locations.
9. Launch conditions
10. Method of calculation for the attenuation or attenuation coefficient.
11. Acceptable link attenuation.

C) Optic Fiber Cable Testing with Optical Power Meter. The CONTRACTOR shall conduct an Optical Power Meter Test for each fiber installed.

Singlemode segments shall be tested in one direction at both the 1310 nm and 1550 nm wavelength.

In compliance with SSN 8-1, the following information shall be recorded during the test procedure:

As above
1. Names of personnel conducting the test.
2. Type of test equipment used (manufacturer, model, serial number, calibration date).
3. Date test is being performed.
4. Optical source wavelength, spectral width,
5. Fiber identification.
6. Start and end point locations.
7. Test direction.
8. Reference power measurement (when not using a power meter with a Relative Power Measurement Mode).

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REVISION OF SECTION 614
TEST FIBER OPTIC CABLE

9. Measured attenuation of the link segment.
10. Acceptable link attenuation.

D) Acceptable Attenuation Values. Acceptable attenuation values shall be calculated for each fiber tested. These values represent the maximum acceptable test values.

1. *Singlemode Fiber.* The general attenuation equation for any singlemode link segment is as follows:

   Acceptable Link Attn. = Cable Attn. + Connector Attn. + Splice Attn.

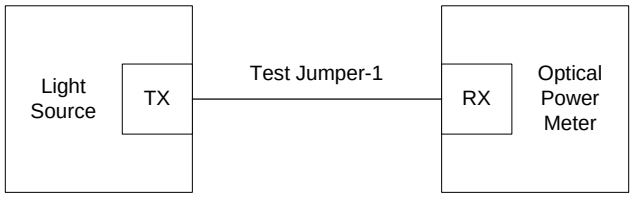
   8.3 μm Single-mode Attenuation Coefficients:

   (i) Cable Attn.=Cable Length (km) x (0.35 dB/km@1310 nm or 0.25 dB/km@1550 nm)
   (ii) (No. of Mated Connections x 0.50 dB)+Connection Attn. (LC connectors)=(No. of Connections x 0.14 dB)+0.24 dB.
   (iii) Splice Attn. (Fusion)=Splices x 0.30 dB.

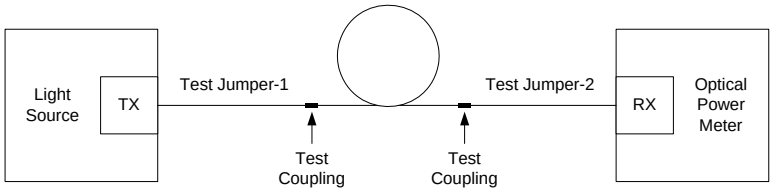
E) Test Procedures. All fiber testing shall be performed on all fibers in the completed end-to-end system.

1. *Singlemode Fiber.* The singlemode Optical Power Meter fiber test shall be conducted as follows:

   i) Clean the test jumper connectors and the test coupling per manufacturer's instructions.
   ii) Follow the test equipment manufacturer's initial adjustment instructions.
   iii) Connect Test Jumper-1 between the light source and the power meter. Avoid placing bends in the jumper that are less than 100 mm (4 inches) in diameter.



   iv) If the power meter has a Relative Power Measurement Mode, select it. If it does not, reduce the Reference Power Measurement (P_{ref}). If the meter can display power levels in dBm, select this unit of measurement to simplify subsequent calculations.
   v) Disconnect Test Jumper-1 from the power meter. Do NOT disconnect the test jumper from the light source.
   vi) Attach Test Jumper-1 to one end of the cable plant to be measured and Test Jumper-2 to the other end.



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TEST FIBER OPTIC CABLE

vii) Record the Power Measurement (P_{sum}). If the power meter is in Relative Power Measurement Mode, the meter reading represents the true value. If the meter does not have a Relative Power Measurement Mode, perform the following calculation:

a) If P_{sum} and P_{ref} are in the same logarithmic units (dBm, dBu, etc.):
CPR (dB) = P_{sum} - P_{ref}
b) If P_{sum} and P_{ref} are in watts:
CPR (dB)= 10 x $\log_{10}$ [O_{sum}/P_{ref}]

F) Test Acceptance. The CONTRACTOR shall demonstrate that the tests result in acceptable attenuation values.

The CONTRACTOR, solely at the CONTRACTOR'S cost, shall resplice any fusion splices and/or reterminate any terminations that have test results exceeding acceptable attenuation values. The CONTRACTOR, solely at the CONTRACTOR'S cost, shall retest any fiber links that have been re-spliced.

The CONTRACTOR, solely at the CONTRACTOR'S cost, shall bring any link not meeting the requirements of this specification into compliance.

G) Submittals. The CONTRACTOR shall submit test results documentation as both a hard copy and electronic copy.

After each reel test, the CONTRACTOR shall submit one hard copy of the OTDR trace for every fiber on the reel. After installation, the CONTRACTOR shall submit one hard copy of the OTDR trace for every fiber. Hard copy traces shall be organized and bound in logical order in an 8 ½" x 11" hard cover binder.

The CONTRACTOR shall submit, after approval of the hard copy traces, electronic copies of all traces (pdf and native file format) and appropriate software, if needed, to allow reading the traces.

The CONTRACTOR shall submit one copy of the complete contract Plans, including additional drawings issued as part of any change orders, with any deviations clearly marked in color. Deviations to be noted and shall include but not be limited to the following:

1. Fiber Splice location
2. Fiber Splice configuration
3. Termination layout

H) 30 Day Burn In Period.

8.10e: During the 30-day burn-in period, the CONTRACTOR is responsible for the maintenance of the system or systems. The cost of any maintenance necessary, except electricity, damage by public or act of God, shall be borne by the CONTRACTOR and will be considered as included in the price paid for the contract item involved, and no additional compensation will be allowed therefore.

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REVISION OF SECTION 614
TEST FIBER OPTIC CABLE

BASIS OF PAYMENT

Payment will be made under:

Pay Item	**Pay Unit**
Test Fiber Optic Cable	Lump Sum

Payment will be full compensation for all labor, materials and equipment required to complete the work.

REVISION OF SECTION 614
FIBER OPTIC SPLICE CLOSURE

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

DESCRIPTION

Subsection 614.01 shall include the following:

Fiber optic splice closures and fiber reseal kits are to be furnished and provided to CDOT ITS. All fiber optic splicing will be performed by Comcast. The contractor shall contact Bill Kascek with CDOT at 303-564-5549 two weeks prior to splicing to coordinate fiber optic cable splicing by Comcast.

MATERIALS

Subsection 614.08 shall include the following:

(u) Fiber Optic Splice Closure. The fiber optic splice canister shall be furnished by the Contractor and provided to CDOT ITS. It shall be sized to provide capacity for splicing the total number of strands in all cables entering the canister.

The splice closure shall be a stand-alone closure that does not require an outer closure and shall meet the following minimum requirements:

1. The closure shall seal, anchor and protect fiber optic cable splices.
2. The closure shall provide for a minimum of two additional spare entries in addition to the required number of cables being spliced up to a maximum of six total cable entries.
3. The closure shall be suitable for underground applications and shall be water and airtight.

The closure shall be sized to provide the capacity equal to the total number of strands in all cables entering the closure.

If an existing closure, or a closure provided by the Contractor requires reentry and resealing, the Contractor shall furnish the fiber reseal kit and provide to CDOT ITS.

It is the Contractor's responsibility to ensure that the fiber optic splice enclosure and associated fiber cable coil fit adequately within the pull box specified on the plans. No additional payment shall be made for modifications to the pull box.

The Contractor shall contact the Bill Kascek with CDOT at 303-564-5549 two weeks prior to work at each splicing location to coordinate fiber optic splicing.

METHOD OF MEASUREMENT / BASIS OF PAYMENT

Subsection 614.13 shall include the following:

Fiber Optic Splice Closure will not be measured or paid for separately but will be considered subsidiary to pay item Fiber Optic Cable (Single Mode).

REVISION OF SECTION 614
ETHERNET SWITCH

Section 614 of the Standard Specifications is hereby revised to include the following:

DESCRIPTION

For this project the Ethernet Switch shall be an IE3000 CISCO Ethernet Access Switch to be installed at roadway Intelligent Transportation System (ITS) devices for data communications from the field device to the regeneration node.

MATERIALS

This Ethernet switch is proposed for the transport of Ethernet data for roadway devices on this project. The Cisco 3000 switch shall be configured with 8 10/100 Ethernet ports in addition to two (2) Small Form-Factor Pluggable (SFP) based 1 Gigabit Ethernet ports. An additional SFP shall be provided at the existing Hidden Valley node building switch.

The Contractor shall furnish and install the Cisco 3000 Ethernet Switch as configured in the item table below. The tables describes items for a single CICSO Ethernet switch

ITEM DESCRIPTION	ITEM NUMBER	QUANTITY
CISCO IE 3000 Switch, 8 10/100 + 2 T/SFP	IE-3000-8TC	1
IE 3000 Power Transformer	PWR-IE3000-AC=	1
Smartnet 8x5xNBD	CON-SNT-IE38TC	1
1000Base LX/LH SFP, Rugged	GLC-LH-SM-RGD=	3*

* One of the SFP Optics shall be installed at the existing Hidden Valley node building switch.

The Ethernet switch shall be installed with a basic configuration in conformance with CISCO Systems by certified CISCO Systems personal either prior to installation or at the installation site. Final configuration for data transport will be conducted by CDOT personnel after installation, basic configuration approval and final acceptance has been given.

The contractor shall place attenuators on the receive end of the optics if necessary. After the fiber has been installed, the contactor shall test the actual loses and base the attenuator on the field conditions.

If field changes are made which would affect the original Contractor order of the Ethernet switch, and would require any reconfiguration of the Ethernet switch order, the Contractor shall ensure that the CISCO Systems representative is contacted and made aware of such changes in order to alleviate any possible delays in the delivery.

All associated hardware not listed in the item table is considered subsidiary and is required for a complete installation and shall be included as part of the work.

If for any reason the switch or any associated device modules are defective or are damaged at the time of installation by either the Contractor or by CISCO Systems, the item shall be removed and replaced at no additional cost to the project. Items shall also be replaced if any failures occur do to by manufacture defects, at no additional cost to the project prior to the final acceptance.

The Ethernet switch shall be DIN Rack mountable.

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REVISION OF SECTION 614
ETHERNET SWITCH

The Contractor shall provide patch cables for the connection of the Ethernet switch to the fiber optic patch panel. The cable shall be a single mode-duplex cable, in lengths sufficient to span from the switch to the patch panel with a maximum of two feet of slack. Connectors shall match both the switch SFP module and the proposed patch panels.

METHOD OF MEASUREMENT

Ethernet Switch will be measured by the actual number of Ethernet Switches installed and accepted.

BASIS OF PAYMENT

Payment will be under:

Pay Item	**Pay Unit**
Ethernet Switch	Each

Payment will be full compensation for all labor, materials and equipment required to complete the work

REVISION OF SECTION 614
VIDEO ENCODER

Section 614 of the Standard Specifications is hereby revised to include the following:

DESCRIPTION

For this project the Video Encoder shall be installed at field locations noted on the plans. The video encoders shall be used for conversion of analog images from highway monitoring closed circuit television cameras, (CCTV) for transport over an IP Ethernet Network.

MATERIALS

The video encoder shall have four 4 x analog composite video BNC inputs and have the ability to compress native National Television System Committee, (NTSC) camera video images to high quality digitized video. The encoder module shall be user configurable to enable the selection of compressed digital video formats including International Telecommunication Union (ITU) H.264 and Moving Picture Experts Group-4 standard, (MPEG-4). This conversion shall be equal to full motion video and shall not be derogated due to transition distances of those shown on the plans. The video encoder shall also allow the choice of IP multicast or unicast protocols.

The video encoder shall be compatible with the current Department video surveillance standards including CCTV cameras, video matrix switcher and cabling standards including coax cable with BNC connectors for video and copper RS-485 for CCTV control. The unit shall also contain an I/0 connector, network connector with PoE, SFP connector, and an audio connector.

The unit shall contain an open API for software integration.

CONSTRUCTION REQUIREMENTS

The Video Encoder shall be installed in the field communications cabinet. The Contractor shall install all cabling from individual video inputs on the encoder module to the video optical transceivers. This shall include coax cabling for video and copper wiring for the RS-485 4-wire video control communications in the field cabinet using current industry standards for cable management and workmanship techniques.

The Contractor shall make all arrangements for a qualified manufacturer's representative to be on-site to ensure proper configuration and installation of the video encoders and chassis for integration into the Ethernet network.

All work pertaining to the actual Ethernet cable connections to the Ethernet switch and any network configuration requirements will be made by CDOT personnel.

METHOD OF MEASUREMENT

Video Encoder will be measured by the actual number of installed and accepted, including the power supply, cabling, and any other items necessary to make a wholly functioning unit.

BASIS OF PAYMENT

Pay Item	Pay Unit
Video Encoder	Each

REVISION OF SECTION 614
SIGN PAINTING (DARK BROWN)

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

Subsection 614.01 shall include the following:

This work consists of providing powder-coated sign materials and support structures for new and reset sign installations.

Subsection 614.02 shall include the following:

Dark brown paint for sign backs, posts and support structures shall be manufactured to meet Fed. Spec. TT-E-529G and the color shall match Fed. Std. 595B, No. 20059 or Sherwin Williams Color SW2838 and shall meet the requirements of Section 708.

The following website has the color fan available for viewing: www.colorserver.net

In subsection 614.09, eleventh paragraph, delete the first sentence and replace with the following:

Backs of new Class I, Class II, and Class III signs shall be powder-coated at the factory with dark brown paint as specified above.

Sign support structures for new Class III guide signs (cantilever and sign bridge structures) shall be powder-coated at the factory with dark brown paint as specified above.

Galvanized steel sign posts, backing zees and attached hardware for new and reset Class I and Class II signs shall be painted with dark brown paint as follows:

1. Structural steel shall be given one shop coat of primer and two (2) coats of dark brown paint as specified above and in conformity with subsection 509.24. All exposed portions of galvanized steel shall conform to the following:

   (a) All foreign substances shall be removed.

   (b) One coat of bonding agent shall be applied uniformly on the surface. Bonding agent shall be Vinyl Butyral Wash Primer conforming to MIL-P-15328 (SSPC Paint No. 57). After the bonding agent has dried sufficiently, (not more than 24 hours) one coat of exterior enamel shall be applied by a suitable method that will insure a uniform coating free of blemishes, discontinuities, base edges or other imperfections. Defective surfaces shall be touched up with paint as required.

2. All aluminum surfaces to be painted shall be prepared as noted above for galvanized steel.

Subsection 614.14 shall include the following:

Painting signs and sign structures dark brown will not be paid for separately but shall be included in the work.

REVISION OF SECTION 620
FIELD FACILITIES

Section 620 of the Supplemental Specifications is hereby revised for this project as follows:

Subsection 620.02 shall include the following:

The Field Office (Class 2) shall be equipped with a facsimile machine and a copy machine with scanner capability. The functions of both machines may be combined into a single machine or may be separate, as approved by the Engineer.

The Contractor shall install and maintain the facsimile and copy machines in the Engineer's field office.

The facsimile machine shall print on plain paper and shall be capable of sending documents of all sizes up to and including 11" X 17". The machine shall be one of the following or an equivalent as approved by the Engineer.

1. Panasonic UF-750 Plain Paper Laser Fax
2. Xerox 7020 Facsimile Terminal
3. Canon Fax 850

The copy machine shall be a dry, desk top model with a stationary platen.

The copy machine shall be capable of producing a minimum of 15 copies per minute. Maximum size of the original shall be 11" x 17" with standard intermediate sizes and shall have an automatic document feeder capable of feeding a stack of up to 25 originals ranging in size from 5-1/2" x 8-1/2" to 11" x 17".

Copy machine shall have two (2) standard paper cassettes accommodating paper sizes 5- 1/2" x 8-1/2" to 11" x 17". Each cassette shall accept 250 sheets for a total of 500 sheets of paper capacity. Machine shall have a single sheet bypass for manual copying onto special stock not in paper cassettes and capable of using copy paper sizes 5-1/2" x 8-1/2" to 11" x 17".

Copy machine shall have an automatic exposure control to automatically control exposure level for each original with a manual light/dark exposure control and shall be capable of copying original documents of both sheets and bound documents.

Copy machine shall be capable of making 1 to 99 continuous copies and shall be capable of copying onto light weight paper of 16# or onto heavier paper of 32#.

Copy machine shall be capable of zoom magnification/reduction from 70% to 150% in 1% increments.

Paper for both machines will be provided by the Department. All other supplies, parts, and repairs shall be provided by the Contractor. One additional toner cartridge for each machine shall be provided and shall be replaced by the Contractor as directed by the Engineer.

The Field Office (Class 2) shall be provided with a minimum of three telephones, one located at each end office of the facility and one in the center portion. Two private lines shall be provided with roll over capability for incoming phone calls. Each of the telephones provided shall be fully capable of utilizing either line. The Contractor shall supply an ISDN line to the field office for the duration of the project. This shall include an internet service provider and all necessary hardware to allow the Project Engineer and the Project Inspector (2 computer Connections) to have internet access using a VPN connection. This will not be paid for separately but will be included in the Field Office Item. Three jacks shall also be provided for connection to a microcomputer modem or to a facsimile machine modem. One jack shall be located in each of the offices in either end of the field office, and one jack shall be located in the center

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REVISION OF SECTION 620
FIELD FACILITIES

portion of the field office. The Contractor shall provide a communications cord for the facsimile machine and one for a microcomputer, each long enough to reach one of the jacks from any location in the field office.

Subsection 620.06 shall include the following:

The Field Office (Class 2) and the Field Laboratory (Class 2) shall each be equipped with one of the two following security systems or an approved equal:

1. Security guard on premises at all time during non-working hours, or

2. Surveillance or silent watchman type electronic security system installed in each of the field facilities and in the yard in which the facilities are set.

The Contractor shall provide insurance against theft or damage for all inventory stored in the field facilities. The Contractor shall replace any equipment damaged or stolen within five working days.

The Contractor shall maintain all furnished equipment in good working condition and shall replace or repair any nonfunctional equipment within five working days.

Field facilities shall be fully functional for the Engineer's use from the beginning day of work, until 30 calendar days after final project acceptance or until the Engineer requests its removal in writing, whichever time is least.

Subsection 620.08 shall include the following:

All costs incidental to the foregoing requirements shall be included in the original contract price for the field facility.

REVISION OF SECTION 623
VALVE BOX (SPECIAL)

Section 623 of the Standard Specifications is hereby revised for this project as follows:

Subsection 623.01 shall include the following:

This work consists of constructing special valve box assemblies for the purpose protecting access to underdrain cleanouts within the eastbound tunnel in accordance with these specifications and in conformity with the lines and grades shown on the plans or established.

Subsection 623.02 shall include the following:

Valve box assemblies shall be fabricated with cast iron parts and be of the adjustable screw type, complete with drop cover as required in subsection 716.07. Covers shall be marked with "C.O." to identify it as a cleanout access.

Joint fillers used to seal the space between the valve box assembly and the cleanout pipe shall conform to the requirements of subsection 705.01.

Plastic pipe riser, fitting and screw cap shall conform to the requirements of subsection 712.11.

Subsection 623.14 shall include the following:

Valve Box (Special) shall be centered over the underdrain cleanout and sealed around the cleanout pipe with backer rod/foam and sealant after placement of the concrete pavement. The casting shall be set 1/4 inch to 1/2 inch below the finish grade of the pavement to prevent snagging during plowing operations. The riser pipe access cap shall be positioned such that it is one inch to two inches below the valve box cover when fully seated.

Subsection 623.32 shall include the following:

Valve Box (Special) will be measured by the complete unit including valve box assembly, riser pipe and screw cap with sealant, installed and accepted.

Subsection 623.33 shall include the following:

The accepted quantity for Valve Box (Special) 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**
Valve Box (Special)	Each

REVISION OF SECTION 625
CONSTRUCTION SURVEYING (HOURLY)

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

Subsection 625.01 shall include the following:

The Contractor shall also perform Construction Surveying (Hourly) as required by the Engineer. This item will not be used for work as defined in item 625 Construction Surveying. The intent of this is to compensate the Contractor for plan revisions or work to be done due to inconsistencies or errors on the plans that could not have been reasonably detected by the Contractor.

Subsection 625.12 shall include the following:

The method of measurement for the work described as construction surveying (hourly) shall be measured on an hourly basis. The number of hours paid will be the actual crew time, based on a 2-man crew, as determined by the Engineer. Office support hours for calculations, etc., will be paid at one half hour of crew time per one hour of office work as determined by the Engineer.

In subsection 625.13, delete the second paragraph and include the following:

Payment for the work described as construction surveying (hourly) shall be paid at the hourly rate bid and will be full compensation for the work necessary to complete the work. The payment will be made when the work is complete.

Payment will be made under:

Pay Item	**Pay Unit**
Construction Surveying (Hourly)	Hour

REVISION OF SECTION 625
CONSTRUCTION SURVEYING (TUNNEL)

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

Subsection 625.01 shall include the following:

This work shall consist of performing construction surveying in the tunnel under the supervision of a registered Professional Land Surveyor or Professional Engineer in accordance with Subsection 211A.15. Professional Land Surveyors supervising required work shall carry professional liability insurance in accordance with Subsection 107.15.

Subsection 625.02 shall include the following:

Equipment used for this work shall conform to the requirements listed in Subsection 211A.15.

Subsection 625.03 shall include the following:

All work shall conform to the requirements listed in Subsection 211A.15.

Subsection 625.12 shall include the following:

Construction Surveying (Tunnel) will not be measured, but will be paid on a lump sum basis.

Subsection 625.13 shall include the following:

The accepted quantities will be paid for at the contract unit price for the pay item listed below.

Payment will be made under:

Pay Item	**Pay Unit**
Construction Surveying (Tunnel)	Lump Sum

Payment shall be full compensation for all labor, materials, and equipment required to perform the construction surveying in the tunnel.

REVISION OF SECTION 625
VIBRATION MONITORING (TUNNEL)

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

Subsection 625.01 shall include the following:

This work consists of conducting pre- and post-blasting surveys and videos of critical structures; and furnishing, installing, and monitoring seismographs at these critical structures.

Subsection 625.02 shall include the following:

Seismographs provided and installed on the project shall comply with Sections 203B and 211A. Seismographs shall be capable of recording readings for documentation purposes, and shall be capable of automatically alerting project staff when any readings approach or exceed the established threshold values for each structure. Alerts shall be in the form of an electronic communication such as phone, email, text, etc.

Subsection 625.03 shall include the following:

The Contractor shall conduct pre- and post-blast surveys of the following structures to establish their existing conditions before blasting and their condition after all blasting is complete, in order to determine whether any damage was caused by blasting activities. The inspections shall be performed by a Professional Engineer licensed in the state of Colorado with expertise in building structures and blasting effects. A report shall be prepared documenting the pre-blast existing condition and post-blast final condition of each structure, including an assessment of whether any effect from blasting is evident. Pre- and post-videos shall be taken of each structure for documentation purposes and later assessment.

1. Scott Lancaster Memorial Bridge
2. Doghouse Rail Bridge
3. City of Idaho Springs Wastewater Treatment Plant
4. The nearest residence to blasting activities

The Contractor shall install a total of eight seismographs in the following numbers and locations to record the peak particle velocity (PPV) imparted on each structure during blasts. The Contractor shall check each seismograph daily, and shall record the readings and provide same to the Engineer daily. If a PPV threshold value is exceeded, all blasting shall cease until the blasting plan is modified accordingly to ensure that subsequent readings do not exceed the established threshold.

1. Three in the existing westbound tunnel bore
2. One at the Scott Lancaster Memorial Bridge
3. One at the Doghouse Rail Bridge
4. One at the City of Idaho Springs Wastewater Treatment Plant
5. One at the nearest residence to blasting activities
6. One at a location to be determined by the Engineer

Readings from the seismographs installed in the westbound bore shall be provided to the Engineer immediately after a blast for interpretation and evaluation by the Engineer to determine whether the bore can be safely reopened to traffic.

Subsection 625.12 shall include the following:

Vibration Monitoring will not be measured but will be paid for on a lump sum basis.

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REVISION OF SECTION 625
VIBRATION MONITORING (TUNNEL)

Subsection 625.13 shall include the following:

The accepted quantities will be paid for at the contract unit price for the pay item listed below.

Payment will be made under:

Pay Item	**Pay Unit**
Vibration Monitoring (Tunnel)	Lump Sum

Payment shall be full compensation for conducting pre- and post-blasting structure inspections, videos, and reports; and for furnishing, installing, monitoring, recording, and reporting of seismographs and data.

REVISION OF SECTION 626
MOBILIZATION

Section 626 is hereby deleted and replaced with:

DESCRIPTION

626.01 This work consists of the following:

(1) The mobilization of personnel, equipment and supplies at the project site in preparation for work on the project for the prime and all subcontractors on the project;
(2) Insurance, bonds, and insurance deductible losses;
(3) Overhead and indirect costs of the overall work on the project including project management, mechanics, project engineering, safety officers, and all other personnel required for managing or supervising the work;
(4) Establishment of offices, buildings, staging areas, supply yards, and any other facilities required for the work including the upkeep for such facilities;
(5) All other costs incurred or labor and operations which must be performed prior to beginning the other items under the Contract.

BASIS OF PAYMENT

626.02 Partial payments for mobilization items will be made once each month as the work progresses.

The total sum of all payments shall not exceed the original contract amount bid for the items, regardless of the fact that the Contractor may have, for any reason, including:

(1) Shutting down the work on the project
(2) moving equipment away from the project and then back as multiple mobilizations were specifically bid into the Guaranteed Maximum Price (GMP) for certain work on the project.
(3) Additional mobilizations unless otherwise approved by the Engineer.

For the purpose of this Section the term “original contract amount” as used above shall mean the amount bid for the construction items in the Contract not including the amount bid for mobilization. Payments for materials on hand, as described in subsection 109.07, will not be included as a percent of original contract amount earned until the materials on hand have been incorporated into the work and accepted and paid for as contract items.

These payments shall be independent of partial payments as defined in subsection 109.06. Payment will be full compensation for all work necessary to complete the item.

626.02 Payment will be made under:

Pay Item	**Pay Unit**
Mobilization (without Autopay)	Lump Sum
Mobilization (Tunnel) (without Autopay)	Lump Sum

Nothing herein shall be construed to limit or preclude partial payments for other items as provided for by the Contract.

REVISION OF SECTION 626
PUBLIC INFORMATION SERVICES

Section 626 of the Standard Specifications is hereby revised for this project as follows:

Subsection 626.01 shall include the following:

The Contractor shall prepare and maintain a Public Information Plan (PIP) in coordination with CDOT to develop and communicate information to and from the public regarding the Project. This PIP shall be used throughout the duration of the Work by the Contractor to manage and implement the public information process.
Included in the PIP and in coordination with CDOT, the Contractor shall provide information on project vision, progress and coping during project work.

The Contractor shall be accessible 24 hours a day, seven days a week, for Activities associated with public information and shall have experience in this area. The Contractor shall provide contact information, including home, mobile and e-mail addresses to CDOT for Acceptance (which may include Public Information Manager (PIM), project managers, and the additional public information officers) at NTP. The Contractor shall hold regular coordination meetings with CDOT to provide Project schedule, accomplishments, and planned activities for the upcoming week.

The Contractor's final PIP shall be submitted to CDOT for Approval prior to NTP. The Contractor shall schedule and hold PIP review meetings with CDOT to review, assess input, and/or modify the Contractor's PIP as necessary.

CDOT has identified the below listed Stakeholders as audiences requiring Contractor outreach. The Contractor shall describe in the PIP its approach to communicating with these stakeholders and coordinating with CDOT. The Stakeholders include, but are not limited to:

1. Area residents.
2. Property owners and property management companies.
3. Commuters.
4. The traveling public.
5. Commercial vehicle operators and Colorado Motor Carriers Association.
6. Local, regional, and state government officials.
7. Chamber of Commerce
8. Business owners, employees, and customers.
9. Neighborhood associations.
10. Emergency response agencies, such as the Colorado State Highway Patrol, Police
    a. Departments, AMR (ambulance), Fire Departments, hospitals.
11. Delivery and courier services.
12. Recreational users and businesses.
13. CDOT employees and other internal team members, including CDOT headquarters and
    a. Public Relations Office.
14. Mass transit agencies/companies.

As part of the Contractor's PIP, the Contractor shall develop and use a communication matrix listing the stakeholders and the information tools to be used to address each group of stakeholders' informational needs. The Contractor shall develop a communications matrix for stakeholder groups, and individuals and businesses with special needs, which will identify:

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REVISION OF SECTION 626
PUBLIC INFORMATION SERVICES

1. The customer group(s) that require information.
2. Location or region of customer group(s).
3. What information is needed?
4. When information is needed?
5. Tools to be used for disseminated information.
6. Results of information dissemination.

The Contractor shall develop a master distribution list (or database) of contacts to be used for General public information, publications, and informational flyers/newsletters. This list or database shall be presented to CDOT for review, prior to NTP.

Depending upon project impacts, contact with stakeholders may be required daily, weekly, monthly or periodically throughout the duration of the project. Communications tools could include hand flyers, door hangers, newsletters, mailers, using e-mail distribution lists, and the I-70 Twin Tunnels website, as approved by CDOT in the Public Information Plan. Each communication tool shall include contact information, PIM's name, office phone, CDOT Web-site address with CDOT logo. Cell phone numbers and e-mail addresses shall be provided where service is available. All public information correspondence and subsequent updates must be approved by CDOT Region Public Relations Manager 48 hours before distribution.

The Contractor shall be responsible for collecting, processing, and providing to CDOT several types of coping information that impact the Project. Outlined below are some, but not all, of the types of information necessary to inform the public regarding the Project. The Contractor shall include the following types of information and minimum performance expectations when developing the various components of the PIP:

7. Construction Activities.
   Construction notification shall be made available to CDOT at least two weeks prior to the beginning of any construction in any area of the Project. The Contractor shall coordinate, communicate, and address coping strategies in its PIP. Notification of construction events shall include:
   (1) Description of activity.
   (2) Start and end of the activity.
   (3) Residents and businesses impacted or affected.
   (4) Proposed alternative routes and detours.
   (5) The Contractor's contact for further information.
   (6) Project public web site address for further information.
   (7) Commercial Vehicle Access and Restriction Information.

8. Maintenance of Traffic.
   The Contractor shall issue a weekly lane closure report information to CDOT, using a template provided by the Engineer, that it can be used for notices regarding the Maintenance of Traffic for the entire Project for commuters, emergency services agencies, residents, businesses, or any other stakeholders who will be impacted by the Project. The Contractor shall include, at a minimum, the following elements within the notifications:
   (1) Description of the activity.
   (2) The start of the activity.
   (3) The end of the activity.

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REVISION OF SECTION 626
PUBLIC INFORMATION SERVICES

9. Pedestrian and Bicycle Access
   The Contractor shall clearly define and communicate to stakeholders and CDOT information that it can use to inform the public and other associated stakeholder groups its plans for maintaining bicycle access, pedestrian access, and handicapped mobility.

In an event of a crisis, CDOT will be the lead agency to handle communication with the media, public, CDOT staff, etc. The Contractor shall be available to help coordinate with CDOT and provide information necessary to respond to the crisis. The PIP shall include a crisis communications plan for the Contractor's response to incidents and its communications with CDOT.

Department of Public and Environmental Health two weeks prior or within 24 hours of any unexpected construction that results in turbidity or sedimentation in Clear Creek.

The Contractor shall implement a telephone hotline prior to NTP as a means of receiving community input, answering questions, and prompting possible solutions regarding Project related activities. The hotline shall be available to the public 24 hours a day, seven days a week, and shall be publicized in all Project information materials and signage throughout the Project. The PIM shall record a friendly greeting on the project's published phone line each week, updating the message throughout the week, as necessary, depending on changes in work schedule, activities and traffic impacts. The recording shall include each week's forthcoming activities including work days, hours and expected traffic delays, posted detours, project completion date, and office hours. The PIM shall check the answering machine at least twice every calendar day, including weekends. The PIM shall respond to callers and e-mail inquiries as soon as possible, but at least within 24 hours. The PIM shall keep a logbook of all calls including the contact name, date of contact, date responded, the contact's comments, and the action the PIM took. A copy of this log shall be submitted to the Engineer every two weeks or more frequently, as requested by the Engineer.

The Contractor shall maintain a logbook of citizen and business contacts, including names, addresses, phone numbers, nature of the inquiry and subsequent action taken during construction and shall provide the Engineer a copy each week. All inquiries and complaints shall be followed up with either a return phone call, or a meeting, as warranted.

Media relations efforts shall be directed and distributed by CDOT including news releases, traffic advisories, editorial, feature stories, etc. During the Work, the Contractor shall immediately notify CDOT of any situations involving the media, and all communication requests shall be tracked by CDOT. The Contractor shall be familiar with, and comply with, the CDOT News Media Communications Guidelines, which outlines required protocol when contacted by media representatives.

The Contractor shall develop and implement community and business relation strategies that communicate coping messages to the public. Coping strategies shall focus on providing the public with the information they need to make short-term and long-term decisions about how they can deal with the work with as little disruption as possible.

The Contractor shall erect construction traffic signs with the dates the Contractor expects to initiate and complete construction and with the Contractor's public information office's or PIM's phone number at each major approach to the project. The signs shall conform to the requirements of Section 630 and shall be erected at least one week prior to the beginning of construction. These signs shall be updated if the project schedule changes, at no cost to the project.

An individual project Web-site has been developed for this project and is hosted on CDOT's web site using the CDOT template. The PIM shall provide a link to this website to all of the contacts listed below so they may include it on their respective websites.

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REVISION OF SECTION 626
PUBLIC INFORMATION SERVICES

http://www.coloradodot.info/projects/i70twintunnels

The site will be revised as directed by the Engineer but shall at a minimum be updated weekly to include the information provided on the phone greeting as described above.

The Contractor shall host public or other stakeholder meetings at the request of the Engineer. The meetings will be held in a convenient location for community and business groups. Depending upon the Contractor's proposed

Traffic Control Plan (TCP), and areas impacted within each phase, other meetings may be required. The Contractor's PIP shall outline its approach to these construction information meetings. Public meetings shall provide construction schedules, impacts, traffic management plans, and other coping information. A member of the Contractor's management team or public information team and CDOT will attend all meetings. The Contractor and CDOT shall jointly organize, conduct and arrange all meetings and extend invitations to appropriate participants.

Subsection 626.02 shall include the following:

The Engineer will monitor the PIM and all public information services. When the Contractor provides acceptable public information services in accordance with these specifications, partial payments for the pay item Public Information Services will be made as the work progresses. These partial payments will be made as follows:

When 25 percent of the original Contract amount is earned, 50 percent of the amount bid for this item, less all previous payments, will be paid.

When 50 percent of the original Contract amount is earned, 60 percent of the amount bid for this item will be paid.

When 75 percent of the original Contract amount is earned, 80 percent of the amount bid for this item, less all previous payments, will be paid.

When 100 percent of the original Contract amount is earned, 100 percent of the amount bid for this item, less all previous payments, will be paid.

Failure to provide acceptable public information services will result in withholding of progress payment for this item. Continued failure to provide the services required will result in non-payment of the corresponding percentage of the original bid item and may result in suspension of the work in those areas affected until acceptable public information services are provided by the Contractor.

For the purpose of public information services, the term "original Contract amount" as used above, shall mean the amount bid for the construction items on this Contract, not including the amounts bid for Public Information Services and Mobilization, and "aggregate Contract amount earned" shall mean the net amount on the current monthly pay estimate, not including the amounts earned for Public Information Services and Mobilization.

Payment for Public Information Services will be full compensation for all fliers, public information office, telephone lines, and all other labor and materials required to complete the item, except signs. Signs will be measured and paid for in accordance with Section 630.

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REVISION OF SECTION 626
PUBLIC INFORMATION SERVICES

Payment will be made under:

Pay Item	**Pay Unit**
Public Information Services	Lump Sum

The Public Information Services Contact Sheet shall include the following:

Public Information Services Contact List

Dial 911 for any emergencies

City of Idaho Springs City Manager
Phone: 303-567-4421ext. 126

City of Idaho Springs Public Works
Phone: 303-567-2400

City of Idaho Springs Police
Phone: 303-567-4421 ext. 117

Contact for Project UTC Coordination
Officer Wolf
Phone: 303-567-4421 ext. 117

City of Idaho Springs Fire Chief
Phone: 303-567-4342

Clear Creek County Sheriff's Department
Phone: 303-679-2376

Clear Creek County: Road and Bridge Dept.:
Phone: 303-679-2334

Clear Creek County: Administrator
Phone: 303-679-2309

Clear Creek County: Commissioners
Phone: 303-679-2312

Clear Creek County: Emergency Response Manager
Kathleen Krebs 303-679-2370
kkrebs@co.clear_creek.co.us

Clear Creek Dispatch (non-emergency situations)
303-679-2393

Clear Creek County: Environmental Health
Mitch Brown, 303-679-2335

Clear Creek County: Emergency Management
303-679-2320

Colorado State Patrol
Phone: 303-567-4201 (Idaho Springs Post)
Phone: 303-249-4501 (Region Dispatch is in Frisco)

Colorado Department of Transportation, Public Information Office
Mindy Crane, 4201 E. Arkansas, Room 277, Denver, CO 80222
Phone: 303-757-9469 Fax: 303-757-9153
Stacey.Stegman@state.co.us

Colorado Department of Transportation Region Public Relations Manager
Bob Wilson, 4201 E. Arkansas, Room 277, Denver, CO 80222
Phone: 303-757-9431 Fax: 303-757-9153
Bob.J.Wilson@state.co.us

REVISION OF SECTION 630
PORTABLE MESSAGE SIGN PANEL

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

Subsection 630.01 shall include the following:

This work includes furnishing, operating, and maintaining a portable message sign panel.

Add subsection 630.031 immediately following subsection 630.03 as follows:

630.031 Portable Message Sign Panel. Portable message sign panel shall be furnished as a device fully self contained on a portable trailer, capable of being licensed for normal highway travel, and shall include leveling and stabilization jacks. The panel shall display a minimum of three - eight character lines. The panel shall be a dot-matrix type with an LED legend on a flat black background. LED signs shall have a pre-default message that activates before a power failure. The sign shall be solar powered with independent back-up battery power. The sign shall be capable of 360 degrees rotation and shall be able to be elevated to a height of at least five feet above the ground measured at the bottom of the sign. The sign shall be visible from one-half mile under both day and night conditions. The message shall be legible from a minimum of 750 feet. The sign shall automatically adjust its light source to meet the legibility requirements during the hours of darkness. The sign enclosure shall be weather tight and provide a clear polycarbonate front cover.

Solar powered message signs shall be capable of operating continuously for 10 days without any sun. All instrumentation and controls shall be contained in a lockable enclosure. The sign shall be capable of changing and displaying sign messages and other sign features such as flash rates, moving arrows, etc.

Each sign shall also conform to the following:

(1) In addition to the onboard solar power operation with battery back-up, each sign shall be capable of operating on a hard wire, 100-110 VAC, external power source.

(2) All electrical wiring, including connectors and switch controls necessary to enable all required sign functions shall be provided with each sign.

(3) Each sign shall be furnished with an operating and parts manual, wiring diagrams, and trouble-shooting guide.

(4) The portable message sign shall be capable of maintaining all required operations under Colorado mountain-winter weather conditions.

(5) Each sign shall be furnished with an attached license plate and mounting bracket.

(6) Each sign shall be wired with a 7-prong male electric plug for the brake light wiring system.

Subsection 630.12 shall include the following:

The portable message sign panel shall be on the project site at least **14 days** prior to the start of active roadway construction. Maintenance, storage, operation, relocation to different sites during the project, and all repairs of portable message sign panels shall be the responsibility of the Contractor.

Subsection 630.14 shall include the following:

Portable message sign panels will be measured one of the two following ways:

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REVISION OF SECTION 630
PORTABLE MESSAGE SIGN PANEL

(1) By the actual number of days each portable message sign is used on the project as approved by the Engineer.

(2) By the maximum number of approved units in use on the project at any one time.

Subsection 614.15 shall include the following:

Pay Item	**Pay Unit**
Portable Message Sign Panel	Each

REVISION OF SECTION 630
PORTABLE TRAFFIC SPEED MONITOR

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

Subsection 630.01 shall include the following:

This work includes furnishing, operating, installing, and maintaining portable speed control monitors.

Subsection 630.031 is added following Subsection 630.03 as follows:

630.031 Portable Speed Control Monitor. If the Portable Traffic Speed Monitor is powered by solar panels, it shall use a battery bank with a charge controller that will operate the monitor for 30 days (running continuously) without any sunlight. The Portable Traffic Speed Monitor shall have its own separate power source with independent back-up battery powered source. Monitors that are diesel generator powered shall be provided with enough fuel capacity for 30 days.

The actual speed of approaching vehicles shall be displayed on a panel that uses light emitting diodes (LEDs) that conform to MUTCD requirements on a flat black background. The pixels (groups of LEDs) shall be arranged so they form at least a two-digit display of 18 inches high by 12 inches wide numbers. The speed limit shall be visible from a minimum of 650 feet. The display shall contain an ambient light sensor that allows the internal CPU to adjust the screen's brightness automatically to account for daytime or nighttime light conditions.

The trailer shall be equipped with a rack, when raised allows speed limit signs to be mounted. A lockable storage compartment shall be provided to store speed limit signs. Portable Traffic Speed Monitor shall be self-contained on a portable trailer, licensed for normal highway travel.

Weatherproof casing shall enclose the LED display modules, electronics, and radar, which will be able to withstand harsh outdoor environments, including snow. The Portable Traffic Speed Monitor shall be capable of maintaining all required operations under Colorado all season weather conditions, and shall also be able to survive vibrations caused by transporting it on uneven road surfaces.

The Portable Traffic Speed Monitor shall be adjustable to show speeds at 5 mph increments from 10 mph through 65 mph. Speed limits signs to match the possible speed increments shall be included and shall meet CDOT standards. The Portable Traffic Speed Monitor shall be able to operate in the range of –22° F to 110° F.

Prior to obtaining the item, the Contractor shall submit the trade name, model number, and specifications of the portable message signs the Contractor intends to use to the Engineer for approval. The Department's decision concerning the acceptability of the item will be final.

The unit shall use K Band radar to detect speed.

Subsection 630.11 shall include the following:

Maintenance, storage, operation, relocation and all repairs of Portable Traffic Speed Monitor shall be the responsibility of the Contractor. In case of sign failure or malfunction, the Contractor shall repair or replace the non-operational sign immediately.

Subsection 630.13 shall include the following:

Portable Traffic Speed Monitor will be measured by the actual number of the units approved and used on the project.

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REVISION OF SECTION 630
PORTABLE TRAFFIC SPEED MONITOR

Subsection 630.14 shall include the following:

Pay Item	**Pay Unit**
Portable Traffic Speed Monitor	Each

REVISION OF SECTION 630
PORTABLE VARIABLE SPEED LIMIT SIGN

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

Subsection 630.01 shall include the following:

This work includes furnishing, operating, installing, and maintaining portable variable speed limit signs.

Subsection 630.032 is added following Subsection 630.03 as follows:

630.032 Portable Variable Speed Limit Sign. If the Portable Variable Speed Limit Sign is powered by solar panels, it shall use a battery bank with a charge controller that will operate the monitor for 30 days (running continuously) without any sunlight. The Portable Variable Speed Limit Sign shall have its own separate power source with independent back-up battery powered source. Signs that are diesel generator powered shall be provided with enough fuel capacity for 30 days.

The posted speed limit shall be displayed on a panel that uses light emitting diodes (LEDs) that conform to MUTCD requirements on a flat black background. The pixels (groups of LEDs) shall be arranged so they form at least a two-digit display of 18 inches high by 12 inches wide numbers. The speed limit shall be visible from a minimum of 650 feet. The display shall contain an ambient light sensor that allows the internal CPU to adjust the screen's brightness automatically to account for daytime or nighttime light conditions.

The trailer shall be equipped with a rack, when raised allows speed limit signs to be mounted. A lockable storage compartment shall be provided to store speed limit signs. Portable Variable Speed Limit Sign shall be self-contained on a portable trailer, licensed for normal highway travel.

Weatherproof casing shall enclose the LED display modules, electronics, and radar, which will be able to withstand harsh outdoor environments, including snow. The Portable Variable Speed Limit Sign shall be capable of maintaining all required operations under Colorado all season weather conditions, and shall also be able to survive vibrations caused by transporting it on uneven road surfaces.

The Portable Variable Speed Limit Sign shall be adjustable to show speeds at 5 mph increments from 10 mph through 65 mph. The Portable Variable Speed Limit Sign shall be able to operate in the range of –22° F to 110° F.

The Portable Variable Speed Limit Sign shall be equipped with communications that allow for remote configurations of speed settings and scheduling.

Prior to obtaining the item, the Contractor shall submit the trade name, model number, and specifications of the portable message signs the Contractor intends to use to the Engineer for approval. The Department's decision concerning the acceptability of the item will be final.

Subsection 630.11 shall include the following:

Maintenance, storage, operation, relocation and all repairs of Portable Variable Speed Limit Signs shall be the responsibility of the Contractor. In case of sign failure or malfunction, the Contractor shall repair or replace the non-operational sign immediately.

Subsection 630.13 shall include the following:

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REVISION OF SECTION 630
PORTABLE VARIABLE SPEED LIMIT SIGN

Portable Variable Speed Limit Sign will be measured by the actual number of the units approved and used on the project.

Subsection 630.14 shall include the following:

Pay Item	**Pay Unit**
Portable Variable Speed Limit Sign	Each

REVISION OF SECTION 630
IMPACT ATTENUATOR (TEMPORARY)

Section 630 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing, installing, certifying, moving, repairing, maintaining, and removing temporary impact attenuators in accordance with these specifications and in conformity with the lines and details shown on the plans or established.

MATERIALS

Each impact attenuator shall be selected from the Crash Cushion and End Treatment Application Chart as listed in the *Safety Selection Guide* on the CDOT Design and Construction Project Support web site. Impact attenuators shall conform to the requirements of the manufacturer and be capable of bi-directional shielding of the objects detailed and located on the plans. Filler materials shall be treated according to the manufacturer's recommendations to prevent freezing to a temperature of -50 °F.

If the posted speed limits of the construction zone are 45 miles per hour or less, the impact attenuator shall meet the requirements of NCHRP Report 350 TL-2. For posted speed limits in the construction zone greater than 45 miles per hour, the attenuator shall meet the requirements of TL-3.

CONSTRUCTION REQUIREMENTS

If sand barrel arrays are used, the Contractor shall paint, with white epoxy paint, an outline and the weight of each barrel on the pavement prior to final placement. All numbers shall be a minimum of 6 inches high. Barrel type shall be one of those listed in the Safety Selection Guide.

The site shall be prepared to receive the impact attenuator by filling, excavating, smoothing, constructing the paved foundation pad, installing approved transition and anchoring, and all other work necessary for the proper installation of the attenuator.

The impact attenuator shall be fabricated and installed in accordance with the manufacturer's recommendations. The Contractor shall provide a copy of the manufacturer’s installation instructions and parts list to the Engineer prior to installation of the device.

Each installation shall be supervised and certified as correct upon completion by a representative of the device manufacturer or by an employee of the Contractor who is a certified installer. The certified installer shall have completed device training and shall be registered with the manufacturer as a certified installer. The Contractor shall submit all appropriate documentation to validate that the certified installer has completed device training and has been registered with the manufacturer as a certified installer.

METHOD OF MEASUREMENT

Impact Attenuator (Temporary) will be measured by the number of attenuators shown on the plans, installed, certified, and accepted.

BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for the pay item listed below:

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REVISION OF SECTION 630
IMPACT ATTENUATOR (TEMPORARY)

Payment will be made under:

Pay Item	**Pay Unit**
Impact Attenuator (Temporary)	Each

Payment will be full compensation for all work and materials required to furnish, install, certify, move, repair, maintain, and remove the impact attenuator. Site preparation, foundation pad, epoxy painting, and all necessary hardware including anchors and transitions will not be paid for separately, but shall be included in the work.

REVISION OF SECTION 630
MOBILE ATTENUATOR

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

Subsection 630.01 shall include the following:

This work shall consist of furnishing, operating, and maintaining a truck with an attached impact attenuator.

Subsection 630.09 shall include the following:

Mobile Attenuator Options:

Truck Mounted Attenuator. The Contractor shall supply a vehicle with a truck mounted attenuator approved by the FHWA to meet NCHRP 350 criteria for level TL-3 collisions. The attenuator shall be mounted to a suitable truck in a manner meeting the Manufacturer's specifications. The truck shall be furnished with a roof mounted Advance Warning Flashing or Sequencing Arrow Panel (B Type). The truck shall be used when setting up or taking down the work zone and shall be parked in the activity area protecting the construction work while work is being performed, unless otherwise directed.

Trailer Attenuator. The Contractor shall supply a vehicle with an attached trailer attenuator approved by the FHWA to meet NCHRP 350 criteria for level TL-3 collisions. The trailer attenuator shall be attached to a suitable host truck in a manner meeting the Manufacturer's specifications, to include factory-installed 20-ton (minimum) rated pintle hook and ½-inch (minimum) steel frame plate, or as specified by Manufacturer. The trailer shall be furnished with a mounted Advance Warning Flashing or Sequencing Arrow Panel (B Type).

The weight of the host truck shall be between 10,000 and 20,000 lbs, or as specified by the trailer attenuator manufacturer. The Contractor shall provide a certified scale ticket confirming the weight of the truck without trailer attached.

The Trailer Attenuator attached to its host truck shall be used when setting up or taking down the work zone and shall be parked in the activity area protecting the construction work while work is being performed, unless otherwise directed. A buffer zone shall be provided in front of the host truck, for worker safety. This buffer zone shall be in accordance with the manufacturer's recommendations, but shall be no less than 100 feet in length, unless otherwise directed.

Subsection 630.13 shall include the following:

Maintenance, storage, operation, and all repairs of Mobile Attenuator and associated vehicle shall be the responsibility of the Contractor.

Subsection 630.15 shall include the following:

Mobile Attenuators will be measured as the actual number of days that it is used on the project. For this project, a day will be considered to be one 12-hour shift of a Mobile Attenuator is used on site. Mobile Attenuators which are left in place during non-working will not be included, and will not be considered active on the project.

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REVISION OF SECTION 630
MOBILE ATTENUATOR

Subsection 630.16 shall include the following:

Pay Item	**Pay Unit**
Mobile Attenuator	Day

Payment will be full compensation for all labor, materials and equipment required to operate and maintain the truck and attenuator for the duration of the project, including the attenuator and flashing panel.

REVISION OF SECTION 630
TRAFFIC CONTROL MANAGEMENT

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

Subsection 630.11 shall include the following:

The Contractor shall designate individuals, other than the superintendent, to be the Traffic Control Supervisors. The Traffic Control Supervisors shall be certified as a worksite traffic supervisor by either the American Traffic Safety Services Association (ATSSA) or the Colorado Contractors Association (CCA), and shall have a current Department flaggers certificate. A copy of each of the Traffic Control Supervisors certifications shall be provided to the Engineer at the preconstruction conference. The Contractors Superintendent and all others serving in a similar supervisory capacity shall have completed a CDOT-approved two-day Traffic Control Supervisor training as offered by the CCA. The one-day ATSSA Traffic Control Technician (TCT) training along with the two-day ATSSA Traffic Control Supervisor training will serve as an alternate. If the alternate is chosen, the Contractor shall provide written evidence that at least an 80 percent score was achieved in both of the two training classes. The certifications of completion or certifications of achievement for all appropriate staff shall be submitted to the Engineer at the preconstruction conference.

Traffic Control Supervisors duties shall include:

(1) Preparing, revising, and implementing each required Method of Handling Traffic in accordance with the Traffic Control Plan;
(2) Directly supervising project flaggers;
(3) Coordinating all traffic control operations including those of subcontractors and suppliers;
(4) Coordinating project activities with appropriate police, emergency service, and fire control agencies;
(5) Preparing a traffic control diary for each shift traffic control devices are in use. Only one diary per 12 hour shift is necessary per TCS. This diary shall be submitted to the Engineer daily and become a part of the Department's project records. The diary shall include the following information as a minimum:
    (i) Date;
    (ii) For Traffic Control Inspection, the time of the inspection;
    (iii) Project number;
    (iv) Traffic Control Supervisor name;
    (v) Description of traffic control operations (lane closures, shoulder closures, pilot car operations, detours, etc.) including location, setup and takedown time, and approved Method of Handling Traffic (MHT) number;
    (vi) Types and quantities of traffic control devices used in accordance with the approved MHT;
    (vii) List of flaggers and uniformed traffic control (UTC) used, including start time, stop time, and number of flagging hours and UTC hours used; and
    (viii) Traffic control problems (traffic accidents; damaged, missing or dirty devices, etc.) and corrective action taken.
(6) Inspecting traffic control devices on every calendar day that traffic control devices are in use, masked, or turned away from traffic. These inspections shall include at least one night inspection per week. The designated shift TCS or another representative who is certified as a work site traffic supervisor shall perform these inspections. During the course of such inspections, the TCS or other representative shall immediately report any traffic incidents requiring assistance to the Contractor's superintendent and/or project manager.
(7) Insuring that traffic control devices are functioning as required.
(8) Overseeing all requirements covered by the Contract which contribute to the convenience, safety and orderly movement of traffic. Have an up-to-date copy of the MUTCD and applicable standards and specifications available at all times on the project.
(9) Attending all project scheduling meetings

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REVISION OF SECTION 630
TRAFFIC CONTROL MANAGEMENT

(10) Supervising the cleaning and maintenance of all traffic control devices. A certified worksite traffic supervisor shall be responsible for Traffic Control Management (TCM) on a 24-hour-per-day basis. A TCS shall be on the work site at all times when Traffic Control Management (TCM) is performed and shall be on call at all Upon request of the Engineer, the TCS may be required to be on the project site at times other than normal times.

working hours. During non-work periods, a designated TCS shall respond to the job site within 45 minutes. The TCS may appoint a qualified representative to serve as the TCS for periods of time as approved by the Engineer. The qualified representative shall be certified as a TCS and shall assume all duties and responsibilities of the TCS. The Contractor shall maintain a 24 hour telephone number at which one of the designated TCS can be contacted. A TCS shall not act as a flagger except in an emergency or in relief for short periods of no more than 15 minutes over a 60 minute period.

The Contractor's Superintendent, Traffic Control Manager (TCM), Courtesy Vehicle, and each UTC unit shall be equipped with a reliable mobile telephone unit or at all times that has a local number for contact with one another, the Project Engineer, or emergency response dispatchers when emergency services are required. UTC mobile telephone units shall be made available at the project field office and shall be signed in and out by UTC personnel each shift.

The Contractor shall furnish a push to talk radio with telephone service or equivalent as approved by the Engineer. One each will be required for the project staff, one each for the Project or Construction Superintendents, one each for Traffic Control Supervisors, two for the impact truck drivers, two for the stop flaggers and any other essential personnel as required. All radios shall have a group talk feature or equivalent. The radios shall be equipped with battery chargers and rechargeable batteries. The radios shall be supplied one week prior to the commencement of work

The TCM shall make immediate contact with emergency personnel as required to assist accident victims, expedite the removal of broken-down vehicles, and maintain the smooth flow of traffic in accordance with the Tunnels Incident Management Plan.

Subsection 630.15 shall include the following:

METHOD OF MEASUREMENT

Traffic Control Management will be measured as the actual number of days that it is used on the project. For this project, a day will be considered to be one 12-hour shift of a Traffic Control Supervisor (TCS) in which traffic control conforms to the approved MHT. Traffic control devices which are left in place during non-working hours will not be included, and will not be considered active traffic control.

Subsection 630.16 shall include the following:

BASIS OF PAYMENT

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.

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REVISION OF SECTION 630
TRAFFIC CONTROL MANAGEMENT

Payment will be made under:

Pay Item	**Pay Unit**
Traffic Control Management	Day

REVISION OF SECTION 641
SHOTCRETE

Section 641 of the Standard Specifications is hereby revised for this project as follows:

Subsection 641.02 shall include the following:

Reinforcing steel, unless otherwise noted, shall conform to the requirements of Section 602.

Geocomposite strip drains, as shown in the plans, shall conform to the requirements of Revised Section 605 Geocomposite Drain.

Expansion joints shall be constructed at the locations and as shown in the plans. Expansion joint filler shall conform to the requirements of Section 705.01(b) Preformed Joint Fillers.

Subsection 641.09 shall include the following:

Pay Item	**Pay Unit**
Shotcrete	Square Yard

Reinforcing steel, including welded wire fabric, deformed steel bars, geocomposite strip drains and expansion joints, will not be measured and paid for separately but shall be included in the work.

SECTION 641A
TUNNEL SHOTCRETE

Section 641A is hereby added to the Standard Specifications for this project as follows:

DESCRIPTION

641A.01 General. The work specified in this Section consists of: the application of fiber reinforced and plain shotcrete installed in the tunnel for initial support, and for smoothing to fill overbreak and to achieve smoothness criteria required for subsequent installation of geocomposite drain panels or strips for conveying groundwater and limiting groundwater seepage though the final lining (see Revisions of Section 605 for drain specifications). The use of the term “shotcrete” in this section includes plain or fiber reinforced shotcrete unless otherwise noted.

641A.02 Shotcrete shall comply with the requirements of ACI 506.2, "Specifications for Materials, Proportioning and Application of Shotcrete," except as otherwise specified. Shotcrete shall consist of an application of one or more layers of concrete conveyed through a hose and pneumatically projected at a high velocity against a prepared surface. For additional descriptive information, the Contractor's attention is directed to the American Concrete Institute ACI 506R "Guide to Shotcrete." The Wet-Mix Shotcrete process shall be used for work specified herein. The Dry-Mix Shotcrete process may be used for small volume or minor application.

Fiber reinforced shotcrete shall be placed for initial support as shown on the Plans based on the support category assigned to the ground being excavated as determined by the Engineer and the Contractor. The permanent tunnel lining will be cast in place concrete as specified in Section 601 Structural Concrete. The shotcrete work shall include furnishing of materials, equipment, tools, and labor to perform the preparation, application, and clean-up.

Steel Fiber Reinforced Shotcrete shall comply with the requirements of ACI 544.3R, “Guide for Specifying, Proportioning, Mixing, Placing, and Finishing Steel Fiber Reinforced Concrete.” For additional information, the Contractor’s attention is directed to ACI 506.1R “Committee Report on Fiber Reinforced Shotcrete” in addition to the publications listed above.

The design calls for steel fiber for reinforcing of the shotcrete used for initial support. However, polypropylene or other synthetic macro-fibers may be substituted for steel fiber provided the specified strengths, toughness and other characteristics are met. Glass fiber shall not be used to substitute for the steel fiber.

641A.03 Definitions.

(a) *Shotcrete.* Portland cement concrete applied from a nozzle by compressed air and containing, if necessary, admixtures to provide quick set, high early strength, required toughness and satisfactory adhesion.

(b) *Fiber Reinforced Shotcrete (FRS).* Shotcrete containing steel or synthetic plastic fibers for reinforcement.

(c) *Steel Fiber Reinforced Shotcrete (SFRS).* Shotcrete containing steel fibers for reinforcement.

(d) *Flashcrete.* Fiber reinforced shotcrete formulated for accelerated set and applied in a thinner layer to exposed rock for more immediate support and control of raveling.

(e) *Supplemental Shotcrete.* SFRS placed as directed or approved by Engineer in addition to indicated thickness of initial support shotcrete to increase capacity of initial support system for local rock conditions.

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SECTION 641A
TUNNEL SHOTCRETE

(f) *Steel Fiber, Synthetic Fiber.*-- Discrete, cold drawn, steel fibers, or fibers composed of synthetic (i.e. polypropylene) materials, uniformly distributed in shotcrete to improve the bending capacity, durability and especially the yield resistance of shotcrete, as measured by the toughness index property.

(g) *Smoothing Shotcrete.* Plain (unreinforced) shotcrete used as required to fill overbreak, block steel channels or steel sets, cover rock reinforcement end hardware or cover protruding steel fibers as required to create a suitable substrate for placement of geocomposite drain materials or other follow-on activity where a smooth surface is required.

(h) *Formation Drainage.* Strips or overlapping panels of dimpled plastic geocomposite drainage and piping installed to relieve hydrostatic pressures build-up behind the permanent cast in place tunnel lining.

(i) *Wet-Mix Shotcrete Process.* Thorough mixing of solid and liquid materials in a batch plant or portable mixer followed by application at high velocity through an air jet.

(j) *Dry-Mix Shotcrete Process.* Thorough mixing of solid materials, feeding these materials into a special mechanical feeder or gun, carrying materials by compressed air to a special nozzle, introducing water and intimately mixing it with other ingredients at the nozzle. Mixture is then jetted from the nozzle at high velocity onto the surface to receive the shotcrete.

MATERIALS

641A.04 General.

(a) All materials for tunnel shotcrete shall conform to the following requirements:

Cement	AASHTO M85/ ASTM C150, Type I, II or III.
Fine Aggregate	AASHTO M6 clean, natural as per Section 703, Aggregates, of the Standard Specifications / ASTM C33.
Coarse Aggregate	AASHTO M80, Class B for quality as per Section 703, Aggregates, of the Standard Specifications / ASTM C33
Water	Clean and Potable. AASHTO M157/ASTM C94
Accelerator	Fluid type, applied at nozzle, meeting requirements of AASHTO M194/ASTM C494/ASTM C1141
Water-reducer and Superplasticizer	AASHTO M194/ASTM C494 Type A,C,D,E,F, or G
Retarders	AASHTO M194/ ASTM C494 Type B or D.
Fly Ash	AASHTO M295/ASTM C618 Type F or C, cement replacement up to 35 percent by weight of cement.
Air-Entraining Agent	AASHTO M154/ASTM C260

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SECTION 641A
TUNNEL SHOTCRETE

Silica Fume	ASTM C1240, 90 percent minimum silicon dioxide solids content, not to exceed 12 percent by weight of cement.
Fiber	ASTM A820, Type 1 The aspect ratio of the steel fiber shall be between 55 and 65. The average tensile strength minimum 150,000 psi (on the wire). . Fibers shall be from 20 mm to 35 mm. Straight or continuously corrugated fibers shall not be used. If polypropylene fibers are used, they shall conform to ASTM C-1116, Section 4.1.3 and Note 3.
Curing Compounds	AASHTO M148, Type 1D or Type 2

Materials shall be delivered, stored, and handled to prevent contamination, segregation, corrosion, or damage. The Contractor shall store liquid admixtures to prevent evaporation and freezing.

641A.05 Tunnel Initial Support Shotcrete Materials. In addition to the listed material specifications; the aggregate gradation of the combined coarse and fine aggregate mixture shall conform to the following limits:

1. Maximum aggregate size: No. 67, 3/4 inch.

2. The amount of fine particles passing the number 200 sieve shall not exceed two percent by weight.

641A.06 Shotcrete Mix Design. The Contractor must receive notification from the Engineer that the proposed mix design and method of placement for Tunnel Support are acceptable before any shotcrete placement can begin.

(a) *Aggregate*. Aggregate for shotcrete shall meet the strength and durability requirements of AASHTO M6 and M80 as defined in Section 703, Aggregates.

(b) *Proportioning and Use of Admixtures*. The Contractor shall proportion the shotcrete to be pumpable with the concrete pump furnished for the work, with a water/cement ratio not greater than 0.45. Admixtures shall be approved by the Engineer. Accelerators shall be compatible with the cement used and shall not promote detrimental effects such as cracking or excessive shrinkage.

(c) *Air Entrainment.* The air content measured at the truck shall be between 7 to 10 percent when tested in accordance with AASHTO T152/ASTM C231.

(d) *Mixing and Batching*. Aggregate and cement may be batched by weight or by volume in accordance with the requirements of ASTM C94 or AASHTO M241/ASTM C685. Mixing equipment shall thoroughly blend the materials in sufficient quantity to maintain placing continuity. Ready mix shotcrete shall comply with AASHTO M157. Shotcrete shall be batched, delivered, and placed within 90 minutes of mixing. The use of retarding admixtures may extend application time beyond 90 minutes if approved by the Engineer.

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(e) *Strength Requirements.* The average compressive strength for fiber reinforced shotcrete used for initial support based on cores taken from applied shotcrete and tested in accordance with ASTM C42 shall meet the following minimum requirements:

Age	Unconfined Compressive Strength (psi)
1 hr	70
24 hrs	1,400
7 days	3,200
28 days	5,000

Plain shotcrete used for smoothing shall have an average minimum 28 day compressive strength of not less than 3,000 psi.

(f) The average compressive strength of each set of three test cores extracted from test panels or wall face must equal or exceed 85 percent of the specified compressive strength, with no individual core less than 75 percent of the specified compressive strength.

(g) *Toughness*. The average energy absorption at 7 days shall be at least 350 Joules at 40 mm deflection when tested in accordance ASTM C 1550 Standard Test Method for Flexural Toughness of Fiber-Reinforced Concrete (Using Centrally-Loaded Round Panel)". In lieu of project specific shotcrete toughness testing using the Round Determinate Panels (ASTM C1550), Contractor may submit fiber type, dosage, mix design and test results from past projects where comparable toughness levels to those specified here have been achieved, tested and successfully applied. Energy absorption test results obtained in accordance with European standard EN 14488-5 are acceptable to demonstrate achieved toughness levels of mix.

CONSTRUCTION REQUIREMENTS

641A.07 Shotcrete Pre-Construction Submittals. At least 3 weeks before the planned start of shotcrete placement, the Contractor shall submit the following information to the Engineer for review:

(a) Written documentation of nozzlemen's qualifications including proof of ACI certification.

(b) Proposed methods of shotcrete placement and of controlling and maintaining shotcrete thickness.

(c) Shotcrete mix design for each type of shotcrete, including:

1. Type of Portland cement.
2. Aggregate source and gradation.
3. Proportions of mix by weight and water-cement ratio.
4. Proposed admixtures, manufacturer, dosage, technical literature.
5. Proposed fiber dosage.

6. Previous strength and toughness test results for the proposed shotcrete mix completed within one year of the start of shotcreting may be submitted for initial verification of the required compressive strengths and toughness at start of production work.

7. Sample of fibers to be used and manufacturer's literature.

Changes or deviations in the mix design from the approved submittals must be re-submitted for approval.

641A.08 Contractor's Experience Requirements. Workers, including foremen, nozzlemen, finishers, and delivery equipment operators, shall be fully experienced to perform the work. Shotcrete foremen/supervisors shall have no less than five years experience as supervisor and/or nozzle operator.

All shotcrete nozzlemen on this project shall have experience on at least two projects in the past two years in similar shotcrete application work and shall demonstrate ability to satisfactorily place the shotcrete. Initial qualification of nozzlemen will be based either on previous ACI certification or satisfactory completion of preconstruction test panels. The requirement for nozzlemen to shoot preconstruction qualification test panels will be waived for nozzlemen who can submit documented proof they have been certified in accordance with the ACI 506.3R Guide to Certification of Shotcrete Nozzlemen. The Certification shall have been done by a recognized shotcrete testing lab and/or recognized shotcreting consultant and have covered the type of shotcrete to be used (shotcrete with or without fibers).

The Contractor shall notify the Engineer not less than 2 days prior to the shooting of preconstruction test panels to be used to qualify nozzlemen without previous ACI certification. The Contractor shall use the same shotcrete mix and equipment to make qualification test panels as those to be used for the tunnel initial support. Initial qualification of the nozzlemen will be based on a visual inspection of the shotcrete density and void structure and on achieving the specified 7-day and 28-day compressive strength requirements determined from test specimens extracted from the preconstruction test panels.

Preconstruction and production test panels, core extraction and compressive strength testing shall be conducted in accordance with ACI 506.2 and AASHTO T24/ASTM C42, unless otherwise specified herein. Nozzlemen without ACI Certification will be allowed to begin production shooting based on satisfactory completion of the preconstruction test panels and passing 7-day strength test requirements. Continued qualification will be subject to passing the 28-day strength tests.

641A.09 Pre-Construction Meeting. A shotcrete pre-construction meeting scheduled by the Engineer will be held prior to the start of construction. Attendance is mandatory. The shotcrete Contractor, if different than the tunnel Contractor, shall attend.

641A.10 General Requirements.

(a) *Shotcrete Alignment and Thickness Control***.** The Contractor shall ensure that the thickness of the Shotcrete satisfies the minimum requirements shown on the Plans using thickness control pins, laser scanning techniques, or other methods acceptable to the Engineer. The Contractor shall inspect each shotcrete layer visually and by sounding with a hammer.

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(b) *Surface Preparation.* The Contractor shall clean the excavated surfaces to be shotcreted of loose materials, mud, rebound, overspray or other foreign matter that could prevent or reduce shotcrete bond. The Contractor shall protect adjacent surfaces from overspray during shooting and avoid loosening, cracking, or shattering the ground during excavation and cleaning. The Contractor shall remove any surface material which is so loosened or damaged, to a sufficient depth to provide a base that is suitable to receive the shotcrete. The Contractor shall divert water flow and remove standing water as required to allow shotcrete placement to the indicated nominal thickness. The Contractor shall not place shotcrete on frozen surfaces.

(c) *Delivery and Application*. The Contractor shall maintain at all times a clean, dry, oil-free supply of compressed air sufficient for maintaining adequate nozzle velocity and for simultaneous operation of a blow pipe for cleaning away rebound. The equipment shall be capable of delivering the premixed material accurately, uniformly, and continuously through the delivery hose.

The Contractor shall control shotcrete application thickness, nozzle technique, air pressure, and rate of shotcrete placement to prevent sagging or sloughing of freshly applied shotcrete. The Contractor shall apply the shotcrete so that rebound will be minimal and compaction will be maximized. The Contractor shall pay special attention to encasing and blocking steel channels and steel sets. The Contractor shall not work rebound back into the construction. Hardened rebound and hardened overspray shall be removed prior to application of additional shotcrete using suitable techniques.

(d) *Defective Shotcrete*. The Engineer shall have authority to accept or reject the shotcrete work. Shotcrete which does not conform to the project specifications may be rejected either during the shotcrete application process, or on the basis of tests on the test panels or completed work. The Contractor shall repair shotcrete surface defects as soon as possible after placement and remove and replace shotcrete which exhibits segregation, honeycombing, lamination, voids, or sand pockets. In-place shotcrete determined not to meet the strength requirement will be subject to remediation as determined by the Engineer. Possible remediation options include placement of additional shotcrete thickness or removal and replacement, at the Contractor's cost.

(e) *Weather Limitations.* The Contractor shall protect the shotcrete if it must be placed when the ambient temperature is below 40°F and falling or when it is likely to be subjected to freezing temperatures before gaining sufficient strength. The Contractor shall maintain cold weather protection until the in-place compressive strength of the shotcrete is greater than 700 psi. Cold weather protection includes blankets, heating under tents, or other means acceptable to the Engineer. The temperature of the shotcrete mix, when deposited, shall be not less than 50°F or more than 95°F. The Contractor shall maintain the air in contact with shotcrete surfaces at temperatures above 32°F for a minimum of 7 days.

(f) Curing. Moist curing or curing compounds*: ASTM C 309,* apply as recommended by manufacturers.

***641A*.11 Construction Tolerances.** Shotcrete thicknesses are stated as minimum thicknesses in design drawings; thicknesses should therefore not be thinner than as stated in design drawings. The Design Line and Excavation Line are as defined in specification section 211A Underground Excavation and Initial Support.

641A.12 Safety Requirements. Nozzlemen and helpers shall, at a minimum, be equipped with gloves, eye and dust protection, and adequate protective clothing during the application of shotcrete. The Contractor is responsible for meeting all federal, state and local safety code requirements.

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641A.13 Field Quality Control. Both preconstruction test panels (for nozzlemen without previous ACI certification) and production test panels and test cores from the Tunnel are required. Qualified personnel, in the presence of the Engineer, shall perform shotcreting and coring of test panels. The Contractor shall provide equipment, materials, and personnel as necessary to obtain shotcrete cores for testing including construction of test panel boxes, field curing requirements and coring. Compressive strength testing will be performed by the Contractor and results reported to the Engineer.

Round test panels shall be sprayed as part of preconstruction submittals and production testing. Testing shall be in accordance with ASTM 1550.
Shotcrete production work may commence upon initial approval of the design mix and nozzlemen and continue if the specified strengths are obtained. The shotcrete work by a crew will be suspended if the test results for their work do not satisfy the strength requirements. The Contractor shall change all or some of the following: the mix, the crew, the equipment, or the procedures. Before resuming work, the crew must shoot additional test panels and demonstrate that the shotcrete in the panels satisfies the specified strength requirements. The cost of all work required to obtain satisfactory strength tests will be borne by the Contractor.

Test cores and test panels shall be maintained and stored in conditions similar to those experienced in the field, including temperature and humidity.

Preconstruction Test Panels. Each nozzleman without previous ACI certification shall furnish at least two preconstruction test panels for each proposed mixture being considered and for each shooting position to be encountered on the job. Preconstruction test panels shall be made prior to the commencement of production work by the nozzleman whose work is being certified for the project using the same equipment, materials, mixture proportions and procedures proposed for the job. The Contractor shall make preconstruction test panels with minimum dimensions of 3 feet x 3 feet square and at least 4 inches thick. The Contractor shall slope the sides of preconstruction and production test panels at 45 degrees over the full panel thickness to release rebound. The preconstruction test panels shall be constructed with steel fiber reinforcement and have cores extracted for compressive strength testing. At least one preconstruction test panel shall be overhead and at least one shall be vertical to simulate construction conditions. Three round panels shall also be cast for preproduction toughness testing.

The Contractor shall provide at least six 3-inch diameter core samples cut from preconstruction panels for compressive strength testing.

The Contractor has the option of extracting test specimens from test panels in the field or transporting panels to another location for extraction. Transported panels shall be kept in their forms. The Contractor shall clearly mark the panels and cores and their corresponding locations in the tunnel. The Contractor shall immediately wrap cores in wet burlap or material meeting the requirements of ASTM C171 and seal in a plastic bag and deliver cores to the Engineer or testing lab. The remainder of the panels will become the property of the Contractor. Three cores shall be tested at seven days and three cores shall be tested at 28 days for compressive strength per AASHTO T24/ASTM C42.

(a) *Production Testing*. Production testing shall take place within the first 20 linear feet of supported tunnel driven from each portal and be repeated if the mix design, equipment or placement procedures change. The samples to test shall include 3 round panels, and 6 cores from test panels, and four cores from the tunnel wall. If any test core from the tunnel wall fails to show adequate thickness, adequate bond with the rock, or have obvious defects, two additional cores shall be taken within approximately five feet of the unsatisfactory core. As for extraction, handling transport of panels and cores see above description for preconstruction panels.

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METHOD OF MEASUREMENT

641A.14 Shotcrete (Initial) for initial support including FRS applied as supplemental shotcrete will be measured by the cubic yard in-place to the indicated or required thickness completed and accepted. Measurement for payment will be based on the volume of ready-mixed concrete delivered to the site and pumped through the nozzle reduced by a rebound factor of 20% and a handling loss factor of 5%.

641A.15 Smoothing Shotcrete will be measured by the cubic yard in-place, completed and accepted as determined using the volume difference between the laser scanned surfaces obtained before and after placement of smoothing shotcrete.

Shotcrete associated with a specific rock excavation class will be measured and paid for according to the following table:

Design Excavation Class	Pay Item Class
TTP	A
TT2	B
TT2S	C
TT3	D

Shotcrete required for overbreak and other types of waste and spill factors will be measured in accordance with terms of risk pool provisions defined in Section 109.

BASIS OF PAYMENT

641A.16 The accepted quantities of Shotcrete will be paid for under the pay items listed below. Shotcrete shall include all work necessary to result in a complete installation including fiber reinforcing.

Payment will be made under:

Pay Item	Pay Unit
Shotcrete (Class A)	Cubic Yard
Shotcrete (Class B)	Cubic Yard
Shotcrete (Class C)	Cubic Yard
Shotcrete (Class D)	Cubic Yard
Shotcrete (Portal Brow) (8 Inch)	Cubic Yard
Shotcrete (Smoothing) (Geocomposite Drains)	Cubic Yard
Shotcrete (Smoothing) (Supplemental)	Cubic Yard

Payment will be full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the designated pay items.

REVISION OF SECTION 715
LIGHTING AND ELECTRICAL MATERIALS

Section 715 of the Standard Specifications is hereby revised for this project as follows:

Subsection 715.01 shall include the following:

The Contractor shall provide new material and equipment of current manufacture that is entirely suitable for the intended service and that will perform as required and specified.

Materials used in equipment manufacture shall be of the kind, composition, and physical properties best adapted to their various purposes in accordance with the best engineering practices. Tolerances, fit, and manufacturing shall conform to the best modern shop practices in the manufacture of finished products of a nature similar to those required by these Special Provisions. All like parts shall be interchangeable. The equipment shall conform to the latest applicable requirements of the relevant approved standards.

All material shall conform to industry standards set forth in publications of the NEMA, IES, ANSI, ICEA, AASHTO, and ASTM; to these Specifications, and the special requirements of the Plans and shall meet the approval of the Underwriters Laboratories Inc. (UL) and Colorado Department of Transportation Standard Specifications for Road and Bridge Construction.

All anchoring materials, mounting hangers, brackets, supports, stands, and other miscellaneous steel required for such items as conduit, boxes, miscellaneous lighting systems, wiring devices, miscellaneous electrical equipment, grounding, power outlets, relay and distribution panels, lighting fixtures, and all other similar equipment shall be furnished and installed by the Contractor.

Subsection 715.04 shall include the following:

(f) *Tunnel Luminaires*. Tunnel luminaires shall be a complete pre-wired lighting device specifically manufactured for the purpose of tunnel lighting. A luminaire unit shall consist of housing, lens, reflector, ballast, lamp holder, and all necessary internal wiring. Luminaires shall be adaptable to the type of power distribution system to be used.

In Subsection 715.06, second paragraph, delete the first and second sentences and replace with the following:

Plastic conduit shall be a semi-rigid type currently recommended and approved by Underwriters Laboratories, Inc. for the proposed use. Galvanized rigid conduit may be substituted for underground plastic conduit and shall conform to the requirements of ASTM F 441 Schedule 80. PVC materials shall not be used in the tunnels or when exposed above ground.

In Subsection 715.06, delete the third and fourth paragraphs and replace with the following:

Materials for junction boxes shall be as described in the Revision of Section 613, Electrical Conduit and Wiring.

Materials for pull boxes shall be as described in the Revision of Section 613, Pull Boxes and sizes shall be as shown in the Plans.

Subsection 715.06 shall include the following:

1. Quality Assurance: All conduit and fittings shall be UL approved.

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REVISION OF SECTION 715
LIGHTING AND ELECTRICAL MATERIALS

2. Conduit Bodies: Conduit bodies shall be constructed of a gray iron alloy with physical properties similar to ASTM-A48 Class 30A (30,000 psi tensile). The manufacturer shall durably and legibly mark mogul type conduit bodies with their cubic-inch capacity as referenced in NEC article 370

Subsection 715.08 shall include the following:

Tunnel Facility Wiring for circuits under 600 volts shall meet the following requirements:

1. Description: NFPA 70 non-jacketed Type RHH/RHW

2. Compliance: Underwriters Laboratories, Inc. Standard 44 (UL 44)

3. Conductor: Stranded copper conductor, single insulated wire.

4. Insulation: EPR

5. Insulation Voltage Rating: 600 volts

6. Insulation Temperature Rating: 90 degrees C wet or dry.

7. Color Coding: Solid permanent colors as specified in Revision of Section 613, Electrical Conduit and Wiring.

FORCE ACCOUNT ITEMS

DESCRIPTION

This special provision contains the Department's estimate for force account items included in the Contract. The estimated amounts marked with an asterisk will be added to the total bid to determine the amount of the performance and payment bonds. Force Account work shall be performed as directed by the Engineer.

BASIS OF PAYMENT

Payment will be made in accordance with subsection 109.04. Payment will constitute full compensation for all work necessary to complete the item.

Force account work valued at $5,000 or less, that must be performed by a licensed journeyman in order to comply with federal, state, or local codes, may be paid for after receipt of an itemized statement endorsed by the Contractor.

Force Account Item	Estimated Quantity	Amount
F/A Minor Contract Revisions	F.A.	$1,600,000
F/A Partnering	F.A.	$5,000
F/A Asphalt Pavement Incentive	F.A.	$50,000
F/A Fuel Cost Adjustment	F.A.	$90,000
F/A Asphalt Cement Cost Adjustment	F.A.	$150,000
F/A On-The-Job-Trainee	F.A.	$15,360
F/A Roadway Smoothness Incentive	F.A.	$45,000
F/A Concrete Pavement Incentive	F.A.	$10,000
F/A OCIP Enrollment and Reporting and Accuracy	F.A.	$20,000
F/A OCIP Safety Compliance and Loss Reporting	F.A.	$20,000
F/A Obtain Power from XCEL Energy	F.A.	$10,000
F/A Relocation of Utilities	F.A	$475,000
F/A Environmental Health and Safety Management	F.A.	$50,000
F/A Shared Risk Contingency Pool	F.A.	$1,100,000
F/A Incentive	F.A.	$300,000
F/A Hotel Vouchers	F.A	$5,000
F/A Interim Surface Repair	F.A.	$10,000

F/A Minor Contract Revisions - This work consists of minor work authorized and approved by the Engineer, which is not included in the contract drawings or specifications, and is necessary to accomplish the scope of work of this contract.

F/A Partnering - This force account is to account for costs associated with the partnering process for CMGC processes during construction activities.

F/A Asphalt Pavement Incentive – Roadway Smoothness Incentive payment will be made in accordance with Standard Special Provisions Revision of Section 105 – Hot Mix Asphalt Pavement Smoothness.

F/A Fuel Cost Adjustment - This force account is to pay for contract price adjustments to reflect increases or decreases in the prices of gasoline, diesel and other fuels from those in effect during the month in which bids were received for the Contract if the Contractor has specified on the Form 85 that the price adjustment will apply to the Contract.

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FORCE ACCOUNT ITEMS

F/A Asphalt Cement Cost Adjustment - Asphalt Cement Cost Adjustment will be made in accordance with Revision of Section 109 – Asphalt Cement Cost Adjustment (Asphalt Cement Included in the Work).

F/A On-the-Job Trainee - This force account is to cover the cost of the OJT Training hours.

F/A Roadway Smoothness Incentive - The Roadway Smoothness Incentive will be made in accordance with Standard Special Provisions Revision of Section 105 – Hot Mix Asphalt Pavement Smoothness.

F/A Concrete Pavement Incentive – The Concrete Pavement Incentive payment will be made in accordance with Standard Special Provisions Revision of Section 105 – Portland Cement Concrete Pavement Smoothness.

F/A OCIP Enrollment, Reporting, and Accuracy – This force account covers the incentive for the OCIP require enrollment and reporting for the Contractor and all subcontractors. It also has incentive for accurate reporting.

F/A OCIP Safety Compliance and Loss Reporting – This force account covers the incentive for the OCIP for Safety Compliance and Accurate and Timely Loss Reporting.

F/A Obtain Power from XCEL – This force account covers the cost of obtaining power source connections by XCEL Energy for electrical systems on this project.

F/A Relocation of Utilities – This force account covers the relocation of utilities that is going to be executed by XCEL and paid for by CDOT.

F/A Environmental Health and Safety Management – This force account covers the incentive for developing and implementation of early stage hazardous waste disposal plans. This is a mitigation requirement through the I-70 Twin Tunnels Widening FONSI and I-70 Twin Tunnels Widening Materials Management Plan.

F/A Shared Risk Contingency Pool – This force account covers the shared risk contingency items as defined in special project provision Revision of Section 109 CMGC Force Accounts and the Twin Tunnels 1A and 1B Combined Risk Register.

F/A Hotel Vouchers – This force account covers hotel vouchers for residents in and near the Twin Tunnels Widening project site to be issued at the direction of the Engineer and CDOT Region 1 ROW.

F/A Incentive – This force account covers the $300,000 incentive based on the Commencement and Completion specification.

F/A Interim Surface Repair – This force account covers the surface repairs needed on detour asphalt and any milled surfaces as needed throughout the project.

SPECIAL CONSTRUCTION REQUIREMENTS

1. The Contractor shall submit a plan to contain debris from all wall construction and excavation operations as approved by the Engineer. The plan will specifically identify how the traveling public will be protected and how the protection for fallen debris will be accomplished. Plan shall be submitted to the Engineer at least 5 working days prior to work on the excavation or walls begins.

2. The Contractor shall submit a plan to maintain drainage during construction as approved by the Engineer. Special attention to drainage during milling operation when only driving lanes are milled shall be addressed. Maintaining drainage will not be paid for separately, but shall be included in the cost of the work.

3. Extra equipment, labor, and materials may be required for the Contractor to meet the schedule and will not be paid for separately.

4. The Contractors personnel on the construction site shall wear personal protective equipment (including hard hats and safety vests) at all times.

5. The field office shall remain in place 30 calendar days after final acceptance or as approved by the Engineer in writing.

6. The Contractor shall attend a Pre-Construction and Environmental Pre-Construction meeting prior to starting any work on the project.

7. The Field Office and Field Lab shall be fully operational prior to any work starting on the project.

8. All BMPs for this Construction Package 2 shall be in place prior to any work starting on the project.

9. All costs associated with the foregoing requirements will not be paid for separately, but shall be include in the cost of the work.

10. The Contactor shall address commitments in the Materials Management Plan for the I-70 Twin Tunnels Widening project.

11. The Contractor shall follow and implement all environmental commitments from the June 2012 Twin Tunnels Environmental Assessment, the October 2012 Twin Tunnels FONSI, and help CDOT provide mitigation tracking throughout the construction phase.

12. The Contractor shall perform the following Inspection Scheduling and Quality Control Responsibilities:

Inspection Scheduling

The Contractor shall perform the following:

1) A daily proposed work schedule shall be developed by the contractor and his sub-contractors which shall communicate all work being performed on the project.
2) The game plan shall be written onto dry erase boards in a field facility easily accessible to all project personnel during construction.
3) The dry erase boards shall be divided into the following columns:
4) Location and Brief Description of Work
5) Tests and Inspections Required and Time of Inspection or Test (Night work is also detailed here)
6) Look Ahead Information

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SPECIAL CONSTRUCTION REQUIREMENTS

7) All work for the next day and the following night shall be entered into the board by 1:00PM each day.
8) Weekend or Holiday work is required shall be entered into the board by Thursday by 1:00PM.
9) The items on the board shall be entered into a spreadsheet and sent to a standing email list every afternoon by 3:30PM. Work assignments for owner construction management staff shall be made by the Engineer based on this spreadsheet.
10) Every attempt shall be made to accommodate work which appears on the schedule and occurs close to the scheduled time. Work which does not appear on the spreadsheet or is significantly delayed shall be rescheduled.

Contractor's Quality Control Responsibilities

The Contractor shall perform a Quality Control inspection before the owner's Quality Assurance inspection. The Contractor's quality control inspection results shall be documented on a signed Inspection Request Form which shall be given to the owner's inspector before the quality assurance inspection may begin.

The owner's inspector may place a green tag on the work if it is found to be acceptable and a red tag if there are issues which must be addressed before subsequent work can be performed (eg. concrete placement). The Contractor shall reschedule any Red Tagged work for a follow-up inspection once it has been complete.

TRAFFIC CONTROL PLAN - GENERAL

The key elements of the Contractor's method of handling traffic (MHT) are outlined in subsection 630.10.

The components of the TCP for this project are included in the following:

(1) Subsection 104.04 and Section 630 of the specifications.
(2) Standard Plan S-630-1, Traffic Controls for Highway Construction and Standard Plan S-630-2.
(3) Schedule of Construction Traffic Control Devices.
(4) Signing Plans.
(5) Detour Details.
(6) Manual on Uniform Traffic Control Devices (MUTCD).

Special Traffic Control Plan requirements for this project are as follows:

At least one week prior to starting construction, the Contractor shall notify the CDOT Engineer of the date the Contractor intends to start construction.

Temporary striping shall be in full compliance at the completion of each working day.

Lane Closure and traffic crossovers shall conform to the I-70 Project Specific Lane Closure Strategy.

Traffic shall be returned to normal operation, on a paved surface at the completion of each day's work unless otherwise approved.

Prior to starting construction, the Contractor shall notify the Region 1 Traffic Engineer and Clear Creek County Road and Bridge of the date the Contractor intends to start construction.

The Contractor shall coordinate all operations requiring traffic control with scheduled Holidays and special events. No work requiring traffic control will be allowed for the following events unless directed by the Engineer.

1. Monday May 27th, 2013 – Memorial Day
2. Thursday July 4th, 2013 – Independence Day
3. Monday September 2nd, 2013- Labor Day
4. Monday October 14th, 2013 – Columbus Day
5. Monday November 11th, 2013 – Veteran's Day
6. Thursday November 21st, 2013 – Thanksgiving Day
7. Wednesday December 25th, 2013 – Christmas Day
8. Wednesday January 1st, 2014 – New Year's Day
9. Monday January 20th, 2014 – Martin Luther King Day
10. Monday February 17th, 2014 – President's Day
11. Monday May 26th, 2014 – Memorial Day

There may be other events as directed by the Engineer. These events are in addition to the ones listed.

A pathway will be kept clear of dirt, gravel, and other construction debris for pedestrian and bicycle traffic. If any closures are required, contractor shall provide a courtesy vehicle to transport bicyclists through the project construction zone.

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TRAFFIC CONTROL PLAN - GENERAL

Unauthorized delays or traffic interruptions resulting from Work not in accordance with the I-70 Twin Tunnels Lane Closure Strategy will be considered a violation of this provision and shall be subject to price reductions as described in Revision of Section 105 – Violation of Working Time Limitation.
The Contractor shall provide all construction vehicles with flashing amber lights.

The Contractor shall submit construction sequencing, traffic sequencing proposal, and methods of construction to the Engineer for approval.

All traffic operations, detours, and associated MHTs shall be submitted to the Engineer for review and approval. The Contractor shall schedule and coordinate all traffic closures and MHTs at least seven days prior to the closure or MHT taking effect.

The Contractor shall not have construction equipment or materials in the lanes open to traffic at any time.

The Contractor shall organize the work such that there will be no hazards within the Clear Zone at the completion of each day's work.

Employee vehicle parking is prohibited where it conflicts with safety, access or flow of traffic. No employee parking will be allowed within the clear zone. The Contractor and the Engineer, prior to starting work, shall locate parking areas to be approved by the Engineer.

The crossover detour shall be restored back to normal I-70 operations at the completion of each working day. Traffic shall be returned to normal operation, on a paved surface at the completion of each day’s work unless otherwise approved.

The Contractor and the Engineer, prior to starting work, shall locate staging areas to be approved by the Engineer.

Unless otherwise included in the plans, or as directed by the Engineer, the Contractor shall maintain access to ingress and egress to all local roads and driveways. Special consideration should be given to bicycle traffic. A MHT shall be required for handling bicycle traffic and shall be submitted to the Engineer for approval.

Any signs damaged due to the Contractor’s operations shall be replaced in-kind or repaired by the Contractor at no expense to the project.

Sufficient Traffic Control Devices are included in the plans to cover expected construction activities. Should the Contractor elect to utilize additional devices to enhance the operation, the additional devices will not be paid for but shall be provided at the Contractor's expense, unless otherwise approved for payment by the Engineer and shall be paid for at the unit prices approved in the GMP.

The Contractor shall contract directly or through a subcontractor with Idaho Springs Police Department, Colorado State Patrol (CSP), and Clear Creek County Sheriff agencies for Uniformed Traffic Control (UTC). Uniformed Traffic Control (UTC) shall be coordinated as follows:

(a) Contractor shall coordinate with Officer Wolf with Idaho Springs Police Department (ISPD) to schedule all UTC hours for all agencies.
(b) Contractor shall first contract UTC with Idaho Springs Police Department within the city limits of Idaho Springs.
(c) Contractor shall contract with Colorado State Patrol outside of Idaho Springs including when UTC is required on Floyd Hill.

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TRAFFIC CONTROL PLAN - GENERAL

(d) Contractor shall contract with Clear Creek County Sheriff with UTC is required for closures at the US 6/I-70 Interchange.
(e) Contractor shall coordinate with Officer Wolf with Idaho Springs Police to fill in any UTC hours that cannot be filled if responsible agencies cannot perform. Additional CSP participation, if needed, shall be coordinated through Officer Wolf with ISPD and Captain Prater with CSP.
(f) Contractor shall coordinate UTC so that each agency is responsible for incident response in the project areas where they are assigned for UTC.

During I-70 closure operations the Interstate may be closed no longer than 30 minutes. All traffic shall be cleared before any other operation that interferes with traffic will be permitted. Violation of these closure limitations shall be subject to all provisions set forth in the Revision of Subsection 105.03 of the Standard Special Provisions.

UTILITIES

The following table includes contacts within CDOT that can assist in locating CDOT owned facilities. Please note CDOT is now affiliated with UNCC. For additional assistance, call 303-365-7312.

CDOT Fiber Optic facilities are located by Comcast Cable.

UTILITY OWNER / ADDRESS	CONTACT / EMAIL	PHONE / FAX
CDOT Electric – Region 1 18500 E. Colfax Ave. Aurora, CO 80011	Jim Chase jim.chase@state.co.us	303-365-7312 – Office 303-303-981-0922 – Cell CDOT Locates:303-365-7312
CDOT Utilities – Region 1 18500 E. Colfax Ave. Aurora, CO 80011	Dave Ruble, Region Utility Engineer dave.ruble@state.co.us Tracy Vance, Asst, Utility Engineer tracy.vance@state.co.us Dave Campbell, Utility Inspector david.campbell@state.co.us	303-365-7310 303-365-7309 303-365-7304
CDOT ITS (FIBER) 425 C Corporate Circle Room 109 Golden, CO 80401	Jill Scott Jill.Scott@state.co.us	303-512-5878 – Office
CDOT Traffic Signals Mountain Areas Only 219 County Road 1003 Frisco, CO 80443	Steve Smith steve.smith@state.co.us	970-668-0253 Office 970-485-0136 Cell 970-668-0276 Fax
Xcel Energy (East of Eisenhower) 4019 Evergreen Pkwy., P.O. Box 640, Evergreen, CO 80437	Jonnye Worrell jonnye.worrell@Xcelenergy.com	303-445-4504 – Office 303-957-7152 – Cell 303-445-4572 – Fax
Century Link 1855 S. Flatirons Ct., Boulder, CO 80301	Dan Lewis Dan.Lewis@centurylink.com	303-441-7142 Business 303-441-6021 Cell 720-291-0703 Business Fax
Comcast Cable 6793 W. Canyon Ave., #13-C, Littleton, CO 80128	Scott Moore Scott_moore@cable.comcast.com	303-603-2970 Business 720-413-0171 Cell
City of Idaho Springs (Water & Sanitation) Public Works	John Bordoni pw@idahospringsco.com	303-567-2400 Business

The Contractor shall coordinate with the CDOT Project Engineer and any appropriate utility company to facilitate the installation, placement and relocation of all utilities impacted on this project.

The work described in these plans and specifications requires full cooperation between the Contractor and the utility owners in accordance with Subsection 105.11 in conducting their respective operations, so the utility work can be completed with minimum delay to all parties concerned. Also, in accordance with the plans and specifications, and as directed by the Engineer, the Contractor shall keep each utility owner advised of any work being done to its facility, so that each utility owner can coordinate its inspections for final acceptance of the work with the Engineer.

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UTILITIES

The Contractor shall coordinate the work with the owners of the utilities impacted by the work. Coordination with utility owners includes, but is not limited to, staking construction features, providing and periodically updating an accurate construction schedule which includes all utility work elements, providing written notification of upcoming required utility work elements as the construction schedule indicates, allowing the expected number of working days for utilities to complete necessary relocation work, conducting necessary utility coordination meetings, and all other necessary accommodations as directed by the Project Engineer. Surveying and/or staking of utility relocations to be performed by the owner shall be the responsibility of the utility owner.

Prior to excavating or performing any earthwork operations, the Contractor shall positively locate all potential conflicts with existing underground utilities and proposed construction, as determined by the Contractor according to proposed methods and schedule of construction. The Contractor shall modify construction plans to avoid existing underground facilities as needed, and as approved by the Engineer.

The CDOT Contractor shall provide traffic control for any utility work expected to be coordinated with construction, as directed by the CDOT Engineer.

All costs incidental to the foregoing requirements will not be paid for separately but shall be included in the work.

THE WORK LISTED BELOW SHALL BE PERFORMED BY THE CONTRACTOR:

NOTE: The Contractor shall provide written notice to each utility owner, with a copy to the Engineer, immediately prior to each utility work element expected to be coordinated with construction. The number of days of prior notice is noted for each owner.

Contractor coordination with Xcel Energy

Coordinate the relocation of the overhead power lines and poles and any affected segment of underground or aerial electric cable for this project. Confirm the existing locations for all overhead and buried electrical lines along the limits of this project and coordinate the relocation of any overhead or buried power lines that conflict with the construction of this project. Coordinate the installation of temporary power for this project. All work will be done by Xcel Energy forces. Use caution when working around these lines.

CDOT Contractor shall provide the utility owner written notice 30 days immediately prior to each utility work element expected to be coordinated with construction.

Contractor coordination with Century Link

Field locate any buried or aerial telephone lines or fiber optic lines, pedestals, manholes, splice boxes, markers and risers that are within the project limits. Coordinate any associated telephone risers, telephone lines, splice boxes, markers and pedestal adjustments with Century Link. A Century Link line is attached to Xcel's power poles that are running along the Game Check area. This line will be reset in conjunction with Xcel's relocation. Any power pole relocation will need to be coordinated with Century Link. Relocations will be completed by Century Link. Use caution when working around these lines and utility features

CDOT Contractor shall provide the utility owner written notice 30 days immediately prior to each utility work element expected to be coordinated with construction.

Contractor coordination with Comcast Cable

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UTILITIES

Field locate any overhead or buried cable TV line. A Comcast cable line is attached to Xcel's power poles in various areas. Any power pole relocation will need to be coordinated with Comcast. Comcast will accomplish all utility relocations of their facilities.

The CDOT Contractor shall provide the utility owner written notice 30 days immediately prior to each utility work element expected to be coordinated with construction.

THE WORK LISTED BELOW WILL BE COMPLETED BY THE UTILITY COMPANIES OR THEIR AGENTS:

Although the CDOT Contractor shall provide traffic control for utility work expected to be coordinated with construction, traffic control for utility work outside of typical project work hours will not be permitted unless it is directed by the Engineer.

Xcel Energy

Xcel will accomplish all electrical line relocations. Xcel will provide temporary power for the Contractor's use and they will provide permanent power installations for this project. This work is expected to take 30 working days to complete and shall be coordinated with the construction of this project.

Century Link

Century Link will relocate all buried cables, aerial cables/poles and fiber optic lines that conflict with the construction of this project. Century Link is sharing the overhead utility poles with Xcel. Century Link needs to be notified immediately if there is a conflict with the construction of this project. Century link must give its' customers 90 days of advanced notified prior to splicing fiber optics. All of the relocation work shall be coordinated with the construction of this project.

Comcast Cable

Comcast has an aerial utility line attached to the Xcel Energy's poles. Comcast will relocate their facilities along with Xcel Energy's relocation. Comcast will need to notify their customers 30 days prior to interrupting their customers' service.

The Contractor shall comply with Article 1.5 of Title 9, CRS ("Excavation Requirements") when excavating or grading is planned in the area of underground utility facilities. The Contractor shall notify all affected utilities at least two (2) business days, not including the actual day of notice, prior to commencing such operations. The Contractor shall contact the Utility Notification Center of Colorado (UNCC) at 811, to have locations of UNCC registered lines marked by member companies. All other underground facilities shall be located by contacting the respective owner. Please note that UNCC marks only its member's facilities – Other facilities, such as ditches and drainage pipes may exist, and it is the Contractor's responsibility to investigate, locate and avoid such facilities. Utility service laterals shall also be located prior to beginning excavation or grading.